EurAsian Journal of BioSciences
Eurasia J Biosci 14, 4409-4414 (2020)

Pollution treatments of Tigris River through the chemical and physical characterization in Waset Governorate

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Abstract

Four stations at twelve sites were selected on Tigris river from Aziziah to the center of Kut city, for a distance more than 90 km. The sites were in a cross -section from both river sides and in the middle. The physical and chemical characterization were studied over the period from June 20l6 to May 2017. Air and water temperatures were varied (11-49) ºC and (12-34) ºC respectively. Salinity values were (0.410 -0.726) PPT. pH values, conductivity, total dissolved salts and Sulphate were (6.7-8.3), (670 - 1170), (330 -590) and (116.5-242) respectively. Water turbidity was (5.12) and (53) NTU at stations 2 and 1 respectively. Dissolved Oxygen values were low during Summer and high for the other months of the year. BOD values were high during summer.

Total hardness was (650-1190) mg/L. Nutritive values of phosphate was low in March for all stations, while values of Nitrite and Silica were low in June compared with other months. Total alkalinity and chloride were (l14-162) and (74.5-144.9) mg/L respectively.

Results discussion based on the changes of the four stations and the effect of the river sites on the river water. The stations represent the city centres were the river pass through, depending on the population nature and agricultural area and their effect on the water quality and usages.

Keywords: Tigris river, physical and chemical characterization, population nature effect

Abdul-Jabbar RA (2020) Pollution treatments of Tigris River through the chemical and physical characterization in Waset Governorate. Eurasia J Biosci 14: 4409-4414.

INTRODUCTION

One of the most important freshwater sources are the rivers. River's water flow in one direction, and is important environmental store for nutrients and organisms, and is also with significant differences in chemical, physical and biological characterization, as well as its water level (Kagalou et al. 2002 & Saleh Omar Korbag et al., 2020).

Tigris river has length of 1817 km and is one of the two main rivers in Iraq. It is affected by many factors as rainfall rate duration, dams, therefore, its subjected to many fluctuations (Al-Khalidi, 2004).

Water qualities varies greatly with the addition of industrial, domestic activities and agricultural area surrounds the rivers. These pollutants make it unsuitable for drinking and for other uses. Types of aquatic species may give a good reflection about the quality and degree of water pollution (Xu et al., 2014).

The aim of the study was to determine some of the Tigris river physical and chemical characterization for the distance between Aziziah and the city of Kut for a distance of about 90 km.

MATERIALS AND METHODS

Tigris river is one of the main two rivers in Irag. Tigris river originate from Turkey and cross the longitudinal axis of Iraq from the north to the south. Tigris river is characterized by that it is meandering (Sissakian et al., 2018). Four stations each at three sites (i.e, on both sides and the third site in the middle) were selected for sample collection. **Fig. 1** shows the sampling stations**.**

Water samples were collected over the period from June 2016 to May 2017. The factors were estimated according to the methods according to mentioned references (**Table 1**).

RESULTS AND DISCUSSION

Air and water temperature

Temperature is an important factor for the water quality and affect the dissolved of oxygen (Manhan, 2004). Seasonal changes in air temperature was clear in that, the lowest recorded value was 11ºC at December and February at station 1, while the highest recorded

Received: January 2020
Accepted: March 2020
Printed: October 2020

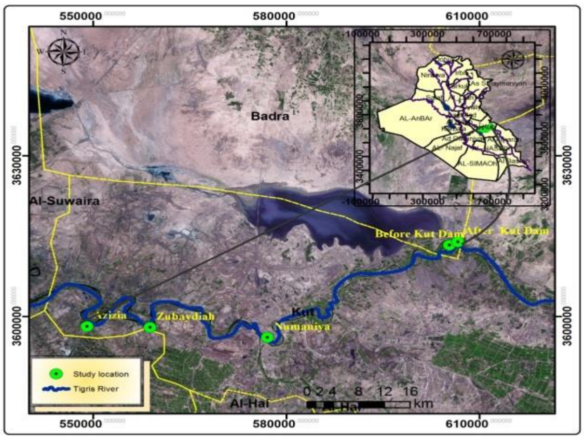

Fig. 1. Map of study areas (Used Arc-GIS Map program)

