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Impact of seasonal changes on the quality of water and fish from Abu Za'baal Lakes

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Abstract

Physicochemical characteristics and concentrations of some heavy metals of water and two fish species in Abu Za'baal lakes during the period from summer 2012 to spring 2013 were investigated. The physicochemical characteristics of water and fish were proved to be within the permissible levels during different seasons. However, heavy metals levels exceed the permissible limits in water samples, and also Pb in fish muscles. The concentrations of heavy metals were significantly higher in water and fish muscles during summer and the metal concentrations in water were present in the following order: Mn> Pb> Zn> Cu> Cd, while those of fish were found in the order of: Zn> Mn> Pb> Cu> Cd. Proximate composition of two fish species showed a significant variation ($p<0.05$) during different seasons. TVBN, TMA, TBA and TPC were under the permissible limits as acceptability for raw fish, moreover heavy metals in water and fish muscle did not exhibit any effect on proximate composition and physicochemical characteristics of fish muscles.

Keywords: *Heavy metals; TBA; TMA; TVB-N.*

1. Introduction

Abu Za'baal lakes are considered as artificial Lakes, which recently created after stone pits stopped in the quarries and received seepage and ground water from the surrounding area particularly from Ismailia canal, Baher El-Bakar drain and cultivated land. These Lakes are located in the north of El-Qalubia Governorate at Abu Za'baal City, 30 kms southwest of Cairo which were created owing to fracture and extract of the Basalt rocks. They are three closed basins that filling during the fifth decade (first Lake), the eighth decade (second Lake) and the ninth decade (third Lake), besides small Lake in a filling phase. These lakes occupy the area between latitudes 30° 16.62' and 30° 17.58' N and longitudes 31° 20.90' and 31° 21.69' E and cover an area of about 608 x 10^3 m^2 (about 150 feddan) and their total water volume is about 5234.075x10^3 m^3. There was a great increase in depth of the first Lake northward (0.6-20 m), with an average of 10.2 m. The water depth of the second and third Lakes fluctuated between 2.9-7.6 and 0.8-7.1 m with an overall average of 6.1and 5.7 m, respectively (**Abd-Ellah, 2003 and Al-Ghanim, 2012**).

Toxic heavy metals compounds affect negatively people's health. Minute amounts these metals compounds are necessary to support life, while larger amounts become toxic and create significant health hazards. Human exposure to heavy metals has risen dramatically over the last few decades as a result of the exaggerated progress in the industrial processes (**Shantakumari, et al., 2012**). The most important heavy metals from the water pollution point of view are Zn, Cu, Pb. Cd, Hg, Ni and Cr. Some of these metals (e.g. Cu. Ni, Cr and Zn) are essential trace metals to living organisms, but become toxic at higher concentrations. Others such as Pb and Cd have no known biological function, but still toxic (**Dudka and Adriano, 1997& Ghannam, et al., 2015**).

Fish freshness is the most important single criterion for judging the quality of the majority of fish and fishery products. Loss of freshness followed by spoilage is a

complex combination of microbiological, chemical and physical processes. Several chemical parameters have been proposed to establish a freshness scale using techniques such as volatile organic acids determination, fat and protein changes, microbiological and sensory changes (**Pedrosa-Menabrito and Regenstein 1990**). The quality of fish and fishery products has become a major concern in fish industry all over the world (**Huss et al., 2003**). Fish, being one of the exceptionally perishable foods and as a result of globalization of food trade fish products tend to be more susceptible to rejection due to poor quality especially if the initial raw materials are of poor quality despite the technological developments in fish production (**FAO, 2009; Huss et al., 2004**). Few studies have been reported on the effect of seasonal changes on the quality and freshness properties of freshwater fish.

The present study aims to evaluate the quality of both water and two selected fish species collected from Abu Za'baal lakes during 2012-2013, and to examine the seasonal fluctuations in Zn, Cu, Mn, Cd and Pb concentrations in both water and fish beside their effect on the proximate composition of selected fish species. These findings are important, not only for clarifying the present status of heavy metals pollution levels of Abu Za'baal lakes but also for the development of rational management plans.

