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Water Quality and Bacterial Load of Water and Tilapia Organs from Edku Lake

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Abstract

Lakes are very important part of the aquatic ecosystem in Egypt. Edku Lake is one of the northern coastal lakes in Egypt which is the third largest wetland area in it. Edku Lake receives huge amounts of drainage water from four main drains, namely, Edku, El Bousily, El Khairy and Bersik which effect on its ecosystem. This study was carried out four seasons of 2017 where twenty-four surface water samples and fish samples were collected from sex stations in the lake. The results of water quality indicated that temperature, pH, dissolved oxygen and phosphorus were indicated in suitable range at all study stations. While, ammonia and nitrite were indicated in stress range for fish, but nitrate results were lied as desirable results. Results of lake water bacterial load (TC& CF) are exceed the permissible values mentioned by EC, 1998 and Ministry of Health, Egypt, 1996. Also, the bacterial loads (Total bacterial count, TC& Coliform group, CF) found in this study for Nile tilapia organs (skin & muscle) was beyond the standard value (FAO, 1979 and ICMSF, 1982), which indicate their unacceptability as food from public health point of view which may be cause human health risk due to consumption of tilapia collected.

Keywords: Edku lake, Water quality, Bacterial load.

INTRODUCTION

Lakes are one of the important water resources used for fisheries **(Ramakrishnaiah *et al*., 2009)**. In Egypt, Lakes are very important part of the aquatic ecosystem, which represent about 15% of the total commercial fishing areas **(Abdel-Hamid, 2017)**. Lake pollution is one of the serious environment problems in recent years with socio-economic development and pollutants discharge increase from industry, agriculture and domesticity. Vast number of lakes have suffered varying degrees of pollution across the world, and to monitor lake water quality, physical and chemical proxies have been commonly used

(Ouyang *et al*., 2016). Basic physical and chemical parameters are included, which determine the characteristics of an aquatic system **(Trikoilidou1 *et al*., 2017)**. Water is one of the most essential constituents of the human environment. The resource generates development in socio-economic issues crucial to the society in general and more specifically for industries, agricultural activities and for the public use. Water quality refers to the physical, chemical and biological characteristics of water in relation to the existence of life and especially human activity.

Microbial indicators of fecal contamination are used as an indicator of water quality, since feces may contain pathogenic organisms that have the potential to negatively impact human health. Currently, there is no routine governmental reporting of microbial indicators in one of the most valuable sources of freshwater in Saskatchewan **(North *et al*., 2014)**.

Fishes are considered as one of the most significant bio-monitors in an aquatic system for the estimation of water pollution concentrations **(Begum *et al*., 2005)**. Fish take a large number of bacteria into their gut from water, sediment and food **(Sugita *et al*., 1988)**. Thus, by determining the bacterial contents of the water samples in grow-out ponds, the bacterial level in fish can be predicted. The latter affects the quality and storage life of the fishery products. The quality of fish refers to the degree of contamination with coliform bacteria, and it is well known that freshwater fish and their aquatic environment can harbor human pathogenic bacteria, particularly members of the coliform group **(Leung *et al*., 1992; Pullela *et al*.,1998; Ramos and Lyon, 2000)**. In a previous study it has been demonstrated that the bacterial flora in fish reflects the aquatic environments **(Shewan and Hopps, 1967)**.

Mandal *et al.* (2009) indicated that fishes are very much susceptible to contamination with different bacteria because of their highly perishable protein content in their body. Coliforms are not the normal flora of bacteria in fish. Due to deposition of human excreta in pond, water is contaminated and when this contaminated water is ingested by the fish, they become contaminated. Bacteria often occur in parts of fish such as scales, gills, gut and alimentary tract. The bacteria present on the body or internal organs of fish indicate the extent of pollution of aquatic ecosystems (**Ibemenuga and Okeke, 2014)**.

So that, the aim of this study evaluates water quality of the lake and its effect on bacterial load (TC and CF) in water and tilapia organs (skin and muscle) of the lake.

MATERIAL AND METHODS

Study area

Edku Lake is one of the northern coastal lakes in Egypt, located at the western part of the Delta Nile **(Khalil *et al*., 2008)**. It is the third largest wetland area in the northern delta. It supports a fishery of moderate importance. It is also of moderate importance for both wintering and breeding water birds **(Bird Life**

International, 2008). Edku Lake is situated approximately 30 km east of Alexandria between Long. 30°8′30″ and 30°23′0.0″E and Lat. 31°10′30″ and 31°N (Fig., 1). Its area has decreased from 28.5 × 10^3 to about 12 × 10^3 Feddans as a result of agricultural reclamation. The depth of the lake fluctuates between 60 and 150 cm with an average of about one meter **(Saad, 2003)**. Satellite images from 2007 indicate that the total surface area of the lagoon is about 62.5 km^2, 22 km^2 of which is open water; the remaining area (42.7 km^2) is covered by aquatic vegetation, islands and islets. According to these estimates, the open water area thus represents only 35% of the total surface area of the lake **(Moufaddal *et al.*, 2008)**.

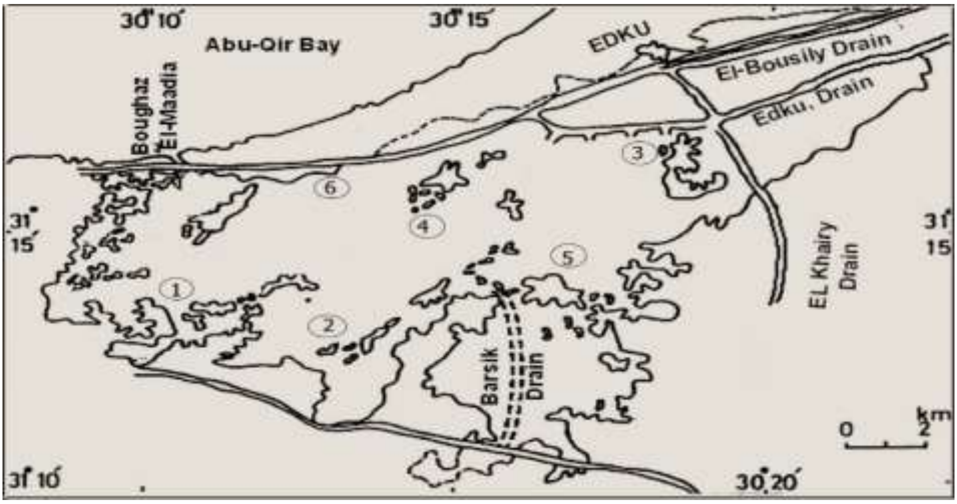


Fig 1: Edku Lake maps clear study stations and main drain canals

The lake can be divided into three ill-defined basins; eastern, central and western. Edku Lake receives huge amounts of drainage water from four main drains, namely, Edku, El Bousily, El Khairy and Bersik as shown in Fig. (1), which open into the eastern basin of the lake **(Okbah and El-Gohary, 2002)**. The drainage water contains unspecified quantities of urban, industrial and agricultural chemicals from the Beheira Governorate and beyond. Based on the diffuse sources of pollution many chemicals from human activities would be present in the drainage water. The water source of El-Khairy Drain (annual inflow 592×10^6 m^3) is from three drainage waters coming from El Bousily, Edku and Damanhour sub-drains, transporting domestic, agricultural and industrial wastes, as well as the drainage water of many fish farms **(Badr and Hussein, 2010)**. While, Barsik Drain (annual inflow 348×10^6 m^3) transports mainly agricultural drainage water to the lake. The lake also receives sea water at its north western part through Boughaz El-Maadia from Abu kir Bay.

Sampling

Sampling stations are shown in Table 1 and Figure 1. Twenty-four surface water samples were collected from sex stations using motor boat during four seasons through 2017. Location of selected stations were determined using Geographic Positioning System (GPS). For water quality analyses, water samples were taken at 0–20 cm below the surface, then it kept in acid cleaned stoppered Polyethylene plastic bottles (500 ml) for later examination, then kept refrigerated and transferred in ice boxes to the laboratory **(APHA, 2000)**. For Bacterial analyses, Bacteria from the water and fish organs (skin, gills and muscle) were isolated using the spread plate technique **(APHA, 1995)**.

