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The variation in physicochemical properties of water in Qarun Lake during four seasons.

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Abstract

Lake Qarun is an inland closed basin, located about 80 Km south west of Cairo. It suffers from a serious water pollution problem which is due to uncontrolled solid and liquid domestic, in addition to agrochemical contamination and lack of sustainable wastewater management. The present study aimed to follow up the variation in the water quality of the lake Qarun through the determination of physicochemical properties of water seasonally (August 2014 to May 2015). The physicochemical parameters showed variations at different sites of Lake Qarun in four seasons. The results showed that the maximum mean value for temperature and EC was found in summer at the Main pump station. The minimum mean values of dissolved oxygen were found in summer but maximum mean values found in winter at the main pump station. On the other hand, the highest mean values of ammonia, nitrite, and nitrate were found at Al-Batts drain which the most highly polluted sampling site due to agricultural and sewage wastes discharged into Lake Qarun from this huge drain.

Keywords: Physicochemical properties, water, ammonia, qarun lake.

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Introduction

The contamination of the aquatic environment with a wide range of pollutants has become a matter of concern over the last few decades. In Egypt, it has been found that many environmental pollutants reach the natural water (rivers, seas, and lakes) through the industrial, agricultural and domestic effluents produced by human activities. Increasing number and amount of industrial, agriculture and commercial chemicals discharged into the aquatic environmental having led to various deleterious effects on fish and human who consumed [1].

Nowadays, Lake Qarun suffers from several environmental problems. It receives agricultural and sewage drainage water from Fayoum Province. Therefore its salinity increase progressively which affects greatly the Lake biota. The Lake receives the agricultural and sewage drainage waters through a system of twelve drains, most of the drainage water reaches the Lake by two main drains, Al Batts and El Wadi, and two pump stations (main pump station and Khor Alhitan pump station). The Lake received annually about 450 million cubic meters of agricultural drainage water. The Egyptian Company for Salts and Mineral (EMISAL) located on the southern coast of the lake, where a port was cut off from the lake and divided into a number of concentrating ponds to concentrate the lake water as much as 10 times of its original salinity. The effluents of EMISAL brine water discharged into the lake and aggravate the condition. Due to Lake Qarun is a closed ecosystem, and as a result of, extensive evaporation of water, the accumulation of chemical pollutants (heavy metals, pesticides, and other pollutants) is expected to increase annually in all its components (e.g. water and fish) and to change their quality and affect their aquatic life [2].

Within an aquatic ecosystem, a complex interaction of physical and biochemical cycles exists, anthropogenic stresses, particularly the interaction of chemicals into water may adversely affect many species of aquatic flora and fauna. Water quality criteria for protection of aquatic life may take into account only physic-chemical parameters which tend to protect and maintain aquatic life [3]. Regular water quality monitoring of water resources is absolutely necessary to assess the quality of water for ecosystem health and hygiene, industrial use, agricultural use and domestic use [4]. The water quality evaluation may be a complicated practice in compound parameters causing numerous anxieties in general quality of water [5].

Water temperature is one of the most basic physicochemical parameters because it varies temporally and spatially. It affects the ability of water to hold oxygen and the metabolic rates of aquatic organisms. Also, it affects the availability of trace metals which have an indirect effect on the pH of water. It affects reproductive behavior and growth of fish. The solubility of solids increases with an increase in temperature while decrease for gases. Therefore, important gases for aquatic life decrease with increase in temperature. In general, temperature controls the rate of fundamental biochemical processes and thereby regulates organismal attributes including development rate and survival [6]. Nutrients salts (ammonia, nitrite, and nitrate) are essential to the metabolism and growth of aquatic organisms when its concentration increased; it's affected the biological equilibrium. In aquatic ecosystem nutrients, salts have a greatly increased with time through a human activity which causes a problem with water quality [7].