Table 1. Factors were estimated according to the methods according to mentioned references

Factors	Reference
Total alkalinity	(Welch, 1950)
Nitrite, Nitrate, Silica and Phosphate	(Strickland & Parsons,1972)
Total hardness	(Lind,1979)
Chloride	(ASTM, 1984)
pH and conductivity	(Ryan et al., 2003)
Dissolved Oxygen, turbidity, salinity, BOD, Sulphate and Total dissolved solids	(APHA, 2005)

value was 49 °C in August at station 4. Differences between the various stations were related to the sampling time. Because time expand between the first record at station 1 and the last station was about six hours. Daily Sampling time was started at 7 am and finished at 2 pm.

Water temperature coincided with air temperature, in that, the lowest temperature (11 °C) was recorded at station one at January and February, and the highest was (49°C) at station four during August. These results goes with many other studies (Manhan, 2004), because Iraqi climate is a tropical type, which is hot/dry during summer and cold/rainy at winter. Also the temperature differences could be related to the river sides or the depth where the samples were taking from (Al-Shawi et al., 2007). **Tables 2**-**5** clarify these results.

Turbidity

Turbidity values at all stations were very close except in December (**Tables 2**-**5**). The range of turbidity values ranged (5.12 -53) NTU. Turbidity is the water purity. This is cause by the high ratios of suspended matter in the water. These suspended matter included; mud, Soil, and could be bacteria, microorganisms and phytoplankton (Kumar et al., 2010). The most effective factors on turbidity are purity and water Currents.

Conductivity

Conductivity values were (670-1170) μs/cm during the study. **Tables 2**-**5** show these values.

Electrical conductivity is water ability to carry electrical current, and the presence of some dissolved solid matter as calcium, chloride and magnesium in a water sample will has the characterization to Carry the current. The increase conductivity value is due to land soil erosion from both river sides which add amounts of salts which affect the water conductivity (Leelahakriengkrai & Peerapornpisal, 2010). In addition to the geological factors inducing dissolved rocks which increase also in dissolved salts, again cause an increase conductivity values (Mallika et al., 2010).

Salinity

Salinity values were (0.410-0.775) mg/L. A variation values were recorded during the study (**Tables 2**-**5**). Water salinity is related to the presence of Calcium, Magnesium, Chloride, Sodium and Potassium ions, and are related to the physiological regulation of living cells. Salinity is considered an important indication for water classification.

A study pointed towards that, the low dissolved salt concentrations is due to the nature and qualities of rocks from where the water is discharged. The salinity level is an important factor to aquatic life and affect also the agricultural activities (Salman, 2006).

Total dissolved solid

The values of total dissolved solid were (330-590) mg/L. The lowest values were recorded at stations 3 and 4 at March and April. While the high value was at station 2 during November (**Tables 2**-**5**). The inclination of total dissolved solids and relation towards the living mass is through their relations to salinity and electrical conductivity. This relation affects the algal distribution, because of their effect on most of the physical and chemical characterization of water (Gupta et al., 2013).

Statistical analyses showed significant differences with sampling time, but not among stations ($p < 0.05$).

pH value

The ph value is considered as important factor in the study of natural water, and play important role in the equalization between the chemical and biological factors (Maulood et al. 1993). The pH values ranged during the present study (6.7-8.3). **Tables 2**-**5** clarify these values at the various stations.

The pH values inclined toward alkalinities almost, because of the rich presence of carbonate and bicarbonate in the naturel water (Lind,1979).

Dissolved Oxygen (DO)

Tables 2-**5** show these results. Dissolved Oxygen is considered as one of the most important factors in determining the quality and pollution ratios in water. In addition, to its importance in the natural water purification through the microorganisms. The ranges of DO values during the study were (0-11.6) mg/L during June and February respectively.