Table 1: Location of Sampling stations

Station	Common Station Name	Latitude /	Longitude
1	El-Tawila	31°26'24.93"N	30°23'48.89"E
2	El-Shlachel	31˚24'01.23"N	30˚21'96.90"E
3	Abu Hummus drain	31˚15'48.15"N	30˚13'57.94"E
4	El-Kanaess	31˚25'33.26"N	30˚20'65.20"E
5	Edko Pumps	31˚15'23.25"N	30˚13'42.64"E
6	Nakhnookh	31˚16'43.17'N	30˚14'42.90"E

Methods of analyses

During sampling, temperature and pH were measured using glass electrode Digital Mini-pH-meter (Model 55). Salinity, total dissolved solid and electrical conductivity were measured by salinity-conductivity meter (model YSI EC 300). dissolved oxygen was measured using a digital oxygen meter (Aqua-lytic OX24). Total ammonia (NH_4-N) concentration was measured by Hach Comparison Apparatus (HCA) following the method reported by **APHA (2000)**.

Laboratory analyses, Total alkalinity (mg/l) was measured by titration method according to **APHA (2000)**. Nitrite, NO_2- N (mg/l) was measured by Diazotizing method at 543 nm. Nitrate, NO_3-N (mg/l) was determined by Phenoldisulphonic acid method at 410 nm **(APHA, 2000)**. Ortho-phosphorus (mg/l), Total phosphorus (mg/l) and chlorophyll-*a* (µg/l) concentration were determined photometrically using was measured according to **APHA (2000)** using spectrophotometer Thermo Electron Corporation (model Nicolet Evolution 100).

For Bacterial analyses, one milliliter of the water sample was serially diluted in sterile peptone water and plated. Skin and muscle contents of tilapia fish were taken aseptically, I cm of skin and 1 g of muscle was homogenized separately in 9 ml sterile peptone water, the homogenized samples were then diluted using 10- fold serial dilution up to 10^5 in sterile peptone water. Total bacterial count and coliform group were estimated on plate count agar and Mackonky agar (Oxoid), respectively according to **APHA (1995)**. Three Petri-dishes from dilutions were incubated for total bacterial count and coliform group at 37 °C for 24 hours.

The statistical analysis was applied according to **Sendector and Cochran (1982)**. Differences between means were tested at 5% probability level according to Duncan's new multiple rang test **(Duncan, 1955)**. All statistical evaluations were done using SPSS computer program according to **Dytham (1999)**.

RESULTS And DISCUSSION

Physicochemical parameters and nutrients of the lake water

The changes to the aquatic environment can be easily detected through the lake water quality monitoring and so monitoring on different aspects of water quality over time allows a complete picture of the status of water resource. All the physical, chemical and biological parameters are to be measured to investigate the degree of stress of the aquatic ecosystem **(Pal *et al.*, 2015**).

Physicochemical parameters (temperature, pH, salinity, DO & T. Alk.), nutrients (NH_4, NO_2, NO_3, OP_4^{-2} & TP) and chlorophyll a (Chl-a) in all stations are tabulated in Tables (2& 3) to assess water quality of the lake. Temporal and spatial changes of parameters (based on average value) were given in Fig. (2).

Water quality parameters of Edku lake were cleared significant difference ($p < 0.05$) among stations, seasons and their interaction except dissolved oxygen not had significant difference ($p > 0.05$) of stations and seasons interaction.

Temperature is one of the most important factors affecting the physiology, growth, reproduction and metabolism of tilapia. The optimum temperature range for normal development, reproduction and growth of tilapia is about 25-32°C, depending on the fish species **(Chervinski, 1982)**. The seasonality fluctuation in the lake water temperature was ranged between 18.5 °C to 31 °C during the study period.

pH values have an important role in the most life processes in aquatic system which can be reflect the productivity and pollution level of the aquatic ecology. It is more important for determining the corrosive nature of water **(Okbah *et al*., 2017)**. Water pH variable had indirect toxic effects on aquatic biota through changes to the toxicity of several contamination **(Abu Khatit *et al*., 2017)**.

From Table (2) and Fig. (2) the smallest pH value was recorded in winter (7.8) at stations 3 and 4, these results may be due to the increase of organic matter in these stations which nearest from drains enters of (El Bosily, EdKu and El Kairy). On the other hand, the highest values were (9.1 and 8.9) in summer season at stations (1 & 6) with the increase of water discharge. These results were agreed with **Saeed, 2013** who indicted that pH of Edku lake lies in the alkaline side. Where the highest values were recorded in summer during the outbreak of chlorophyll "a" biomass and aquatic plants, the lowest pH values appeared in winter due to the increase of sewage wastewater. The desirable pH range for most fish species is 6-9 **(Barker *et al.*, 2009)**.

Okbah *et al*. (2017) showed that pH variation between stations may be controlled by the density of phytoplankton count and the water quality inflow to the lake, where the phytoplankton population increasing cause an increase in the pH value and oxygen super saturation due to the high photosynthetic activity by green and blue green algae **(El-Sherif and Mahmoud, 1991)**, with reducing of CO_2 amount in water **(Masoud *et al*., 2001)**.

Salinity is one of the most important factors that affect the species dynamics, faunal composition, distribution and diversity of bottom population in many aquatic ecosystems (**Darwish, 2016)**. The lake salinity, electrical conductivity and total dissolved solid were varied between 1.3 g/l, 2.47 mS/cm & 1.273 mg/l, respectively as the lowest value at station 1 and 2.8 g/l, 4.93 mS/cm & 3.1 mg/l, respectively as the highest value at stations 5 & 4. Generally, the salinity of the water lake raised in the summer season recorded significantly difference ($p < 0.05$) more than in the rest of the seasons, and this may be due to the high temperature and increasing the evaporation rates which agree with **(Farouk, 2009** & **El Morshedy, 2017)**.

Dissolved oxygen (DO) is one of the most important parameters in the lake ecosystem. Oxygen depletion can cause large changes in the population of fish, leading, in extreme cases, to the massive fish kill **(Barica and Mathias, 1979)**. Oxygen content can be used as an indicator of organic loading, nutrient input and biological activity **(Shaker, 2008)**. The level of dissolved oxygen in the northern Lakes of Egypt is affected by

Table 2: physical parameters of Edku lake water in the study stations.