Great efforts were needed for recovery of the purity and health of this lake and additional information was needed to provide a database for optimal fisheries and water quality status that help the proper management of the lake. So the main aim of this study is to follow up the variation in the water quality of the lake Qarun through the determination of physicochemical properties of water in four seasons.

Materials and Methods

Study area

Lake Qarun is a closed elongated saline basin located between longitudes 30°24´ and 30°49´ E and latitudes of 29°24´ and 29°33´ N in the lowest part of El-Fayoum depression, about 80 km Southwest of Cairo (Figure 1). It has an irregular shape of about 40 km length and about 6 km mean width, with an average area of about 240 km. The lake is shallow, with a mean depth of 4.2 m and about 20% of the lake's area has a depth ranging between 5 to 8 meters. The water level of the lake fluctuated between 43 to 45 m below mean sea level [8].

(B): Al-Batts drain (the distance between B1, B2, and B3 was 2 km)

(W): Al-Wady drain (the distance between W1, W2, and W3 was 3 km)

(K): Kour alhitan pump station (the distance between K1, K2, and K3 was 2 km)

(P): Main pump station (the distance between P1, P2, and P3 was 2 km)

Water samples collection and analysis

Water samples were collected seasonally (August 2014 to May 2015) by using Ruttner Water Sampler from four sites (Al-Batts drain, Al-Wady drain, main pump station and khor Alhitan pump station) of lake Qarun (Three points from each (Figure 1). These samples were kept in polyethylene bottles of one-litre capacity. The bottle was stored in refrigerator and analysis was carried out within 24 hours after collection. Samples collected for the determination of dissolved oxygen (DO) were filled carefully in glass-stoppered oxygen bottles with 300 cm^3 capacity. The samples of dissolved oxygen were fixed immediately by adding 1 ml $MnSO_4$ (40%) and 1ml Alkaline KI solution then mixed well.

The methods cited in American Public Health Association [9] were used for determining the physicochemical parameters.

Temperature

Water temperature was measured during the time of sampling using an ordinary centigrade thermometer in the field. Temperature is expressed in degree centigrade °C.

Electrical conductivity

It was measured using the conductance bridge (YSI model 32, SCT meter). The results will be expressed as µmhos/cm.

Hydrogen ion concentration (pH)

The pH values of water samples were measured on the spot by using of pH meter model Orion Research Ion Analyzer 399 a pH meter.

Dissolved oxygen (DO)

Determination of dissolved oxygen was carried out using the modified Winkler method. Special oxygen bottles were completely filled with water using Nunsen bottle for each depth. Fixation was carried out immediately on the spot by addition of 1 ml of $MnSO_4$, followed by 1 ml of alkaline KI solution and the bottles were thoroughly agitated. In the laboratory, 2 ml of concentrated H_2SO_4 were added, mixed and let stand for 5 minutes. The yellow color produced was titrated against sodium thiosulphate solution (0.0245 N) till faint pale yellow color, 0.5 ml starch was added and titration was continued until the blue color just disappeared.

Standardization of sodium thiosulphate solution was done against potassium bi-iodate 0.025 N. The dissolved oxygen concentration was calculated according to the following equation:

DO mg /l = N × V × 8 × 1000/ml of sample

N=normality of sodium thiosulphate

V=volume of sodium thiosulphate

Ammonia

50 ml of sample water plus 2 ml phenol solution then 2 ml of

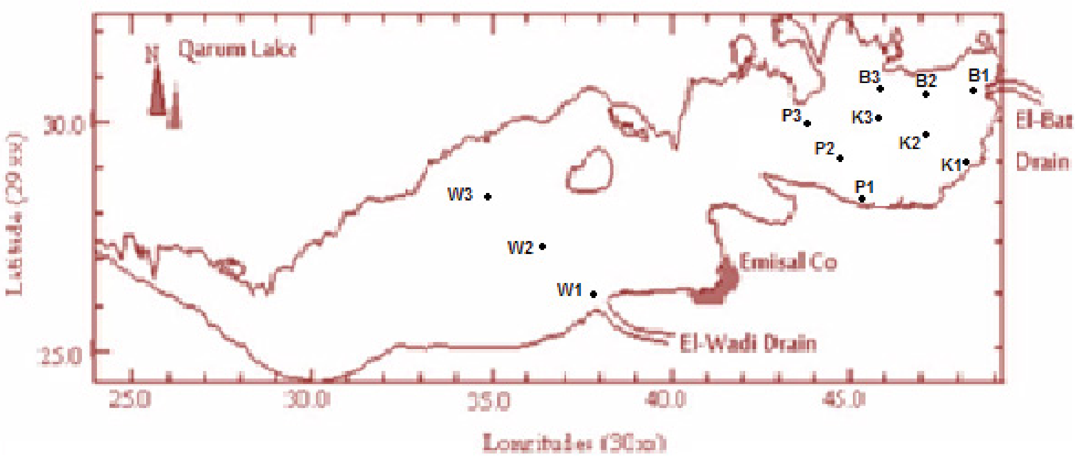

Figure 1. *Map of Lake Qarun showing the sampling location.*

sodium nitroprosside solution plus 5 ml oxidizing solution (100 ml alkaline sodium citrate and 25 ml sodium hypochlorite). Cover samples with plastic wrap or paraffin wrapper and let color to develop at room temperature for at least one hour. Measure the color produced at wavelength 640 nm. Standard solution of ammonium chloride concentrations (0-2 mg) is used for preparing the calibration curve and finding the unknown sample. The results are expressed in (μg/l) [9].

Nitrite

Determination of nitrite was carried out using the colorimetric method. In strongly acid medium (pH 2-2.5) nitrite react with sulphanilamide to form diazonium compound which reacts with N (1-naphthyl) ethylenediamine dihydrochloride (NED) to form strongly colored azo compound measuring at wavelength 543 nm. To 50 ml sample, added one ml of acidified sulphanilamide solution and one ml of NED solution. After 10 minutes the color obtained was measured spectrophotometrically at wavelength 543 nm. Standard solution of sodium nitrite was used for preparing the calibration curve and then finds out the concentration of the unknown sample. The results are expressed in (μg/l) [9].

Nitrate

50 ml of sample plus 1 ml of buffered solution (prepared freshly in use, part to part, NaOH: phenol=1: 1) then 2 ml of reducing solution (prepared freshly in use, using the ratio, 5 of hydrazine sulfate solution: 1 of copper sulfate solution). After standing 24 hours in the dark, add 2 ml of acetone and mix. Allow the reaction to proceed for at least 2 minutes and then add 1ml sulphanilamide solution and 1 ml NED solution. After 10-15 minutes, the color obtained was measured spectrophotometrically at wavelength 543 nm. Standard solution of sodium nitrate was used for preparing the calibration curve to find out the concentration of the unknown sample. The results are expressed in (μg/l), [10].

Statistically analysis

Analysis of variance (One-way ANOVA) was used to indicate significant differences among the different sites in physicochemical parameters. Standard Error (Mean ± SE) which calculated using SPSS 16.0 for Windows (SPSS Inc. Chicago, USA).

Results

Temperature

The minimum mean value of water temperature was (16 ± 0.73°C) found in winter at Al-Wady drain and the maximum mean value was (30.5 ± 0.51°C) found in summer at the Main pump station. The trend of the mean values of water temperature in different sites of Lake Qarun followed the order: main pump station>Khor Al-hitan pump station>Al-Wady drain>Al-Batts drain in summer and autumn, main pump station>Khor A hitan pump station>Al-Batts drain>Al-Wady drain in winter and main pump station>Al-Batts drain>Khor Al-hitan pump station>Al-Wady drain in spring. The results were clearly demonstrated in (Table 1).