The high recorded values during December, January, February and March were related to low temperature values during the mentioned months. And also, could be related to the growth and productivity and

Table 2. Monthly averages of physical and chemical characteristics in the first site in the Tigris River during the period 2016-2017

Months	2016							2017				
Factors	June	July	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
Air Temp.(C°)	37	31	36	32	32	23	11	14	11	20	16	28
Water Temp.(C°)	30	30	34	30	29	21.5	13	12	12	18	18	24
Turbidity (NTU)	14.9	10.63	10.82	10.9	6.5	13.22	16.64	53	13.69	15.7	11.15	11.2
Electrical conductivity E.C (μs/cm)	830	750	750	730	880	1160	1020	940	940	700	900	690
Salinity (g/m)	0.515	0.462	0.462	0.450	0.540	0.720	0.630	0.582	0.582	0.569	0.557	0.425
T.D.S (mg/l)	420	380	350	370	430	580	500	480	470	370	450	350
pH	7.4	7.4	7.2	7.0	7.2	6.7	7.0	7.7	8.2	7.2	6.9	7.1
Dissolved oxygen (mg/l)	5.3	5.0	5.8	5.2	8	8.4	10.4	11.2	11.2	10.8	8.8	7.5
BOD (mg/l)	1.3	1.2	0.8	1.2	1.5	1.8	1.6	1.2	1.0	0.9	1.2	0.7
Total Alkalinity (mg / l)	160	140	120	128	124	120	144	140	145	130	132	115
Total Hardness (mg /l)	830	735	700	625	700	975	950	1020	1000	810	800	820
Sulphate (mg/l)	161.7	130	138.4	147.0	143.2	142.0	139.0	149.3	148.3	230.5	151.4	160.1
Chloride (mg/l)	81.6	81.7	81.7	79	90.5	132.4	114.3	106.5	97.4	88.85	113.6	82.97
Reactive Nitrite (µg/l)	0.176	9.66	0.435	0.352	0.441	0.549	0.146	0.7	7.46	0.485	6.766	0.737
Reactive Nitrate (µg/l)	26.2	19.62	26.19	18.77	12.27	0.71	15.29	15.21	25.85	15.33	25.96	13.18
Reactive Phosphate (µg/l)	0.195	0.975	0.165	0.832	0.806	0.897	0.684	0.085	0.897	0.045	0.858	0.806
Reactive Silicate (µg/l)	11.90	19.52	27.28	28.7	24.88	22.95	28.05	23.62	27.62	27.34	29.3	35.51

Table 3. Monthly averages of physical and chemical characteristics in the second site in the Tigris River during the period 2016-2017

Months	2016							2017				
Factors	June	July	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
Air Temp.(C°)	36.5	38.0	41.0	36.0	32.0	26.0	15.0	16.0	13.0	24.0	21.0	26.0
Water Temp.(C°)	30.0	31.0	33.0	31.0	29.0	22.0	13.0	13.0	12.5	18.0	18.5	24.5
Turbidity (NTU)	14.53	12.65	11.96	9.93	8.14	12.46	15.62	32.77	12.86	16.65	5.93	8.31
Electrical conductivity E.C (μs/cm)	860	800	790	740	860	1170	1030	990	960	770	890	700
Salinity (g/m)	0.531	0.494	0.487	0.456	0.531	0.726	0.638	0.613	0.607	0.475	0.55	0.431
T.D.S (mg/l)	430	400	400	370	430	590	520	500	490	360	440	350
pH	7.4	7.4	7.2	6.8	7.1	6.7	7.0	7.5	8.3	7.1	6.9	7.1
Dissolved oxygen (mg/l)	6	5.6	6.2	6.0	8.0	8.6	10.8	11.3	11.3	10.4	8.0	6.2
BOD (mg/l)	1.5	2.0	2.0	2.1	1.5	1.1	0.8	0.6	0.5	0.8	1.0	1.1
Total Alkalinity (mg / l)	162	140	120	132	124	121	136	120	136	124	128	120
Total Hardness (mg /l)	800	750	660	650	710	1000	1020	1000	950	800	840	810
Sulphate (mg/l)	116.7	160.0	137.8	137.0	142.0	172.0	127.3	128.0	158.6	196.6	173.0	165.5
Chloride (mg/l)	97.6	81.7	85.2	78.1	94.0	132.9	119.2	102.95	104.0	86.97	118.9	88.75
Reactive Nitrite (µg/l)	0.104	0.634	0.553	0.573	0.422	0.464	0.134	0.477	7.667	0.458	7.551	0.512
Reactive Nitrate (µg/l)	21.42	17.82	26.17	9.88	15.78	0.735	8.04	10.68	25.88	19.29	25.88	19.19
Reactive Phosphate (µg/l)	0.169	0.845	0.247	0.811	0.806	0.884	0.042	0.104	0.897	0.078	0.754	0.710
Reactive Silicate (µg/l)	11.36	18.48	26.82	30.02	24.76	25.30	29.80	23.50	27.28	27.66	28.90	35.81