station	season	Temp	pH	Salinity	EC	TDS	DO
1	Winter	18.5±0.115 h	8.1±0.058 i	1.3±0.03 i	2.47±0.115 i	1.273±0.028 n	6.5±0.115 a
	Springe	23.5±0.058 e	8.6±0.033 de	1.3±0.03 i	2.70±0.058 h	1.390±0.038 lm	6.0±0.404 bc
	Summer	30.5±0.289 b	8.7±0.033 de	1.6±0.06 ef	2.83±0.033 h	1.720±0.042 ghi	4.5±0.058 i
	Autumn	24.6±0.173 d	8.9±0.012 b	1.5±0.03 gh	2.77±0.033 h	1.600±0.058 hijk	5.5±0.0001 de
2	Winter	19±0.058 gh	8.2±0.033 hi	1.5±0.03 fgh	3.10±0.058 g	1.587±0.030 ijk	6.0±0.058 bc
	Springe	23.5±0.231 e	8.3±0.029 h	1.4±0.03 h	3.13±0.033 fg	1.393±0.047 lm	5.4±0.115 ef
	Summer	30.5±0.346 b	8.4±0.033 fg	1.8±0.03 d	3.34±0.032 e	1.907±0.058 f	3.8±0.058 jk
	Autumn	24.5±0.115 d	8.4±0.058 g	1.6±0.03 fg	3.33±0.033 e	1.750±0.029 gh	4.7±0.088 hi
3	Winter	19.0±0.289 gh	7.8±0.033 j	1.6±0.03 fg	3.13±0.033 fg	1.657±0.023 hij	5.5±0.0001 de
	Springe	23.5±0.058 e	8.2±0.033 hi	1.5±0.03 fgh	3.03±0.033 g	1.517±0.046 jkl	4.9±0.058 gh
	Summer	30.5±0.231 b	8.3±0.033 h	2.2±0.03 c	3.17±0.033 fg	2.300±0.058 d	2.8±0.0001 m
	Autumn	25.6±0.231 c	8.8±0.044 bc	1.9±0.03 d	3.67±0.033 d	1.950±0.064 ef	3.9±0.058 j
4	Winter	18.5±0.058 h	8.2±0.033 hi	2.2±0.03 c	4.57±0.033 b	2.730±0.064 b	5.0±0.058 gh
	Springe	22.5±0.346 f	8.5±0.033 fg	2.1±0.03 c	4.17±0.033 c	2.100±0.058 e	4.5±0.115 i
	Summer	31±0.173 ab	8.6±0.033 def	2.8±0.03 a	4.93±0.033 a	3.100±0.058 a	2.6±0.058 m
	Autumn	25.7±0.289 c	8.7±0.044 de	2.5±0.03 b	4.50±0.058 b	2.583±0.017 c	3.6±0.115 jk
5	Winter	19.5±0.058 g	7.8±0.044 j	1.9±0.03 d	3.33±0.033 e	2.000±0.058 ef	6.2±0.115 ab
	Springe	24.5±0.173 d	8.1±0.058 i	1.8±0.07 d	3.27±0.033 ef	2.100±0.058 e	5.5±0.115 de
	Summer	31.5±0.346 a	8.5±0.033 fg	2.2±0.06 c	4.14±0.081 c	2.300±0.058 d	3.5±0.088 kl
	Autumn	26±0.404 c	8.6±0.029 ef	2.2±0.03 c	4.17±0.033 c	2.300±0.058 d	4.7±0.088 hi
6	Winter	19.5±0.289 g	8.1±0.058 i	1.6±0.03 ef	3.33±0.032 e	1.610±0.055 hijk	5.8±0.088 cd
	Springe	23.5±0.115 e	8.8±0.060 bc	1.5±0.03 gh	3.10±0.058 g	1.467±0.033 kl	5.1±0.058 fg
	Summer	31.5±0.231 a	9.1±0.058 a	1.9±0.03 d	4.10±0.058 b	1.953±0.044 ef	3.2±0.115 l
	Autumn	26.2±0.115 c	8.7±0.058 cd	1.7±0.06 e	3.83±0.033 c	1.850±0.069 fg	4.4±0.058 i
Two Way ANOVA					*P value*		
Station		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Season		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Station ×Season		0.001	0.0001	0.0001	0.0001	0.0001	0.140

Means having the same letter in the same column are not significantly different at P < 0.05

Table 3: Chemical parameters of Edku lake water in the study stations.

station	season	Ammonia	nitrite	nitrate	PO_4^{-2}	Chlor. - a	TP	T. Alk
	Winter	1.547±0.026 n	0.287±0.003 fg	0.289±0.001 p	0.452±0.001 ij	66.66±0.58 i	1.111±0.011 fgh	260±5.196 kl
1	Springe	1.803±0.009 m	0.226±0.003 jk	0.314±0.001 o	0.461±0.001 gh	74.12±2.32 g	1.172±0.079 ef	500±2.887 c
	Summer	2.083±0.044 k	0.147±0.001 l	0.418±0.001 j	0.488±0.001 e	96.90±2.08 c	1.334±0.021 cde	250±1.155 mn
	Autumn	1.803±0.009 m	0.132±0.001 l	0.376±0.002 m	0.488±0.000 e	81.50±1.55 f	1.241±0.069 def	245±0.333 o
	Winter	2.067±0.033 k	0.248±0.004 ij	0.336±0.001 n	0.455±0.001 hi	71.14±0.60 gh	0.943±0.030 hij	275±1.155 gh
	Springe	2.497±0.055 i	0.219±0.011 k	0.309±0.006 o	0.419±0.002 l	80.16±0.56 f	0.951±0.016 hij	525±1.732 b
2	Summer	3.233±0.033 f	0.294±0.004 fg	0.399±0.002 k	0.462±0.001 g	99.12±0.22 bc	1.072±0.023 fghi	275±1.155 gh
	Autumn	2.843±0.029 gh	0.244±0.002 ij	0.375±0.003 m	0.485±0.003 e	88.94±0.58 de	0.966±0.013 ghij	262±0.577 jk
	Winter	1.943±0.023 l	0.258±0.004 hi	0.961±0.001 f	0.499±0.001 d	91.06±0.61 d	1.135±0.021 fg	255.3±1.453 lm
	Springe	1.940±0.006 l	0.233±0.006 jk	0.758±0.002 h	0.524±0.003 b	101.07±1.37 b	1.242±0.031 def	550±1.732 a
3	Summer	2.500±0.058 i	0.242±0.005 ij	1.134±0.002 d	0.611±0.001 a	110.16±2.92 a	1.367±0.125 cd	285±2.309 f
	Autumn	2.210±0.038 j	0.256±0.001 hi	0.888±0.005 g	0.447±0.002 jk	99.95±0.58 bc	1.421±0.057 bc	274±1.732 ghi
	Winter	1.250±0.029 o	0.052±0.001 n	0.167±0.001 t	0.212±0.001 o	65.72±0.41 i	0.874±0.029 j	295±0.577 e
	Springe	1.500±0.058 n	0.063±0.001 mn	0.179±0.002 s	0.229±0.001 n	70.77±0.43 gh	0.892±0.051 ij	475±1.155 d
4	Summer	1.700±0.058 m	0.081±0.001 m	0.219±0.002 q	0.248±0.001 m	87.16±1.05 e	0.913±0.010 ij	274.3±0.333 ghi
	Autumn	1.503±0.052 n	0.055±0.003 n	0.188±0.001 r	0.251±0.005 m	80.11±1.32 f	0.845±0.043 j	268±0.0001 ij
	Winter	4.150±0.029 d	0.378±0.002 d	1.356±0.002 b	0.462±0.001 g	41.16±1.93 m	1.199±0.075 def	280±2.887 fg
	Springe	5.147±0.074 c	0.335±0.001 e	1.103±0.006 e	0.444±0.0001 k	50.02±1.75 l	1.562±0.080 ab	500±3.464 c
5	Summer	6.450±0.029 a	0.484±0.002 b	1.572±0.005 a	0.511±0.003 c	60.17±0.47 j	1.666±0.089 a	255±4.041 lm
	Autumn	5.700±0.058 b	0.420±0.017 c	1.146±0.003 c	0.473±0.002 f	55.50±0.24 k	1.434±0.117 bc	249±1.155 mn
	Winter	2.433±0.033 i	0.274±0.003 gh	0.311±0.001 o	0.421±0.002 l	55.17±0.10 k	0.794±0.051 j	284±0.577 f
6	Springe	2.740±0.032 h	0.246±0.003 ij	0.332±0.002 n	0.495±0.002 d	60.77±0.45 j	0.824±0.014 j	525±3.464 b
	Summer	3.500±0.058 e	0.550±0.026 a	0.476±0.003 i	0.511±0.002 c	74.19±1.02 g	0.903±0.029 ij	270±1.202 hi
	Autumn	2.933±0.044 g	0.304±0.003 f	0.388±0.001 l	0.473±0.002 f	69.32±0.39 hi	0.817±0.010 j	260±0.577 kl
Two Way ANOVA					*P value*			
Station		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Season		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Station ×Season		0.0001	0.0001	0.0001	0.0001	0.0001	0.031	0.0001

Means having the same letter in the same column are not significantly different at P < 0.05

many factors such as temperature, wind, photosynthetic activity of phytoplankton communities, and respiration of heterotrophic, autotrophic organisms and decomposition of organic matter **(Zaghloul *et al*., 2005)**.

Dissolved oxygen of the lake fluctuated among seasons depending on water temperature where during winter ranged from 5.0 to 6.5 mg/l, in spring ranged between 4.5 to 6.0 mg/l and ranged from 2.6 to 4.5 mg/l during summer, while in autumn ranged between 3.6 and 5.5 mg/l. These results cleared that the highest values of dissolved oxygen recorded during winter while summer recorded the lowest values. **Boyed and Tucker (1998)** reported that the dissolved of oxygen from air to water decrease with increasing temperature.

