



Sulfate content in some water systems within Erbil City/KRG by using turbidimetric and titrimetric methods

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Abstract

This study was conducted on two water bodies; three sites were selected on Erbil wastewater channel and four sites on Greater Zab river. Water samples were collected at regular monthly interval periods beginning at July 2012 to April 2013. Sulfate concentration was determined by EDTA titrimetric and barium sulfate procedures in order to compare the results obtained by both methods. The mean values of sulfate concentration in Greater Zab river was 74.98 and 1205.9 mg.l⁻¹ for EDTA titrimetric and barium sulfate methods respectively, while for Erbil wastewater channel samples sulfate concentration mean values was 109.46 and 1240.5 mg.l⁻¹ for EDTA titrimetric and barium sulfate methods respectively. As a mean values sulfate concentration is ten times more by barium sulfate method than other method. From standard error values it appears that EDTA titrimetric method is more accurate and suitable for sulfate determination than other method which is quick, simple and easy.

Introduction

Sulfate is an abundant ion in the earth's crust and its concentration in water can range from a few milligrams in natural unaffected waters to several thousand milligrams per liter in water in contact with certain geological formation. Industrial wastes and mine drainage may contain high concentrations of sulfate. Sulfate also results from the breakdown of sulphur-containing organic compounds [1]. Water enriched with sulfate may causes deterioration to water quality for different purposes such as drinking, irrigation, etc. One of the main purposes of laboratories for determination method of ions, it should be quick, high accurate and cheap. Most laboratories determine sulfate by barium sulfate turbidity and EDTA titrimetric method. The principle of titrimetric method is that barium ions in water are titrated as hardness in the EDTA hardness determination. Sulfate can therefore be indirectly determined on the basis of the difference in hardness of the sample before and after the addition of barium ions in excess of that required for sulfate precipitation [2]. Barium sulfate turbidimetric method appears to be used almost universally. The turbidity is measured at 420nm. The accuracy and precision therefore depend critically on the crystalline form and size distribution of the light- scattering particles in the suspension [3] and [4]. The purposes of this study are to compare between two methods of sulfate determination (barium sulfate turbidity and titrimetric method).

Materials and Methods

Water samples were collected from the surface from seven monitoring sites at regular monthly intervals from July 2012 to April 2013. Three sites were chosen along Erbil wastewater channel: Arab-Kand village (site 1); Abassyia village (site 2), and Hawera village (site 3), and four sites selected in distal part of Greater Zab River : Kargosek village (site 4), Khabat (site 5), Geatel village (site 6) and Unkown (site 7) (Figure: 1).