increase water currents and mixing (Solomon et al., 2009). While increase temperature cause increase the microorganisms activities, which also cause degradation of organic matter and consumption of Oxygen (Ezekiel et al., 2011).

Biological Oxygen Demand (BOD)

BOD is usually used to estimate the degree of water pollution and the ability of water area to tolerate this. The BOD values were ranged (0.3-2.3) mg/L. The highest value was recorded during June at the fourth station. The increase in BOD values are related to the organic matter spillage, Organic fertilizers in the surrounding agricultural area or to the discharge of sewage to the river. And could be related to the high concentration of organic matter used as bacterial nutritions, which cause a high bacterial colonies growth, and finally cause of high BOD values.

The low BOD values are related to the water filtration to the river from the soil, this will lead towards more clean river water, or could the organic pollutants are hard and difficult to be analyzed (Obaidy et al., 2015). The BOD values were between the allowed limited values. **Tables 2**-**5** show these values.

Total alkalinity

Weathering is the important reference in the water alkalinity and its effect on the geological nature of the area where the water pass through (APHA, 2017). The values of total alkalinity were (114-162) mg/L. And because the pH values did not exceed the (8.3), therefor, the basic factor of alkalinity is due to bicarbonate ions (Al-Saffawi, 2018). The increase of water alkalinity has a positive effect on buffering of pH values. The values of alkalinities are in between the Iraqi values of water quality. **Tables 2**-**5** clarify these values.

Total hardness

Total hardness is caused by calcium and magnesium salts. Water hardness has important role in limiting the overall use of water (Todd and Mays, 2005). The results showed that, the total hardness values did not exceed 900 mg/L in the months June, July, August, September and October, except in very rare cases.

The total hardness depends on the Calcium and Magnesium nature of the ground, where the water pass. Also, it is one of the nutritive which are needed very rare by aquatic plants. Values of total hardness exceeded the alkalinity values in Tigris river, this is because other ions

Table 4. Monthly averages of physical and chemical characteristics in the third site in the Tigris River the period 2016-2017