2. Materials and Methods

Study area

Abu Za'baal lakes (Fig. 1) (30° 17N, 31°20E) are located on the perimeter of Cairo in an area where basalt mining was done by blasting in open pits. In 1992, a severe earthquake occurred and the basin began to fill with water, which rose at a rate of 2-3 m per year, forming a lake about 3 km length, 1.5 km width with a maximum depth of 25 m and an average depth of 18m. In this arid environment, the lakes do not receive surface inflow. Beside the main lake, three smaller lakes have formed subsequently and the amalgamations of all these lakes are possible in the next few years (**Al-Ghanim, 2012**).

Sampling program

Water and fish samples were collected during four successive seasons from summer 2012 to spring 2013. The samples were collected from four different stations of Abu Za'baal lakes (Fig. 1), two in the first lake and one at the middle of each of second and third sampling sites.

Water samples

Water samples were collected from 60 cm depth using polyethylene bottles with capacity of one liter. For heavy metals analysis water samples were collected in one-liter plastic bottles and preserved with 5 ml concentrated nitric acid (**APHA, 1998**). The samples were preserved in an ice-box and returned immediately to the laboratory.

The pH value, temperature and electrical conductivity were measured in the field, using Hydrolab, Model "Multi 340I/SET". The chemical parameters (DO, BOD COD) and heavy metals (Zn, Cu, Mn, Cd, Pb) concentrations were determined in water samples according to the methods described in **APHA, (1998).**

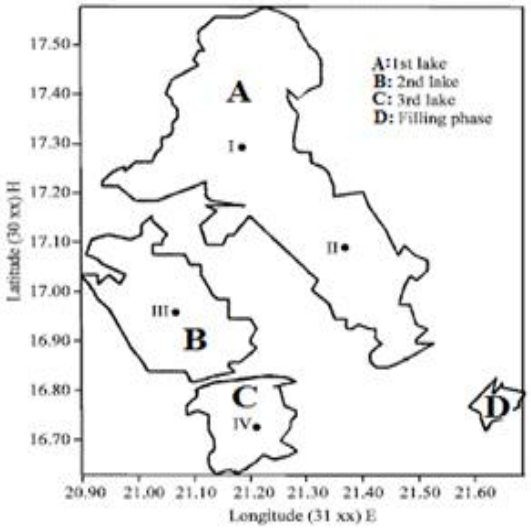

Figure 1. Map of Abu Za'baal lakes (ponds)

Fish samples

Twenty fresh fish samples of Nile tilapia (*Oreochromis niloticus)* and twenty catfish (*Clarias gariepinus)* were collected seasonally from summer 2012 to spring 2013 and transposed using ice-box to the pollution laboratory, National Institute of Oceanography and Fisheries, El-Kanater El-Khiria city, El-Qalubia Governorate, Egypt for the analysis. Mean weights and lengths of collected Nile tilapia and Catfish samples were (349±3.61g and 25.50±2.29 cm) and (695±7.07g and 52.25±2.47 cm), respectively. Fish samples were re-washed thoroughly with potable water then beheaded and dissected to obtain muscles.

The moisture, protein, lipid, ash, total volatile basic nitrogen (TVB-N), trimetylamine (TMA) and thiobarbituric acid (TBA) values were determined using the method of **AOAC (2002).** Total plate counts (TPC) determined according to **(APHA, 1998).** The fish samples were digested according to **Meche et al., (2010).** The concentrations of heavy metals (Zn, Cu, Mn, Cd and Pb) were measured using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) Model Perkin Elmer Optima 3000.

Statistical Analysis

Analysis of Variance (ANOVA) was used to determine differences between various sets of data. Significant differences are stated at $P<0.05$.

3. Results

Water analysis

Physicochemical parameters in Abu Za'baal lakes water from summer 2012 to spring 2013 are shown in Table (1).

Table 1. Physicochemical parameters [a] in Abu Za'baal lakes water from summer 2012 to spring 2013