Also, the DO results had showed the lowest average values at stations (4 then 3) (Fig. 2), this may be attributed to microbial degradation by oxygen consumption of organic matter loaded by higher amount of sewage wastewater and drainage water poured in these areas from the drains (El Bosily, EdKu and El Khairy) which agree with **(Farouk, 2009)**.

In aquatic environmental, ammonia can be product from several sources such as sewage effluents, industrial wastes agricultural run-off and decomposition of biologic wastes **(Randall and Tsui, 2002)**. It may result from the bacterial decomposition of organic matter containing nitrogen **(Shakweer, 2005)**. Nitrogenous compounds, nitrite and nitrate, despite the seriousness of these compounds, it is one of the specific compounds to the water where fertility is considered alongside of the most important sources of ammonia nitrogen for algae and aquatic plants.

The results of ammonia (NH_4-N) in the lake were ranged between 1.54 – 2.08 mg/l, 2.06- 3.23 mg/l, 1.94- 2.5 mg/l, 1.25- 1.7 mg/l, 4.15- 6.45 mg/l and 2.43- 3.5 mg/l for the study stations from 1 to 6 respectively. While, Nitrite (NO_2-N) values of the lake ranged between minimum value of 0.052 mg/l at station 4 during winter and maximum value of 0.484 mg/l at stations 5 during summer, and lake nitrate (NO_3-N) content followed the same trend, where it recorded the highest value in summer (1.572 mg/l) and the lowest one in winter (0.167 and 0.12 mg/l).

These results of inorganic nitrogen compounds indicated that the highest values were recorded at stations (5, 3 &2) nearest the drains to increasing accumulated organic compounds in them and this agree with **Saeed (2013)** and **El Morshedy (2017)**. Also, noted that the highest values were recorded during summer which may be due to the un ionized ammonia depending on temperature, i.e. the rate of the ammonification process increases converting the organic matter to ammonia, especially at high temperature.

These results agree with those obtained by **El Morshedy (2017)** and **Abu Khatit *et al*. (2017)** who reported attributed that results to the high rate of microbial activity associated with high organic compound and in turn high nitrogen content.

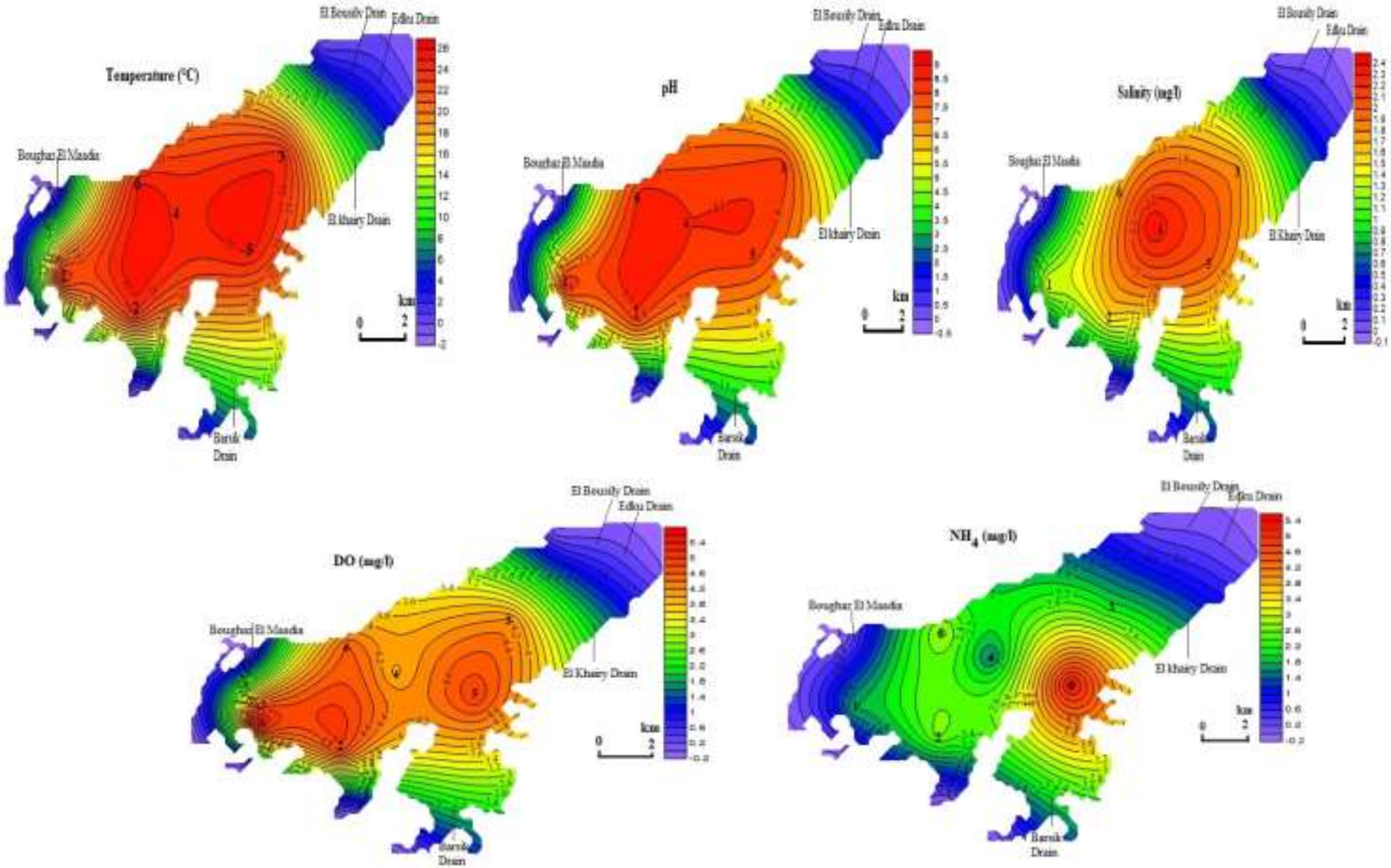
Phosphorus (P) is the rate-limiting nutrient in the eutrophication of most freshwater ecosystems **Mainston and Parr (2002**). **Schlotfeldt and Alderman (1995)** suggested a range of phosphate from 0.6 to 1.0 mg/l for freshwater species.

Ortho phosphate results were ranged from the maximum value of 0.611 mg/l in summer and the minimum value of 0.212 mg/l in winter. Where, station 3 was had the significantly ($p > 0.05$) increase than other stations of reactive phosphate are mostly because of drainage water enriched with phosphorous compounds. The concentration of all nutrients (NH_4, NO_2, NO_3, OP_4 & TP) in this study were higher than those recorded in the same lake by **(Saeed, 2013**; **Okbah *et al*., 2017**& **El Morshedy, 2017)**.

Chlorophyll "a" is an important indicator for the presence of algae and it is often considered as the dominant factor for assessing eutrophication **(Zhou *et al.*, 2004)**. Chlorophyll "a" concentration in Edku lake varied from 41.16 µg/l in winter to 110.16 µg/l in summer. These results are in agreement with **Abel (1998)** and **Shaker (2006)**, who reported that the chlorophyll "a" concentration is depending on many factors in water like water temperatures, algal photosynthetic activities and macronutrient content. Also, **French and Petticrew (2007)** found Positive associations between instantaneous (chlorophyll "a”) and temperature that forecast changes in phytoplankton productivity even if nutrient loading rates remain constant.

the maxima average of chlorophyll "a" was recorded at station 3 during the study because it at nearest of the mains drains (Barsik, Edku and El Khairy) where the high amounts of nutrient salts, Fig. (3) and this agree with **Abu Khatita *et al*. (2017)** who found the same investigation in Manzala lake and indicated that there is good relation between chlorophyll "a" and nutrient salts (ammonia, and orthophosphate) because nutrient concentrations led to an increase in algal density and consequently, severe eutrophic conditions. Generally, chlorophyll "a" is used as an indicator for the fertility of water and phytoplankton. Increases of nutrient in the water is leading to increases phytoplankton and chlorophyll "a".