Months	2016							2017				
Factors	June	July	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
Air Temp.(C°)	40	43	41	37	36	23.5	17	20.5	19	23	22	26
Water Temp.(C°)	31	32	34	32	30	22	13	13	12	18	19	25
Turbidity (NTU)	15.24	16.93	14.98	16.19	12.96	11.81	10.84	10.74	14.98	13.66	5.12	9.63
Electrical conductivity E.C (μs/cm)	910	810	800	750	850	1160	1070	990	950	750	850	690
Salinity (g/m)	0.563	0.500	0.494	0.462	0.525	0.720	0.664	0.613	0.588	0.412	0.524	0.425
T.D.S (mg/l)	460	410	400	380	420	580	530	490	480	370	420	330
pH	7.4	7.7	7.3	6.8	7.1	6.9	6.7	7.6	8.2	7.8	6.8	7.4
Dissolved oxygen (mg/l)	5.6	5.8	6.6	6.7	8.0	8.6	10.8	11.3	11.6	10.8	8.0	6.2
BOD (mg/l)	2.3	2.2	2.0	2.1	1.4	1.2	0.6	0.4	0.3	0.5	0.5	1.4
Total Alkalinity (mg / l)	150	136	114	134	132	124	132	132	140	128	124	120
Total Hardness (mg /l)	910	800	700	660	750	1000	1060	1040	990	840	885	760
Sulphate (mg/l)	119.0	142.4	162.5	135.6	136.1	132.9	150.8	140.0	152.7	242.0	156.2	168.3
Chloride (mg/l)	97.6	97.6	86.9	74.6	95.8	127.4	136.8	124.3	97.62	88.75	108.27	88.75
Reactive Nitrite (μg/l)	0.153	0.244	0.517	0.527	0.422	0.160	0.170	0.468	4.566	0.357	4.078	0.520
Reactive Nitrate (μg/l)	24.55	24.45	24.33	8.66	15.96	0.66	11.88	14.03	25.05	13.40	25.37	17.60
Reactive Phosphate (μg/l)	0.324	0.884	0.361	0.871	0.845	0.923	0.072	0.169	0.928	0.104	0.710	0.728
Reactive Silicate (μg/l)	11.63	21.91	26.88	30.54	25.11	25.37	29.60	23.55	27.54	26.63	29.56	35.40

Table 5. Monthly averages of physical and chemical characteristics in the fourth site in the Tigris River during the period 2016-2017

Months	2016							2017				
Factors	June	July	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
Air Temp.(C°)	40	48	49	43	42	26	21	17.5	13	22.5	24	28
Water Temp.(C°)	31	31	34	31.5	30	25	14.5	13.5	14	19	20	25
Turbidity (NTU)	11.21	12.45	15.00	22.99	22.06	21.54	8.28	10.33	13.2	15.42	3.55	11.58
Electrical conductivity E.C (μs/cm)	970	880	800	770	850	1050	1080	1110	870	670	870	780
Salinity (g/m)	0.601	0.544	0.494	0.475	0.525	0.651	0.670	0.680	0.538	0.410	0.531	0.481
T.D.S (mg/l)	460	420	400	380	420	530	540	550	435	330	420	375
pH	7.5	7.9	7.3	7.1	7.0	6.9	6.9	7.8	8.2	7.1	7.0	7.1
Dissolved oxygen (mg/l)	6.0	6.4	5.6	7.2	7.6	8.6	10.4	10.8	10.8	10.6	8.0	6.8
BOD (mg/l)	2.2	1.4	2.2	1.6	1.6	1.2	0.6	0.3	0.3	0.5	1.0	1.2
Total Alkalinity (mg / l)	150	152	124	132	116	116	154	148	158	126	132	128
Total Hardness (mg /l)	900	780	800	680	730	910	1190	1000	950	760	825	800
Sulphate (mg/l)	116.5	135.4	164.5	148.7	124.9	139.8	125.9	150.2	141.9	179.2	150.7	174.9
Chloride (mg/l)	97.6	98.4	86.9	74.6	93.8	114.3	139.1	144.9	95.7	74.55	110	90.2
Reactive Nitrite (μg/l)	0.186	0.185	0.062	0.031	0.435	0.102	0.129	0.439	3.422	0.380	3.270	0.631
Reactive Nitrate (μg/l)	26.51	23.50	20.83	8.48	11.18	0.806	11.41	14.22	26.37	12.11	20.33	17.58
Reactive Phosphate (μg/l)	0.234	0.272	0.932	0.962	0.829	0.966	0.130	0.068	0.994	0.104	0.657	0.810
Reactive Silicate (μg/l)	11.63	24.91	26.28	30.54	25.11	26.46	33.64	24.49	27.91	26.40	32.39	37.26

(except Carbonate and Bicarbonate) as Chlorides, Sulphide and Nitrite are present. **Tables 2-5** show these results.

Sulphate

Sulphate ions are considered the most widely distributed Compound in natural water (APHA, 2017). The range of this ion were varied (116.5-242) mg/L. **Tables 2-5** clarify the values at all stations. The Sulphate values were close to each other during the study. The increase Sulphate values could be due to the electrical generators which cause the raise up of Sulphate Oxide to the atmosphere and then it will return back and down of this Oxide with rain fall to the area. The present results are less than the results obtained by (Al-Azzawi et al. 2012). These results are limited to the river pollution, but it is a limited to the Canadian values.