Parameters	Stations	Summer	Autumn	Winter	Spring
Air temp.°C	I	31.30±0.06	25.40±0.92	18.20±0.31	22.40±0.76
	II	31.70±0.51	25.60±0.57	17.80±0.25	22.50±0.40
	III	31.50±0.38	25.40±0.75	18.30±0.42	22.60±0.79
	IV	30.80±0.77	25.30±0.82	17.70±0.33	22.40±0.12
Water temp.°C	I	30.80±0.26	24.10±0.37	17.50±0.11	20.90±0.83
	II	31.20±0.85	24.70±0.21	16.60±0.18	20.20±0.75
	III	31.30±0.62	24.30±0.54	17.10±0.39	20.50±0.80
	IV	30.70±0.25	24.60±0.71	16.30±0.21	20.10±0.13
EC (µs/cm)	I	5110.20±0.26	3320.00±0.44	3780.00±0.36	6420.00±0.12
	II	4130.10±0.90	3400.00±0.84	3820.00±0.74	5510.00±0.79
	III	415.20±0.45	239.00±0.17	379.00±0.21	429.00±0.18
	IV	420.10±0.17	271.00±0.54	333.00±0.11	453.00±0.27
pH value	I	7.70±0.52	7.90±0.91	7.80±0.06	7.90±0.31
	II	7.90±0.80	7.80±0.67	7.50±0.12	7.70±0.15
	III	8.50±0.41	7.60±0.21	7.70±0.28	8.20±0.33
	IV	8.20±0.15	7.60±0.33	7.80±0.15	7.80±0.54
DO (mg/l)	I	6.80±0.20	8.10±0.83	8.30±0.36	7.90±0.61
	II	8.00±0.74	8.70±0.51	8.80±0.24	8.50±0.14
	III	7.20±0.62	7.50±0.31	7.80±0.37	7.60±0.72
	IV	7.80±0.94	8.10±0.28	9.50±0.28	9.30±0.92
BOD (mg/l)	I	4.70±0.75	4.30±0.22	4.40±0.48	5.30±0.05
	II	4.90±0.95	4.50±0.37	3.80±0.22	4.50±0.56
	III	6.50±0.11	5.20±0.31	4.30±0.64	5.50±0.15
	IV	4.02±0.30	4.00±0.19	3.30±0.20	5.10±0.36
COD (mg/l)	I	10.20±0.52	6.10±0.35	6.00±0.15	9.20±0.55
	II	13.40±0.07	9.20±0.05	10.50±0.18	11.10±0.91
	III	15.40±0.61	9.90±0.75	10.50±0.79	12.30±0.05
	IV	13.20±0.35	6.20±0.70	6.10±0.58	7.50±0.35

[a] Values represent the mean of three determinations ± SD

The present results showed that, air temperatures ranged from (30.80-31.70), (25.30-25.60), (17.70-18.30) and (22.40-22.60) °C during summer, autumn, winter and spring, respectively, while, water temperatures ranged from (30.70-31.20), (24.10-24.70), (16.30-17.50) and (20.10-20.90)°C during the proceeding period, respectively (Table 1). Electrical conductivity of Abu Za'baal lakes water ranged from (271-6420 µs/cm) during different seasons. The highest values were recorded during hot seasons (spring and summer) 415-6420 µs/cm, while the lowest values (217-3820 µs/cm) were recorded during cold seasons (autumn and winter). pH values was found in the alkaline side (pH >7.0), with the higher values (7.70-8.50) recorded during hot period, while the low values (7.50-7.90) were obtained in the cold period.

The present results showed that dissolved oxygen during summer, autumn, winter and spring recorded the ranges of (6.80-8.00), (7.50-8.70), (7.80-9.50) and (7.90-9.30) mg/l respectively. The highest values of biochemical oxygen demand at Abu Za'baal lakes were recorded during hot period (4.02-6.50 mg/l) while the lowest values were recorded during cold period (3.30-5.02 mg/l). Also, the COD values increased during hot period and ranged from (7.50- 15.40 mg/l) and decreased to (6.10-10.50 mg/l) during cold period.

Heavy metals in water

Heavy metals concentration in water samples of Abu Za'baal lakes are graphically represented in Figures (2-5). The seasonal concentrations of zinc ranged between 0.11 and 0.25 mg/l. The lowest level recorded in winter at station (I) while the highest level recorded in summer at station (III). The copper concentrations ranged between 0.19 and 0.25 mg/l with the highest level in winter at station (III) and the lowest level in autumn at station (IV). Mn concentrations showed the highest value (1.50 mg/l) in spring at station (I) and the lowest value (0.92 mg/l) in winter at station IV. The concentration of Cd showed a wide range of variations between 0.01 and 0.07 mg/l. The highest value of Cd was recorded in winter at station (III), while the lowest one was in summer at station (I). The concentration of Pb varied between 0.29 and 0.74 mg/l and was higher than the permissible limit.