The highest value of total phosphorus was 1.666 mg/l at station 5 during summer while the lowest value of it was 0.794 mg/l at station 6. The


Temperature (°C)
pH
Salinity (mg/l)
DO (mg/l)
NH4 (mg/l)
El Boussily Drain
Edku Drain
El Khairy Drain
Boughaz El Maadia
Barsik Drain
km
0
2

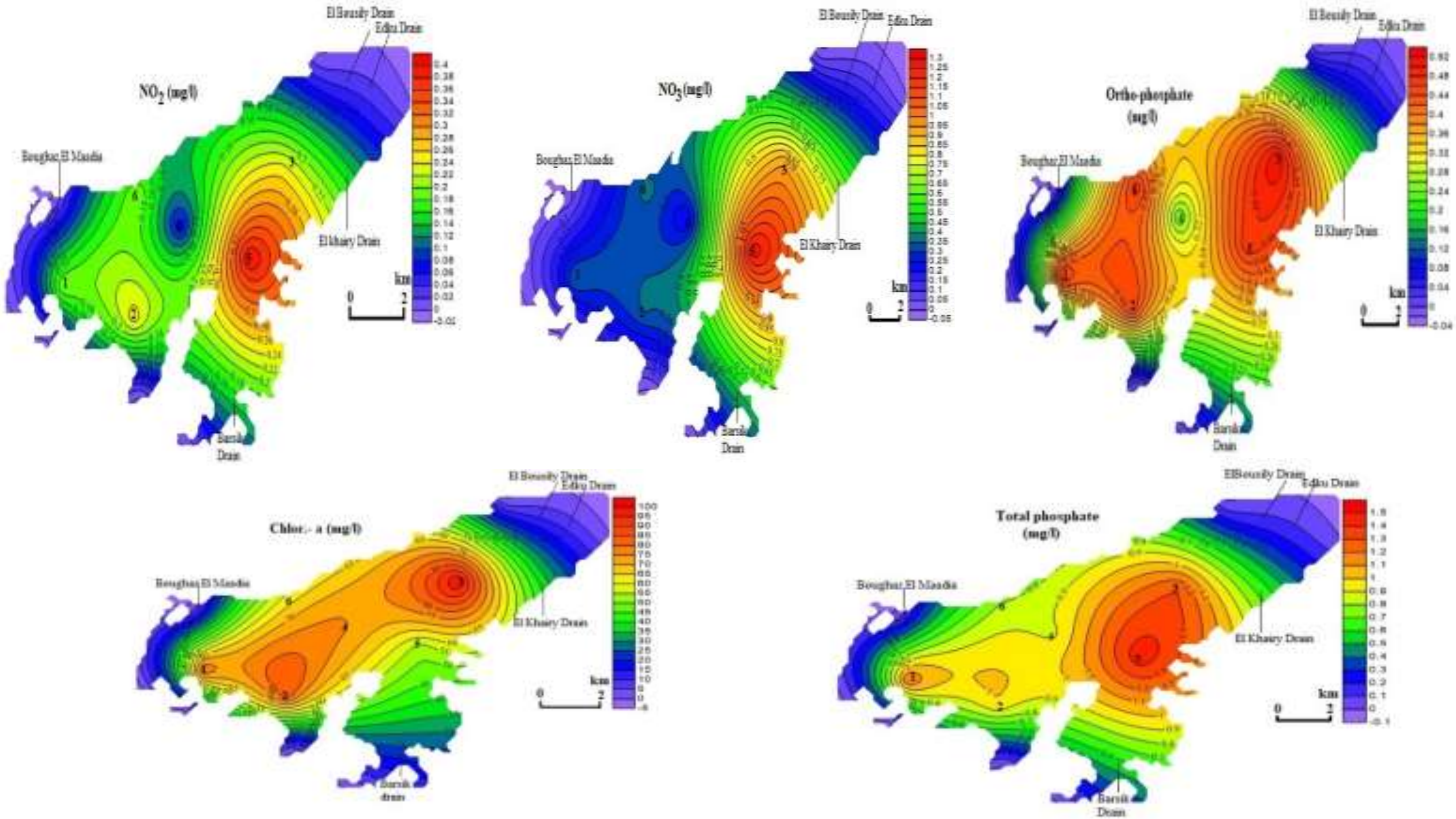


Fig. 2: Lateral distribution based on average values of different parameters in water samples of Edku lake.

highest concentration appeared in stations which are subjected to direct influx of drainage water and sewage wastewater.

As illustrated in Table (3), total alkalinity of the lake varied between the maxima of 550 mg/l at station 3 during springe and the minima of 245 m/l at station 1 during autumn. these finding clear that the total alkalinity in the lake water are depends on organic compounds content in water discharge to the lake and the main drains canals, Fig. (2).

Interpretation of lake water quality average results (Fig. 2) were done according to **Pooja Devi (2013)** who recommended water-quality criteria for fishery for getting high yield via applying minimum input. Where the results of temperature, pH, dissolved oxygen and phosphorus were indicated in suitable range at all study stations. Results of ammonia and nitrite were indicated in stress range for fish while nitrate results were lied as desirable results. Also, total alkalinity results recorded in stress range for fish.

Bacteriological load quality

Bacteriological quality is of importance to public health since it directly relates to fish spoilage and may cause food poisoning. It is therefore important to monitor the quality of harvested freshwater fish **(Ibemenuga and Okeke, 2014)**. In addition to, the bacteriological examination of the source of water on the fish is very necessary in order to detect the kind of bacteria being transferred into the fish environments. It can serve as a guide to monitor and protect our fish quality as well as our health **(Abdel-Hamid, 2017)**.

Data in Table (4) addresses the total bacterial count and coliform group in water and tissues (skin & muscle) of tilapia species at different stations of Edku lake. Water results shows that the highest values of total bacterial count and coliform group were recorded at station 5 and 3 as 63.17 & 27.17 $\times 10^5$ CFU/ml and 10.77 & 5.35 $\times 10^4$ CFU/ml, respectively, while lowest values were 2.1 & 0.33 $\times 10^5$ CFU/ml respectively at station 4 in middle of the lake in side to stations (1, 2 &6) were recoded the lowest values also, Fig, (3). The highest bacterial load at stations (5 &3) related to their site nearest from drains mouth (Edku, El Bousily, El Khairy & Barsik) as shows in Fig. (2) and this gives indicators on pollution of these stations, which agree with **Abdel-Hamid (2017)** investigated pollution of El-Genka station in Manzala lake as result to bacterial load increasing. This can also be attributed to non-processed drainage by different drains to lake water where were had he high loads of organic matter and bacteria this finding is in concurrent with **Mousa *et al*. (2018)** and **Anand *et al*. (2006)** who stated

Table 4: Changes in total bacterial count and coliform group in water and Tilapia tissues (skin & muscle) of Edku lake at the study stations.