Electrical conductivity (EC)

The higher value of Electrical Conductivity (EC) was recorded during summer (44.1 ± 0.69 mmohs/cm) at main pump station while the lower value was recorded during winter (29 ± 4.05 mmohs/cm) at Al-Batts drain. Also, the mean values of transparency in different sites of Lake Qarun followed the order: main pump station>Khor Al-hitan pump station>Al-Wady drain>Al-Batts drain in summer and autumn while, Khor Al-hitan pump station>main pump station>Al-Wady drain>Al-Batts drain in winter and spring. The results were clearly demonstrated in (Table 2).

Hydrogen ion concentration (pH)

The pH values of the lake water were slightly alkaline, the minimum mean value of pH was (8.07 ± 0.06) found during spring at Al-Wady drain and the maximum mean value of pH was (8.88 ± 0.06) recorded during winter at main pump Station. Also, the mean values of pH in different sites of Lake Qarun followed the order: main pump station>Khor Al-hitan pump station>Al-Wady drain>Al-Batts drain in summer, main pump station=Al-Wady drain>Al-Batts drain>Khor Al-hitan pump station in autumn and main pump station > Khor Al-hitan pump station>Al-Batts drain>Al-Wady drain in winter and spring . The results were clearly demonstrated in (Table 3).

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

Dissolved oxygen

Table 4 showed a seasonal variation of DO of water samples collected from lake Qarun. The minimum mean value of dissolved oxygen was (5.40 ± 0.52 mg L^{-1}) found in summer at Al-Batts drain and the maximum mean value was (17 ± 0.57 mg L^{-1}) found in winter at the main pump station. The mean values of DO in different sites of Lake Qarun followed the order: main pump station> Khor Al-hitan pump station>Al-Wady drain>Al-Batts drain during summer, autumn and spring while, main pump station >Khor Al-Proceedings of the National Academy of Sciences of the United States of American pump station>Al-Batts drain>Al-Wady drain in winter .

Table 1. *Seasonal variation of temperature (℃) (Means ± SE) in water samples collected from different sites of Lake Qarun.*

Site	Al-Batts drain					Al-Wady drain					Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	29	28.6	28.3	28.6 ± 0.20	61.6	29	30	29.5	29.5 ± 0.28	84.37	31.1	31	29.5	30.5 ± 0.51	64.8	30.5	30	28.7	29.7 ± 0.53	63.18	0.066
Autumn	20	21	21.5	20.8 ± 0.44	17.5	21	22	22.5	21.8 ± 0.44	36.25	23	23.1	23.5	23.2 ± 0.15	25.4	21.5	22	23	22.2 ± 0.44	21.97	0.017
Winter	16.3	18.5	18.3	17.7 ± 0.70	–	14.7	17.2	16.3	16 ± 0.73	–	18.5	19.5	17.5	18.5 ± 0.57	–	18.5	17.8	18.4	18.2 ± 0.21	–	0.075
Spring	25.4	23.8	23.4	24.2 ± 0.61	36.7	23.5	23.5	23	23.3 ± 0.16	45.62	25.4	25	24.4	24.9 ± 0.29	34.59	24.7	23.5	23.8	24 ± 0.36	31.86	0.107

% percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

Table 2. *Seasonal variation of electrical conductivity (EC) (mmhos cm^{-1}) (Means ± SE) in water samples collected from different sites of Lake Qarun.*