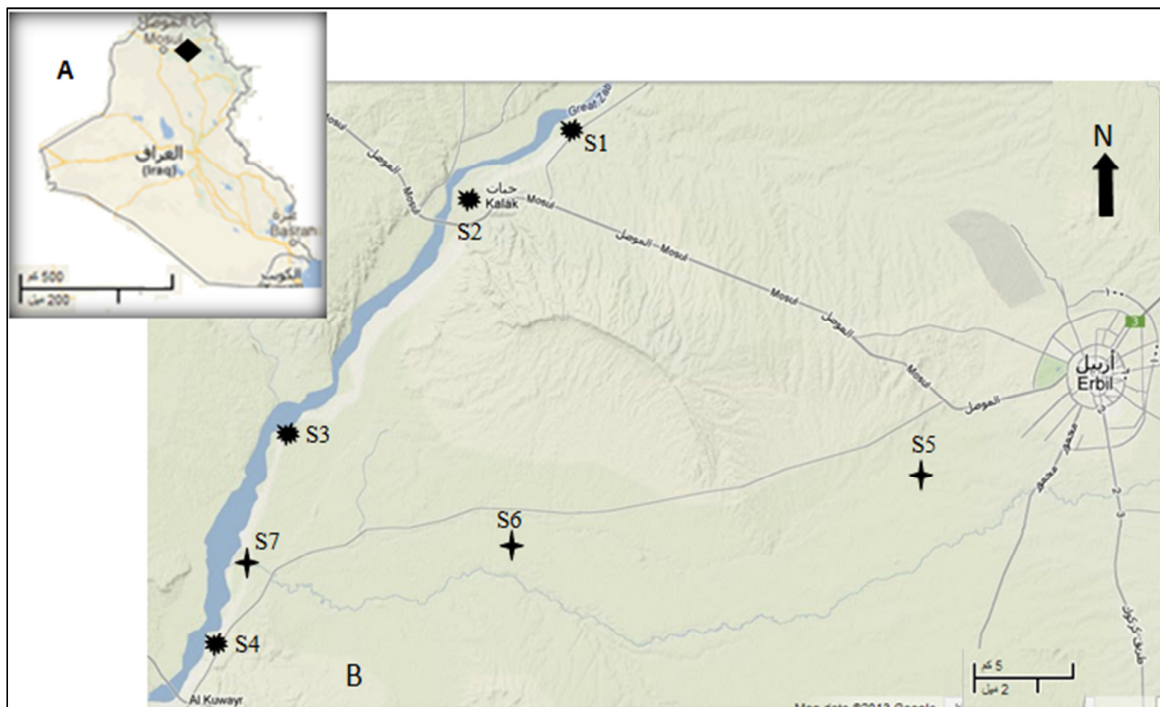


Figure- 1: (a) Map of Iraq, (b) location of sampling sites on Greater Zab River and Erbil wastewater channel.

Erbil sewer system is constructed for storm water and in most cases domestic sewers are connected illegally with storm sewer, so Erbil sewer system is regarded as combined sewer system of storm and sanitary sewage. It extended for nearly 40Km south west of Erbil city to rural region till it discharged into Greater Zab river. The quantity of sewage discharge differs from time to other, as a mean, it may reach 77760 m³.day⁻¹ during dry season and 108000 m³.day⁻¹ during rainfall season. Only at Arab-Kand area more than 350 farmer families irrigate about 600-700 donums for agriculture (vegetable products) by untreated wastewater [5].

The Greater Zab River are the most prominent Tigris river tributaries that contribute the largest flow volume to the Tigris River. The Greater Zab supplies the Tigris River with an average annual flow volume of 12.7 billion cubic meter (measured at Eski Kalak). During their flows providing water supply for irrigation, drinking, fishing, recreation, and waste disposal for several settlement along its course [6].

Sulfate ion (SO₄²⁻) is determined as a precipitated in an acetic acid medium with barium chloride (BaCl₂) so as to form barium sulfate (BaSO₄) crystals of uniform size. Light absorbance of the BaSO₄ suspension is measured by a spectrophotometer at 420nm and the SO₄²⁻ concentration is determined by comparison of the reading with a standard curve as mentioned by [7]. The second method of sulfate determination was using

titrimetric methods using EDTA and barium chloride solution as mentioned by [2]. Simple correlation (r) and descriptive statistics were used to determine the differences between both studied methods [8].

Results and Discussion

The sulfate (SO₄) minimum and maximum values of water samples for Greater Zab river 52.7- 111.86 mg.l⁻¹ and 840- 2000 mg.l⁻¹ by EDTA titrimetric and barium sulfate procedure respectively with differences range values of 59.1 and 1160 for both methods. As mean value sulfate content was 74.98mg.l⁻¹ by EDTA titrimetric method compared to 1205.9 mg.l⁻¹ for turbidimetric method (*Table: 1*). The titrimetric method appears to be more accurate according to standard error (SE) value 2.35 mg.l⁻¹ for first method and 45.93 for turbidimetric method. Lak (2007) [9] obtained same values for sulfate content in the same area 74- 100 mg.l⁻¹ determined by EDTA titrimetric method. The results in (figure 2) showed that there isn't correlation (r =0.123) between both sulfate determination methods for Greater Zab river. On the other hand, sulfate determination for polluted water minimum and maximum value was 64.5- 82.3 mg.l⁻¹ and 800- 2200 mg.l⁻¹ for EDTA titrimetric and barium sulfate methods respectively (*Table: 2*).