station	season	TC water	CF water	TC Skin	TC Muscle	CF Skin	CF Muscle
1	Winter	2.60±0.058 o	0.40±0.029 no	3.33±0.202 p	0.47±0.046 k	0.74±0.040 lm	0.31±0.006 q
	Springe	2.88±0.040 no	0.51±0.006 mno	4.19±0.104 nop	0.69±0.023 jk	0.96±0.026 lm	0.78±0.006 k
	Summer	5.55±0.196 j	0.87±0.062 kl	7.97±0.445 j	1.13±0.075 jk	1.77±0.092 k	1.33±0.012 g
	Autumn	4.79±0.035 k	0.66±0.012 klmno	6.08±0.046 klm	0.89±0.040 jk	1.17±0.046 l	0.91±0.006 i
2	Winter	2.75±0.087 no	0.43±0.006 mno	4.75±0.081 n	0.56±0.040 jk	1.02±0.012 lm	0.11±0.006 t
	Springe	3.11±0.006 n	0.57±0.012 lmno	5.35±0.202 lmn	0.89±0.058 jk	1.77±0.060 k	0.230±0.006 s
	Summer	4.97±0.075 k	0.93±0.012 k	7.73±0.214 j	1.83±0.092 i	2.99±0.115 gh	0.550±0.006 n
	Autumn	3.87±0.046 m	0.78±0.006 klm	6.11±0.127 klm	1.05±0.087 jk	2.15±0.023 jk	0.430±0.006 o
3	Winter	14.55±0.225 h	1.66±0.052 i	21.75±0.260 h	3.88±0.029 h	2.37±0.017 ij	0.787±0.003 k
	Springe	17.11±0.075 g	2.71±0.087 g	27.17±0.416 g	4.79±0.035 g	3.33±0.191 g	1.250±0.006 h
	Summer	27.17±0.098 e	5.35±0.214 d	39.01±0.629 e	7.40±0.248 d	5.16±0.092 e	2.660±0.006 d
	Autumn	21.89±0.312 f	3.79±0.035 f	33.13±0.364 f	6.07±0.098 f	4.24±0.139 f	1.877±0.009 e
4	Winter	2.10±0.064 p	0.33±0.017 o	3.55±0.237 op	0.49±0.035 k	0.71±0.052 m	0.250±0.006 r
	Springe	3.99±0.254 lm	0.67±0.012 klmno	4.61±0.165 no	0.67±0.017 jk	1.11±0.040 lm	0.440±0.006 o
	Summer	5.45±0.202 j	1.63±0.127 ij	6.36±0.202 kl	1.19±0.098 j	2.75±0.196 hi	0.787±0.003 k
	Autumn	4.31±0.162 l	0.94±0.029 k	5.11±0.185 mn	0.93±0.035 jk	2.02±0.052 jk	0.580±0.006 m
5	Winter	35.55±0.115 d	4.44±0.242 e	51.11±0.716 d	6.77±0.191 e	6.14±0.087 d	1.780±0.006 f
	Springe	43.14±0.087 c	6.16±0.156 c	61.66±0.312 c	8.32±0.271 c	8.14±0.341 c	3.140±0.006 c
	Summer	63.17±0.162 a	10.77±0.248 a	88.18±0.491 a	14.04±0.687 a	13.07±0.254 a	5.470±0.006 a
	Autumn	54.18±0.098 b	8.02±0.139 b	70.07±0.901 b	10.14±0.283 b	10.07±0.329 b	4.090±0.006 b
6	Winter	3.77±0.087 m	0.74±0.069 klmn	5.09±0.191 mn	0.64±0.052 jk	1.08±0.064 lm	0.370±0.006 p
	Springe	4.88±0.064 k	1.33±0.069 j	6.88±0.064 jk	1.11±0.075 jk	2.11±0.081 jk	0.650±0.006 l
	Summer	7.09±0.087 i	2.97±0.046 g	9.19±0.404 i	2.29±0.092 i	4.12±0.100 f	1.340±0.006 g
	Autumn	5.75±0.081 j	2.02±0.191 h	7.62±0.195 j	1.77±0.393 i	3.17±0.121 g	0.870±0.006 j
Two Way ANOVA				*P value*			
Station		0.0001	0.0001	0.0001	0.0001	0.0001	0.444
Season		0.0001	0.0001	0.0001	0.0001	0.0001	0.289
Station ×Season		0.0001	0.0001	0.0001	0.0001	0.0001	0.484

Means having the same letter in the same column are not significantly different at P < 0.05

that most of wastewaters are dumped straight into rivers, lakes and estuaries without any treatment.

Figs. (3& 4) shows the seasonal variations of bacterial load (TC & CF) at different stations of the lake, where the highest values recorded during summer then autumn and the lowest values during winter. This indicate that the increase in bacterial load associated with increased temperature was due to the increased degradation of organic matter and daring water in the Lake. the results agree with **Mousa *et al*. (2018)** who investigated that increasing fecal coli load in their study locations during hot seasons which may be attributed to pollution of water from these locations with municipal sewage.

Data presented by **Whitman and Nevers (2008)** also showed a positive relationship between coliform group counts and temperature and concluded that day was the most important component of variation for their data set, more so than beach location, depth, or time of day. Significant relationships between FCs and temperature were also reported by **Frey *et al.* (2013)**, **Staley *et al.* (2013)** and **North *et al.* (2014)**.

Fish possess a diverse array of bacterial taxa, often reflecting the composition of the microflora of the surrounding water **(Austin, 2002)**. Bacteria often occur in parts of fish on the body or internal organs of fish which indicate the extent of pollution of aquatic ecosystems **(Salihu *et al*., 2012; Ibemenuga and Okeke, 2014)**.

The results of bacterial indicators in the lake waters were done according to the European Commission (EC) Guide Standard **(EC, 1998)**, which meet with the Egyptian Guide Standard **(Ministry of Health, Egypt, 1996)**. They accept the guide values of the investigated bacteria up to 50 CFU/ml of marine water for coliforms and 1CFU/ml for fecal coliforms (E. coli). this is indicating that the present results of lake water bacterial load are exceed the permissible values mentioned by **EC (1998)** and **Ministry of Health, Egypt (1996)**. Therefore, in order to prevent harmful bacteria from the fish environment, a lot of work should be done to reduce environment microbial load and to ensure that the water used is free from harmful bacteria.

As shown in Table (4) and Figures (3& 4), the seasonal variation in bacteriological indictors of water lake samples revealed that the bacterial load of tilapia species tissues, where the highest bacterial load (TC& CF) in muscle and skin of tilapia fish in Edku lake recoded at stations (3 & 5) during summer and autumn seasons. These related to centering of these stations from drains mouths in the lake with increasing temperature and

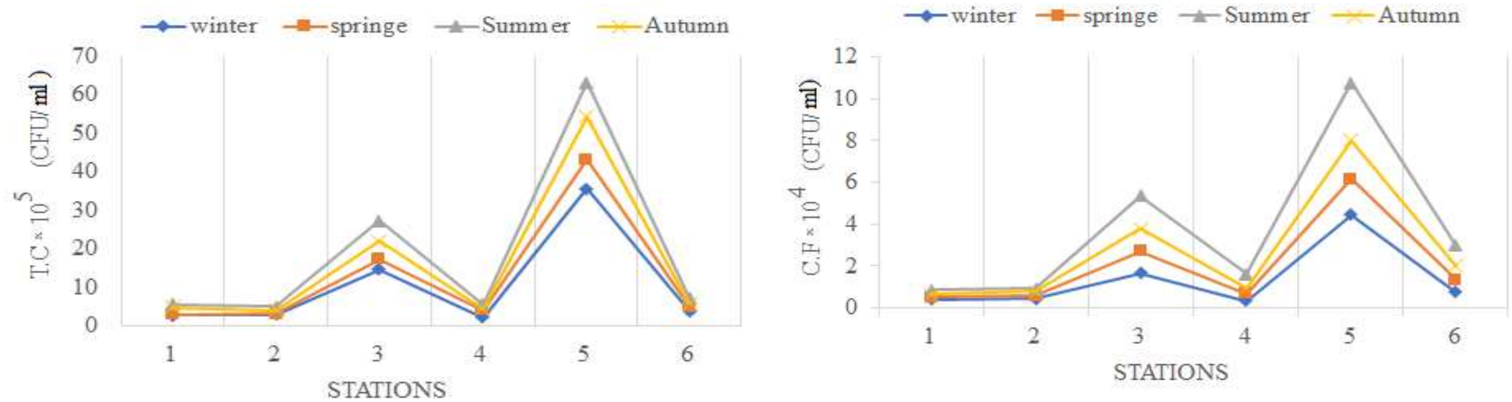


Fig. 3: Distribution of bacterial load (TC & CF) in the lake water at the study stations