Site	Al-Batts drain					Al-Wady drain						Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	29.7	41	38	36.2 ± 3.37	24.82	25.8	44	44.3	44.3	38 ± 6.11	13.43	45.4	44	43	44.1 ± 0.69	14.54	44	43.6	43.5	43.7 ± 0.15	11.76	0.343
Autumn	27.7	39.7	35.6	34.3 ± 3.52	18.27	21.8	43	43.2	43.2	36 ± 7.10	7.46	43.4	43.3	42	42.9 ± 0.45	11.42	43.3	42.6	42.5	42.8 ± 0.25	9.46	0.346
Winter	21.7	35.7	29.6	29 ± 4.05	_	16.08	42.2	42.5	42.5	33.5 ± 8.75	_	42.4	42.3	41.3	42 ± 0.35	9.09	42.3	41.6	42.3	42 ± 0.23	7.41	0.225
Spring	19.33	35.7	39.7	31.5 ± 6.23	8.62	24.3	40	40.18	40.18	34.8 ± 5.26	3.88	38.5	38.6	38.5	38.5 ± 0.03	_	39.6	38.9	38.9	39.1 ± 0.23	_	0.555

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

Table 3. *Seasonal variation of Hydrogen ion concentration (pH) (Means ± SE) in water samples collected from different sites of Lake Qarun.*

Site	Al-Batts drain					Al-Wady drain					Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	7.7	8.3	8.28	8.09 ± 0.19	_	7.8	8.4	8.8	8.33 ± 0.29	3.22	8.7	8.7	8.8	8.73 ± 0.03	4.8	8.36	8.4	8.3	8.35 ± 0.02	2.7	0.161
Autumn	8.15	8.2	8.3	8.21 ± 0.04	1.48	7.99	8.3	8.7	8.33 ± 0.20	3.22	8.25	8.35	8.4	8.33 ± 0.04	_	7.91	8.2	8.3	8.13 ± 0.11	_	0.629
Winter	8.12	8.83	8.35	8.43 ± 0.20	4.2	7.86	8.42	8.54	8.27 ± 0.20	2.47	8.92	8.98	8.75	8.88 ± 0.06	6.6	8.76	8.72	8.8	8.76 ± 0.02	7.74	0.072
Spring	7.82	8.14	8.35	8.10 ± 0.15	0.12	7.94	8.14	8.14	8.07 ± 0.06	_	8.49	8.38	8.39	8.42 ± 0.03	1.08	8.38	8.35	8.38	8.37 ± 0.01	2.95	0.043

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

Table 4. *Seasonal variation of dissolved oxygen (DO) (mg l^{-1}) (Means ± SE) in water samples collected from different sites of Lake Qarun.*

Site	Al-Batts drain					Al-Wady drain					Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	4.6	5.2	6.4	5.40 ± 0.52	_	5.2	5.8	7.6	6.20 ± 0.72	_	8.2	11.2	11.6	10.33 ± 1.07	_	6.6	8	8.4	7.66 ± 0.54	_	0.008
Autumn	5.4	5.8	6.2	5.80 ± 0.23	7.4	7.2	7.8	9.4	8.13 ± 0.65	31.12	12.2	14.8	15.4	14.13 ± 0.98	36.78	10.6	12	12.4	11.66 ± 0.54	52.2	0
Winter	8	15	16	13 ± 2.51	140.7	9	10	12	10.33 ± 0.88	66.12	16	17	18	17 ± 0.57	64.5	16	14	17	15.66 ± 0.88	104.4	0.045
Spring	6.8	9.8	10	8.86 ± 1.03	60.74	8.6	10	12	10.20 ± 0.98	64.51	13.6	14	16	14.53 ± 0.74	40.65	12	14	17	14.33 ± 1.45	87	0.012

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

Table 5. *Seasonal variation of ammonia (μg/l) (Means ± SE) in a water sample collected from different sites of Lake Quran.*