Table- 1: Determination of sulfate by titrimetric and turbidimetric methods for water samples of Greater Zab River.

	Months	Titrant method ppm				Turbidity method ppm			
		Zab river	After Disch.	Kapran	Guwer	Zab river	After Disch.	Kapran	Guwer
2012	August	91.31	57.90	55.58	65.43	1070	1070	870	975
	September	82.08	75.12	66.74	70.16	1470	1620	1250	1150
	October	65.08	71.06	55.59	57.01	1320	1650	1220	1290
	November	67.50	105.49	67.01	85.37	1400	1410	1200	1210
	December	78.38	81.11	89.76	84.56	875	2000	1150	1250
2013	January	111.86	59.18	92.4	90	1200	1800	1400	1400
	February	88.67	82.36	71.61	82.79	840	1300	880	890
	March	68.33	78.41	80.54	77.11	1000	1375	900	1000
	April	52.75	61.59	59.23	70.24	1000	1050	950	980
	Mean		74.98				1205.97		
	Minimum		52.74				840		
	Maximum		111.86				2000		
	Range		59.11				1160		
	Standard Error		2.35				45.93		
	Correlation (r)				0.123				

The mean values is ten times more by turbidimetric method (1240.5 mg.l⁻¹) compared to (195.4 mg.l⁻¹) by EDTA titrimetric method. These results come accordance to results of [9] in the same polluted channel which reported the sulfate concentration ranged from 116.7- 296 mg.l⁻¹ determined by EDTA titrimetric method. The standard error value for titrimetric and turbidimetric procedures was 2.78 and 64.17 respectively, which shows accuracy of titrant method than turbidimetric method. There is no correlation between both procedures (r =0.016) as shown in (*Figure: 3*).

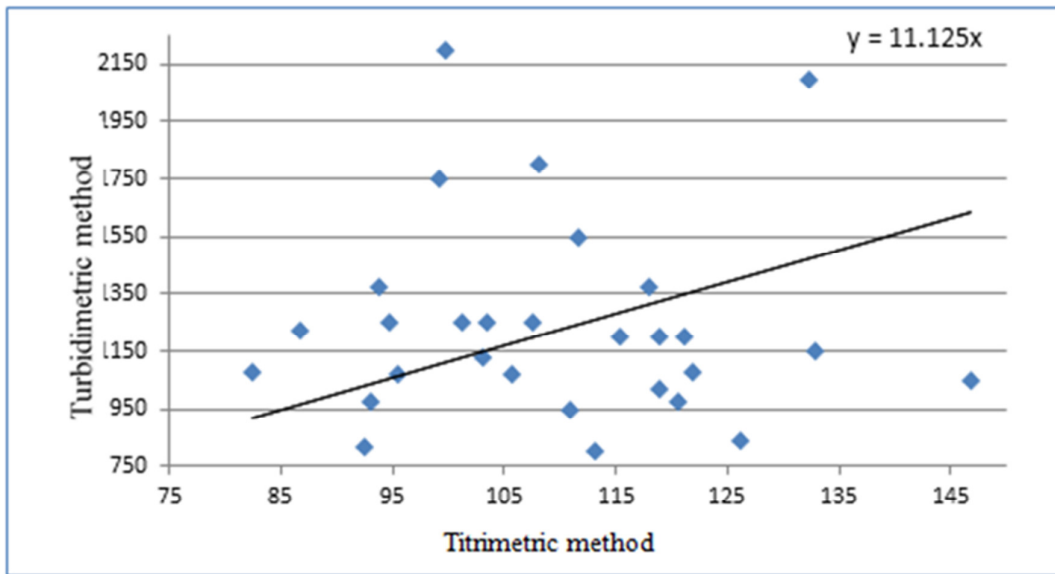


Figure- 2: The relationship between Turbidity metric and titrimetric methods of sulfate determination water samples of Greater Zab River.