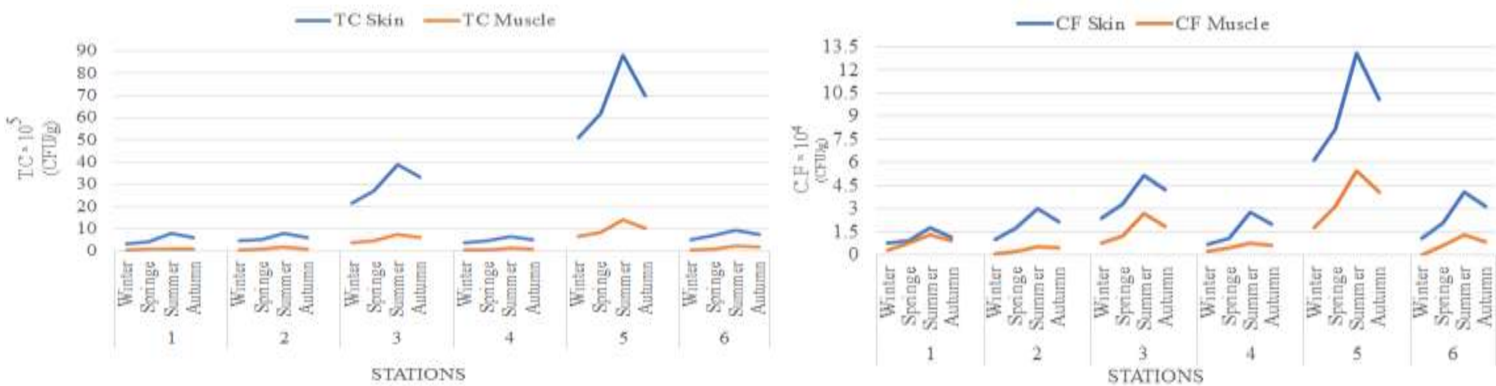


Fig. 4: Distribution of bacterial load (TC & CF) in Tilapia tissues skin &muscle) at the study stations

decomposition, the results in the same trend with **Anand *et al.* (2006)** who stated that most of wastewaters are dumped straight into rivers, lakes and estuaries without any treatment. In addition to faecal coliforms in fish reflect the level of pollution of their environment, as the normal flora of fish do not include coliforms **(Cohen & Suvalm, 1973).** In skin of tilapia, total bacterial count (TC) ranged between the highest numbers of (88.18×10^5 CFU/g) and the lowest number of (3.33×10^5 CFU/g). And coliform group (CF) ranged between the highest numbers of (13.07×10^4 CFU/g) and the lowest number of (0.74×10^4 CFU/g). While, Total bacterial count and coliform group in muscle of tilapia were (14.04 & 0.47×10^5 CFU/g) and (5.47 & 0.31×10^4 CFU/g), respectively as shown in Fig., s (). These results indicated that increasing bacterial load (TC & CF) on skin than muscle of Tilapia species and this agree with **Abdel-Hamid (2017)** which This may be due to contact with the skin directly to the aquatic environment contaminated with bacteria with the possibility of skin friction increases the bacterial load. While, muscle has been considered by some to be sterile **(Apun *et al*., 1999)**, whereas other investigators have reported the presence of bacteria **(Evelyn and McDermott, 1961)**. **Mandal *et al*. (2009)** stated that highest density of coliform bacteria in water is responsible for higher density of these bacteria in fish body.

Manuals of food quality control. FAO indicated **(FAO, 1979)** stated that total bacteria count should less than 10^5/gm and total coliforms should not exceed than 100/gm respectively. While, according to International Commission on the Microbiological Specification of Foods **(ICMSF, 1982)** indicated that acceptable limit of total bacterial counts and total coliform for white fish is 5×10^5 and 10 cfu/g respectively and E. coli should not be present. therefore, the bacterial loads found in this study for Nile tilapia organs (skin & muscle) was beyond the standard value, which indicate their unacceptability as food from public health point of view which may be cause human health risk due to consumption of tilapia collected.

Correlation Matrices

Interrelations between the studied water parameters and bacterial load in Edku lake was carried out by correlation coefficient as tabulated in Table (5). Where, total bacterial count (TC) of the lake water had positive significantly ($P < 0.05$) correlation with temperature and salinity where (r = 0.249 and 0.297, respectively), moreover it had positive significantly ($P < 0.01$) correlation with NH_4, NO_2, NO_3, PO_4^{-2} and TP where (r = 0.865, 0.583, 0.925, 0.329 and 0.762 respectively). And it had negative significantly ($P < 0.01$) correlation with chlorophyll "a" where ($r = -0.322$). Also, coliform group (CF) of the lake water had positive significantly ($P < 0.01$) correlation with temperature, salinity, NH_4, NO_2, NO_4, PO_4^{-2} and TP where (r = 0.397, 0.357, 0.633, 0.890, 0.361 and 0.713 respectively). And it had negative significantly ($P < 0.01$) correlation with dissolved oxygen where ($r = -0.322$).

TC on tilapia skin had positive significantly ($P < 0.05$) correlation with temperature, salinity and TDS where (r = 0.239, 0.278 and 0.268 respectively), moreover it had positive significantly ($P < 0.01$) correlation with NH_4, NO_2, NO_3, PO_4^{-2} and TP where (r = 0.854, 0.851, 0.940, 0.347 and 0.776 respectively). And it had negative significantly ($P < 0.05$) correlation with chlorophyll "a" where ($r = -0.301$). While, TC on tilapia muscle had positive significantly ($P < 0.01$) correlation with temperature, NO_2, NO_3, PO_4 and TP where (r = 0.314, 0.529, 0.944, 0.395 and 0.786 respectively). moreover, it had positive significantly ($P < 0.05$) correlation with salinity, TDS and NH_4 where (r = 0.295, 0.275 and 0.824 respectively). And it had negative significantly ($P < 0.05$) correlation with DO where ($r = -0.240$).

CF on tilapia skin had positive significantly ($P < 0.01$) correlation with temperature, salinity, TDS, NH_4, NO_2, NO_3, PO_4^{-2} and TP where (r = 0.422, 0.356, 0.340, 0.924, 0.657, 0.865, 0.329 and 0.694 respectively). moreover, it had positive significantly ($P < 0.05$) correlation with EC where ($r = 0.270$). And it had negative significantly ($P < 0.05$) correlation with DO and chlorophyll "a" where (r = -0.297 and -0.298 respectively). While, CF on tilapia muscle had positive significantly ($P < 0.01$) correlation with temperature, salinity, NH_4, NO_2, NO_3 and TP where (r = 0.453, 0.324, 0.310, 0.896, 577 and 0.784 respectively). moreover, it had positive significantly ($P < 0.05$) correlation with PO_4^{-2} where ($r = 0.371$). And it had negative significantly ($P < 0.05$) correlation with DO where (r = -0.306 respectively).

Generally, bacterial load had correlation coefficient with water quality parameters, which was positive correlation with temp., saln., Ec, TDS, NH_4, NO_2, NO_3, PO_4^{-2} and Tp. And negative correlation with pH, DO and T. Alk. Previous work on natural waters has shown relationships between indicator bacteria and environmental parameters. Water temperature is one of the most important environmental parameters affecting the concentrations of fecal indicator bacteria **(Matsumoto and Omura, 1980)**. Some authors reported an inverse relationship between FC and water temperature, in contrast to other researchers, who found a direct relationship between FC and water temperature **(Matsumoto and Omura, 1980& Vaatanen, 1980)**. **Simon and Makarewicz (2009)** concluded that the summer peak observed in their bacterial indicators, **Whitman and Nevers (2008)** and **North *et al*. (2014)** also showed a positive relationship between E. coli counts and temperature and concluded that day was the most important component of variation for their data set and the significant relationships between FCs and temperature was also reported by both **Frey *et al.* (2013)** and **Staley *et al.* (2013)**.