Site	Al-Batts drain					Al-Wady drain					Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	1600.4	75.7	183.7	619.9 ± 491	288.2	871.2	81.4	89	347.2 ± 262	130.2	268.9	117.4	102.2	162.8 ± 53.2	36.5	263.2	107.9	206.4	192.5 ± 45.3	87.07	0.659
Autumn	126.8	187.5	164.7	159.7 ± 17.6	_	662.9	77.6	87.1	275.9 ± 193	82.8	871.2	125	98.4	364.9 ± 253	206.1	928.1	126.8	187.5	414.1 ± 257	302.4	0.827
Winter	5477.4	289.7	2297.4	2688 ± 1510	1583.2	795.4	160.9	172.7	376.4 ± 209	149.6	109.5	142	106.1	119.2 ± 11.4	_	121.2	94.7	92.8	102.9 ± 9.1	_	0.117
Spring	1926.4	189.5	141.6	752.5 ± 587	371.1	206.1	147.2	99.3	150.8 ± 30.8	_	147.2	138	163.7	149.6 ± 7.5	25.5	145.3	101.2	156.4	134.3 ± 16.8	30.51	0.415

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$)

Table 6. *Seasonal variation of Nitrite (NO_2) (μg/l) (Means ± SE) in water samples collected from different sites of Lake Qarun.*

Site	Al-Batts drain					Al-Wady drain					Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	373.5	13.29	13.61	133.4 ± 120	49.61	213.6	9.18	10.13	77.6 ± 68	20.64	12.34	14.5	15.19	14.01 ± 0.85	_	15.19	11.71	14.87	13.9 ± 1.11	22.21	0.58
Autumn	344.4	12.98	13.29	123.5 ± 110	38.51	216.5	10.76	12.34	79.8 ± 68.3	23.97	15.51	14.5	14.87	14.9 ± 0.29	6.78	12.34	9.81	12.03	11.3 ± 0.79	_	0.58
Winter	180.4	29.44	57.61	89.1 ± 46.3	_	196.2	28.17	30.7	85 ± 55.6	32.12	23.11	15.51	17.09	18.5 ± 2.31	32.54	23.42	16.77	18.67	19.6 ± 1.87	72.25	0.378
Spring	260.2	28.49	20.89	103.1 ± 78.5	15.74	164.6	25.01	3.48	64.3 ± 50.5	_	20.57	15.19	12..34	15.9 ± 2.50	27.62	15.51	14.56	4.43	11.5 ± 3.54	0.96	0.53

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

%percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$).

Ammonia

The highest mean value of ammonia (Table 5) was (2688 ± 1510 μg/l) recorded in winter at Al-Batts drain and the lowest mean value was (102.9 ± 9.1μg/l) recorded at Khor Al-hitan station. The trend of the mean values of a m m o n i a in different sites of Lake Qarun followed the order: Al-Batts drain>Al-Wady drain>Khor Al-hitan pump station>main pump station in summer, Khor Al-hitan pump station>main pump station>Al-Wady drain>Al-Batts drain in autumn and Al Batts drain>Al-Wady drain >main pump station>Khor Al-hitan pump station in winter and spring.

Nitrite (NO_2)

The concentrations of nitrite in water samples collected from different sites of Lake Qarun represented in Table 6 and Figure1. The highest mean value (133.4 ± 120 μg/l) was recorded at Al-

Table 7. *Seasonal variation of Nitrate (NO_3) (µg/l) (Means ± SE) in water samples collected from different sit Lake Quran.*

Site	Al-Batts drain					Al-Wady drain					Main pump station					Khor Al-hitan pump station					
Season	BI	BII	BIII	M ± SE	%	WI	WII	WIII	M ± SE	%	PI	PII	PIII	M ± SE	%	KI	KII	KIII	M ± SE	%	P value
Summer	674.2	52.8	38.3	255.1 ± 209	–	335.1	45.6	44.2	141.6 ± 96.7	–	49.5	46.2	50.2	48.6 ± 1.22	–	54.8	56.1	37.01	49.3 ± 6.18	4.67	0.568
Autumn	1299.5	59.4	45.6	468.2 ± 415	83.5	1136.9	58.8	57.5	417.7 ± 359	194.98	56.1	52.2	54.8	54.4 ± 1.16	11.95	54.2	52.2	35.03	47.1 ± 6.08	–	0.586
Winter	958.4	370.8	411.8	580.3 ± 189	127.44	613.4	416.4	296.7	442.2 ± 92.3	212.28	397.2	339.1	391.3	375.8 ± 18.4	673.2	525.4	370.1	409.82	435.1 ± 46.5	823.7	0.611
Spring	717.18	356.9	178.4	417.5 ± 158	63.63	634.5	296.1	97.8	342.8 ± 156	142.09	237.2	165.2	126.9	176.4 ± 32.3	262.9	192.3	179.7	250.51	207.5 ± 21.7	340.5	0.438