Chloride

Chloride ions are present in most water in different concentrations. Rocks are considered the principle reference for this ion, in addition to, sewage discharges. The values of chloride ions ranged (74.5-144.9) mg/L during the present study. It is clear to focus on that, the values of June, July, August, September and October months were low and were not reached to (100) mg /L. While the values of November, December, January and February were higher and reached (144.9) mg/L. Chloride ions is one of the most important ions especially when it is connected with Sodium ions to produce NaCl (APHA, 2017). The high chloride concentration has negative effect on both plants and agriculture (Venkatesharaju et al. 2010). **Tables 2-5** show these values.

Reactive Nitrite

Nitrite is the midway between Ammonia and Nitrate (NO_3) and is present in little amount in the natural water (Ewaid; et.al 2019; Smith, 2004). **Tables 2-5** show the variation of Nitrite values during the study. These values were ranged (0.031-9.66)mg/L. The raise in nitrite values indicate towards the damage of water quality, because of the addition of waste water to the river (Shraddha et al. 2011).

The decrease of nitrite values could be related to the increase in phytoplankton photosynthesis, and to increase of nitrate reduction to nitrite, this will increase nitrite. While the decrease values of nitrite could be related to the high density of phragmites and typha.

In a study on China river pointed towards the ability of these plants to eliminate 5% of nitrogen and more than 20% of nitrate, and the low values could also be related to oxygen amounts and the time required for oxidation of ammonia and nitrite results from the degradation of organic compounds to nitrate (Smith, 2004).

Reactive Nitrate

It is the dominant inorganic nitrogenous compound in the water environment (Smith, 2004). The values of nitrate ranged (0.66 - 26.5) mg/L. **Tables 2**-**5** show these values. The nitrate values were more than 10 mg/L in most study stations except October, where it was low and was less than 1 mg/L. This decrease is due to increase photosynthesis because of the macrophytes, in addition to nitrate reduction.

The high nitrate concentrations are due to increase irrigation after the fertilizers use in the agriculture, and land washing nearby the river, in addition to soil catchment, which was caused to increase nitrate concentration (Johnson, 2004). And also, could be related to the decrease phytoplankton consumption of nitrogen including nitrate during winter. The increase of these values during winter season may be related to the ammonia oxidation by bacteria and to the biological nitrogen fixation.

Reactive Phosphate

Phosphorus is one of the most important nutritive, and it is in the mid energy level of the living activities (Schulze et al., 2005). The values, of phosphorus were (0.042-0.974) μg/L (**Tables 2**-**5**). The high phosphorus values at the agricultural area could be related to large amounts of phosphors fertilizers used. While the low values are related to the inclination of phosphate to aggregate on the bottom sediments and also is highly absorbable on the soil elements and compounds. A study clarifies that phragmites and typha have the ability to eliminate and reduce phosphate values in these environments. (Martin and Fernandz, 2012) mentioned that T. domin genesis has the ability to absorb more than 50% of the phosphorus.

Reactive Silicate

Tables 2-**5** show the values of silica during the study and were (11.36-37.26) mg /L. The low silica values are related to its consumption by phytoplankton and diatoms. This is because these living organisms are the only species to consume Silica, and the low Silica circulation from the Sediment to the river.

The high values are related to the alkaline nature of water which leads to the discharge of silica from the bottom Sediments to the river water (Wetzel, 2001). In general, Silica dissolve in water when it is saturated with salts contents, which lead to the formation of acid Silicon and muddy base (EPA, 2009). Also, the high values of silica could be related to the soil chemical contents. The high silica values are controlled by the dissolved Oxygen values.

CONCLUSION

The changes of the four stations and the effect of the river sites on the river water. The stations represent the city centers were the river pass through, depending on the population nature and agricultural area and their effect on the water quality and usages.

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