The absence of favorable environmental conditions and the decreased values of salinity are the main factors affecting the presence of aquatic fauna in the lake **(Shaltout** and **Al-Sodany, 2008)**. Where, **Mousa *et al*. (2018)** mentioned that water salinity decreasing that is being the main factor that leads to the diversion of the microbial communities. **Spietz *et al*. (2015)** found a strong negative association between bacterial richness and dissolved oxygen. The results that showed the influence of pH on the survival fecal coli (FC) was inconsistent **(Jamieson *et al*., 2002** and **Neger, 2002)**. FC bacteria have greater survival in neutral environments in the pH range of 6 to 7, where the survival rate of coliform (fecal coli) in acidic environment was 7.5% and in alkaline environment was 66.11% **(Wahyuni, 2015)**. **Abdel-Hamid (2017)** suggested that DO decreasing was suitable for coliform group which consider facultative anaerobic bacteria. Also, decrease in NO_2, NO_3 and TN explained the nutrient consumed by bacteria and other aquatic life. A comparison of the nutrient levels in different also reveal that the TC was high when the nutrient levels were also high. **Sugumar and Anandharaj (2016**) revealed positive correlation between TBC and nutrients like phosphates. In the same trend **Romero (1999)** indicated that concentrations of FC are coincident with the increased phosphorus and nitrogen concentrations of lake water.

Conclusion

The study recommends that the need to treat the drainage of the lake to reduce the harmful bacterial load in the lake, which is detrimental to the health of fish and human consumption. also recommends to cleanse Boughaz and work on the establishment of radial channels from the Boughaz to many of the sites of the lake to increase the water exchange between the lake and the sea, as well as the disinfection from aquatic plants and benthic plankton for restoring the lake to the ecological balance.

Table 5: Pearson's correlation coefficients among the water parameters and bacterial load of Edku lake during four seasons of the study.

		temp	pH	Saln.	EC	TDS	NH_4	NO_2	NO_3	PO_4^{-2}	DO	Chlor	TP	T. Alk.	TC Water	CF water	TC Skin	TC Muscle	CF Skin	CF Muscle
Temp	Pearson Correlation Sig. (2-tailed)	1																		
pH	Pearson Correlation Sig. (2-tailed)	.598** .000	1																	
Saln.	Pearson Correlation Sig. (2-tailed)	428** .000	.116 .330	1																
EC	Pearson Correlation Sig. (2-tailed)	.303** .010	.239* ·043	.866** .000	1															
TDS	Pearson Correlation Sig. (2-tailed)	.380** .001	.090 .452	.945** .000	.858** .000	1														
NH_4	Pearson Correlation Sig. (2-tailed)	344** .003	-.027- .823	.149 .211	.14 5 .223	.149 .213	1													
NO_2	Pearson Correlation Sig. (2-tailed)	.228 .054	.020 .867	-.187- .117	-.107- .369	-.203- .087	.774** .000	1												
NO_3	Pearson Correlation Sig. (2-tailed)	.185 .119	-.296-* .012	.148 .214	-.027- .825	.135 .258	.754** .000	.618** .000	1											
PO_4^{-2}	Pearson Correlation Sig. (2-tailed)	.221 .062	.002 .988	-.522-** .000	-.641- ** .000	-.542-** .000	.390** .001	.644** .000	.523** .000	1										
DO	Pearson Correlation Sig. (2-tailed)	-.829-** .000	-.497-** .000	-.713-** .000	-.626- ** .000	-.651-** .000	-.120- .314	-.005- .967	-.093- .439	.083 .488	1									
Chlor.	Pearson Correlation Sig. (2-tailed)	.404** .000	.210 .077	.023 .845	-.138- .248	-.012- .922	-.465-** .000	-.331- **.005	-.161- .175	.194 .102	-.473- **.000	1								

TP	Pearson Correlation Sig. (2-tailed)	.294* .012	-.086- .472	.016 .894	-.195- .101	.040 .737	.562** .000	.364** .002	.762** .000	449** .000	-.061- .611	.050 .677	1						
T.ALK.	Pearson Correlation Sig. (2-tailed)	- .181 - .129	-.065- .590	-.295-* .012	-.238-* .044	-.321-** .006	-.081- .497	- .143- .230	- .121 - .310	- .048- .690	.257* .029	-.084- .480	-.043- .718	1					
TC Water	Pearson Correlation Sig. (2-tailed)	.249* .035	-.175- .140	.297* .011	.169 .155	.287* .015	.865** .000	.583** .000	.925** .000	.329** .005	-.148- .215	-.322-** .006	.762** .000	-.083- .489	1				
CF Water	Pearson Correlation Sig. (2-tailed)	.397** .001	-.029- .806	.357** .002	.245* .038	.333** .004	.869** .000	.633** .000	890** .000	.361** .002	-.308-** .009	-.255-* .031	.713** .000	- .11 4- .340	972** .000	1			
TC Skin	Pearson Correlation Sig. (2-tailed)	.239* .044	-.201- .091	.278* .018	.143 .229	.268* .023	854** .000	581** .000	940** .000	.347** .003	- .138 - .247	-.301-* .010	.776** .000	-.063- .596	.997** .000	.968** .000	1		
TC Muscle	Pearson Correlatio n Sig. (2-tailed)	.314** .007	- .148- .214	295* .012	.159 .182	.275* .019	.824** .000	.529** .000	.944** .000	395** .001	-.240-* .024	-.188- .114	.786** .000	-.090- .450	-.980** .000	.974** .000	.985** .000	1	
CF Skin	Pearson Correlation Sig. (2-ailed)	.422** .000	-.028- .816	.356** .002	.270*	.340** .004	.924** .000	.657** .000	.865** .000	329** .005	-.297-* .011	-.298-* .011	.694** .000	-.118- .331	.965** .000	.981** .000	.959** .000	.956** .000	1	
CF Muscle	Pearson Correlation Sig. (2-tailed)	.453** .000	.043 .722	.324** .005	.193 .105	.310** .008	.846** .000	.577** .000	.857** .000	371** .001	.306-** .009	-.211- .076	.784** .000	-.125- .296	.957** .000	.979** .000	.950** .000	.956** .000	.962** .000	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

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جودة المياة و الحمل البكتيري في المياة و أنسجة أسماك البلطي في بحيرة أدكو

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بحيرة أدكو أحد بحيرات مصر الشمالية و ثالثها من حيث المساحة و لها دوراً هام في الإنتاج السمكي إلا أن نظامها البيئي يعاني من العديد من مشاكل التلوث المائي نتيجة صرف مصرف أدكو و الخيري و البوصيلي و برسيق بها كل ذلك أثر على خواص جودة المياة في البحيرة و محتوها البكتري في المياة و الاسماك. لذلك تهدف الدراسة لتقييم جودة مياة البحيرة و الحمل البيكتري في المياة و أنسجة أسماك البلطي في البحيرة.

أجريت الراسة خلال أربع مواسم عام ٢٠١٧ حيث تم تجميع عينات مياة و أسماك من ستة مواقع في البحيرة و عمل تحليل درجة الحرارة- الاس الهيدروجيني- الملوحه- الأمونيا الكلية- النترات- النيتريت- الاكسجين الذائب- الفسفور الذائب- الفسفور الكلي و الكلوروفيل أ. بجانب العد الكلي للبكتريا و عد بكتريا القولون في المياة و أنسجة (جلد و لحم) أسماك البلطي.

أوضحت نتائج الدراسة أن قيم كلا من درجة الحرارة و الأس الهيدروجيني و الأكسجين الذائب و الفسفور في المدى المناسب للأسماك في مواقع الدراسة. بينما قيم الأمونيا و النترات و النيتريت كانت أعلى من الحدود المسموح بما يسبب الأجهاد للأسماك. كذلك كان العد البكتري (الكلي و القولون) في مياة البحيرة قد تجاوز القيم المسموح بها للبيئة المائية تبعا لوزارة الصحة المصرية ١٩٩٦ و المفوضية الأروبيه ١٩٩٨. أيضا العد البكتري (الكلي و القولون) في جلد و عضلات أسماك البلطي كانت أعلى من الحدود و المعاير الدولية لمنظمة الصحة العالمية و تشير إلى عدم قبولها كغذاء من وجهة نظر الصحة العامة و قد تسبب خطر على صحة الإنسان بسبب استهلاك البلطي كغذاء.

توصي الدراسة بضرورة معالجة الصرف النازحة للبحيرة للحد من الحمل البكتري الضار بها مع ضرورة تطهير البوغاز و عمل قنوات شعاعية من البوغاز للعديد من مواقع البحيره للتبادل المائي بين البحيره البحر مع التطهير من النباتات المائية والعوالق القاعية لإستعادة البحيرة للتوازن البيئي.