% percentage of change related to the lowest mean value from season (-) M ± SE: mean ± standard error. The mean difference is significant at ($p \leq 0.05$)

Batts drain during summer and the lowest mean value was (11.3 ± 0.79 µg/l) in autumn at Khor Al-hitan station. The mean values of nitrite in different sites of Lake Qarun followed the order: Al-Batts drain>Al-Wady drain>main pump station> Khor Al-hitan pump station in summer, autumn and spring while, Al-Batts drain>Al-Wady drain> Khor Al-hitan>main pump station in winter.

Nitrate (NO_3)

The highest mean value of nitrate was (580.3 ± 189 µg/l) recorded at Al-Batts drain during winter and the lowest mean value was (47.1 ± 6.08 µg/l) recorded in autumn at Khor Al-hitan pump station. The mean values of nitrate in different sites of Lake Qarun followed the order Al-Batts drain>Al-Wady drain> Khor Al-hitan>main pump station in summer, winter and spring while, Al-Batts drain>Al-Wady drain> main pump station>Khor Al-hitan pump station in autumn. The results were clearly demonstrated in (Table 7).

Discussion

Water is essential for life; it covers 71% of the earth's surface. Water pollution is a major global problem, it occurs when pollutants are directly and indirectly discharged into water bodies without adequate treatment, if water becomes polluted it loses its value to us economically and aesthetically for human beings and aquatic organisms, it requires ongoing evaluation and revision of water resource policy at all levels. Water quality measurements play a significant role in biology and physiology of fish which should be kept within range for their good performance [11].

In the present study, the water temperature of Lake Qarun fluctuated between the four seasons. Many aquatic organisms are sensitive to changes in water temperature. The changes in water temperature in the present study may be attributed to many variables such as season, daytime, depth, wind and water inflow. Our results of temperature are nearly similar to that obtained by Authman M, et al., [12] in the same lake.

The obtained values of electrical conductivity are higher than those of permissible limits (400-1400 µS/cm) of . The higher value of EC in the present study may be due to the presence of high content of anion and cation resulting from the discharge of domestic and agriculture waters [13]. Also, the conductivity Increase with the increased in total dissolved solids and water temperature. A solution of most inorganic compounds and more abundant ions have higher EC. On the other hand, the decreased of EC during winter is mainly due to the sedimentation of suspended solids with ionic salts causing a decrease in chemical elements [14].

In the present work, pH mean values of Lake Qarun water in all stations and all seasons ranged from (8.07 ± 0.06 to 8.88 ± 0.06). These values were within the permissible range (6.5-8.5) according to WHO [15] except the main pump station in summer and winter and khor Al hitan in winter. Its values showed narrow variations and were always around eight. The highest value of pH in the present study may be due to increasing of phytoplankton activities which consume CO_2 during photosynthetic processes and the lowest value of pH may be due to the liberation of CO_2 during the decomposition of organic matter. Our results of pH are in agreement with results that reported by Rabeh SA [16] in the same lake.