Table- 2: Determination of sulfate by titrimetric and turbidimetric methods for water samples of Erbil wastewater channel.

Months	Titrant method ppm			Turbidity method ppm			
	Tooraq	Qadria	Gameshtapa	Tooraq	Qadria	Gameshtapa	
2012	July	121.86	110.80	120.65	1075	950	975
	August	105.58	82.36	107.47	1070	1080	1250
	September	146.82	118.94	115.34	1050	1020	1200
	October	95.36	132.79	126.07	1070	1150	840
	November	92.4	113.16	103.44	820	800	1250
	December	117.92	103.06	132.25	1375	1125	2100
2013	January	121.10	101.14	99.76	1200	1250	2200
	February	107.1	118.84	111.67	975	1200	1550
	March	93.11	93.76	108.12	975	1375	1800
	April	94.77	86.61	99.2	1250	1225	1750
	Mean		109.46			1240.52	
	Minimum		82.35			800	
Maximum		146.81			2200		
Range		64.45			1400		
Standard Error		2.78			64.17		
Correlation (r)			0.016				

Generally, the obtained SO_4 values determined by EDTA titrant method in Greater Zab river fall within safe limit for human consumption according to WHO (2011) [10] and drinking water quality standard of Iraq (1986) [11]. While it exceeding permissible range for drinking purposes according to [10] and drinking water quality standard of Iraq [11] and irrigation purposes according to [12] depending on turbidimetric method for both water ecosystems. Lower ranges were observed by [6] in the same polluted channel which recorded maximum concentration 1309 mg.l^{-1} .

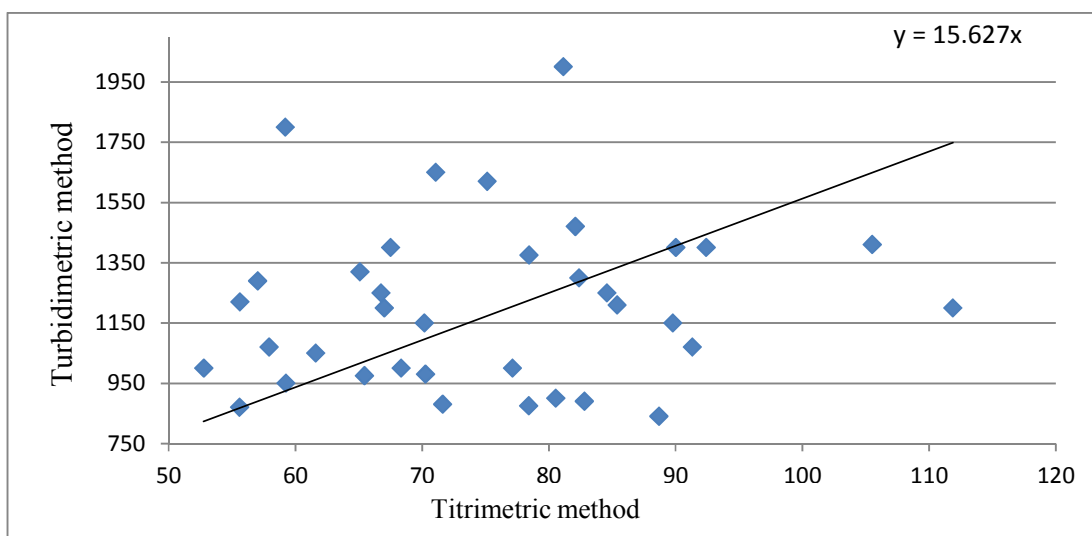


Figure- 3: The relationship between Turbidity metric and titrimetric methods of sulfate determination water samples of Erbil wastewater channel.

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