The current study revealed that the highest mean value (17 ± 0.57 mg L^{-1}) of dissolved oxygen (DO) in lake Qarun water recorded during winter and the minimum mean value (5.40 ± 0.52 mg L^{-1}) recorded at Al- Batts drain in summer. This value lower than the permissible limits (6-14 mg L^{-1}) according to [15] Dissolved oxygen (DO) is the most important factor in the life and health of aquatic organisms. Fishes and other aquatic organisms depend for their respiration and metabolic activity on the DO content in the water body. The lower value of DO in summer may be attributed to the elevation of water temperature that leading to decrease the solubility of oxygen gas [17]. Also, the decreased in DO at Al- Batts drain in the present study may be due to the effect of sewage and agricultural water discharged at Al- Batts drain [18], in addition to the oxidation of organic matter by the microbial activity of microorganisms, which consumes a part of oxygen. On the other hand, the highest value of the DO of Lake Qarun water during winter may be attributed to decreasing of temperature, prevailing winds action that permits to increase the solubility of atmospheric oxygen gas. Our results of DO were in agreement with the results obtained by Hussein H, et al. [19] and Rabeh SA [16] who reported that water DO was decreased in summer and increased in winter.

In the present study, the mean values of ammonia in lake Qarun water ranged from (102.9 ± 9.1 to 2688 ± 1510 µg/l), these values are higher than the permissible limits (50-500 µg/l) of [15]. The highest values of ammonia recorded at Al-Batts (B1) and Al Wady drain (W1) and the concentration decreased as the distance from Al-Batts and Al wady drains increased. High concentrations of ammonia at Al-Batts (B1) and Al Wady drain (W1) may be due to agricultural and sewage wastes discharged into Lake Qarun from surrounding cultivated land and two huge drain Al-Batts and Al Wadi [20]. Decreasing concentration of ammonia as the distance from Al-Batts and Al wady drains increased; prove that Al-Batts and Al wady drains are the main sources of nitrogen pollution. Also, the increased ammonia concentration in the present study may be attributed to denitrification process which occurs by bacterial decomposition and bicarbonate as a final product as the following equation:

Denitrification: $NO^-_3 \rightarrow NO^-_2 \rightarrow NH_3$

Increasing of ammonia>0.5 mg/l has been given an indicator of organic pollution and it is toxic in concentration over 2.5 mg/l to aquatic organisms and may be associated with fish excretion. Ammonia toxicity causes osmoregulatory imbalance, kidney failure and damage to gill epithelium. Our results of ammonia agreed with results obtained by Hussein H, et al. [19] in the same lake.

In the present study, the mean values of nitrite ranged from (11.3 ± 0.79 to 133.4 ± 120 µg/l); these values are higher than the permissible limits (None) of [15]. The highest values of nitrite recorded at Al-Batts (B1) and Al Wady drain (W1). The increasing value of nitrite may be due to agricultural and sewage wastes discharged into the lake. Also, decreasing of nitrite concentration as the distance from Al-Batts and Al wady drains increased seemed that Al-Batts and Al wady drains are the main source of nitrogen pollution. The toxicity of nitrite may be due to the reaction of nitrite with secondary amines to produce the carcinogenic compound nitrosamine [21].

In the present study, the mean values of nitrate ranged from (47.1 ± 6.08 to 580.3 ± 189.4 µg/l); these values are lower than the permissible limits (2500-5000 µg/l) of [15]. The maximum mean value recorded at Al Batts drain. Also, Nitrate showed high values than the corresponding values of nitrite. The low values in nitrate concentration might be attributed to uptake of nitrate by natural phytoplankton and its reduction by denitrification. High values of nitrate than the corresponding values of nitrite may be due to the fast conversion of NO^-_2 to NO^-_3 ions by nitrifying bacteria [20-22]. On the other side, high NO^-_3 concentration in Al-Batts drain is mainly due to domestic, sewage and agricultural runoff beside the fertilizer water which is discharged at this station.

Conclusion

Water quality revealed that Al-Batts and Al wady drains were the most highly polluted sampling site due to agricultural and sewage wastes discharged into lake Qarun from these two huge drains. Also, pollution decreased as the distance from two drains and two pump stations increased, which seemed that sampling sites (B1, W1, P1, and K1) are the main source of pollution and more polluted than other sampling points.

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