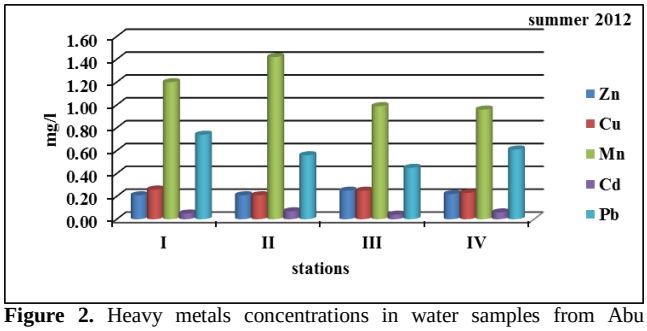

Figure 2. Heavy metals concentrations in water samples from Abu Za'baal lakes during summer 2012

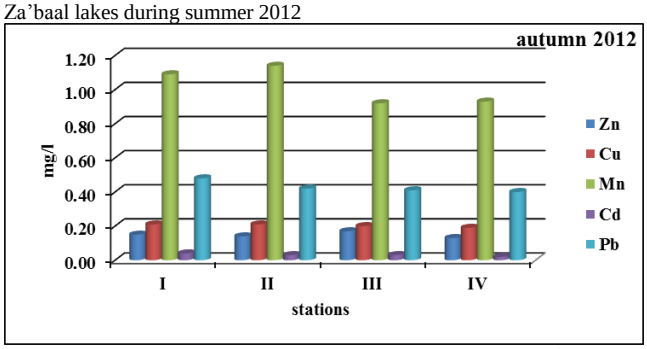

Figure 3. Heavy metals concentrations in water samples from Abu Za'baal lakes during autumn 2012

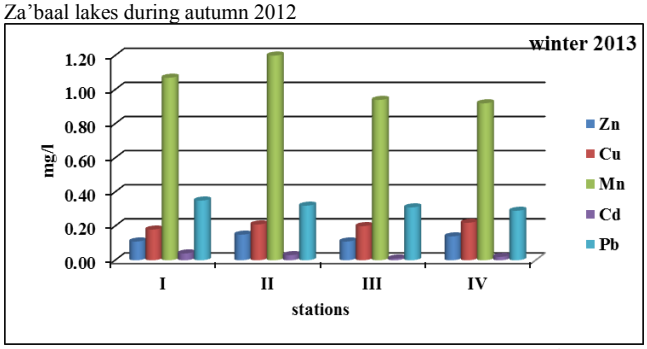

Figure 4. Heavy metals concentrations in water samples from Abu Za'baal lakes during winter 2013

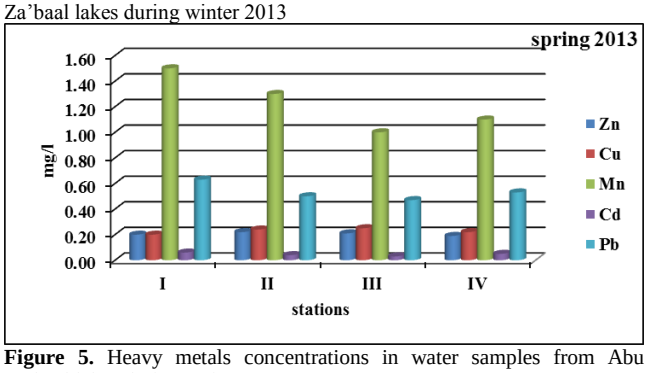

Figure 5. Heavy metals concentrations in water samples from Abu Za'baal lakes during spring 2013

Heavy metals in fish muscles

The results of heavy metals concentrations in fish muscles of *Oreochromis niloticus* and *Clarias gariepinus* during different seasons are given in Figures (6-7). The average concentrations of zinc were 24.91-30.50 µg/g dry weight for *Oreochromis niloticus*, compared with 15.12-16.92 µg/g dry weight for *Clarias gariepinus*. Copper concentrations ranged between 1.01 and 3.41 µg/g dry weight for *Oreochromis niloticus* and 3.52-5.50 µg/g dry weight for *Clarias gariepinus*. Manganese recorded 12.41-13.25 µg/g dry weight for *Oreochromis niloticus*, and 14.25-15.72 µg/g dry weight for *Clarias gariepinus*.

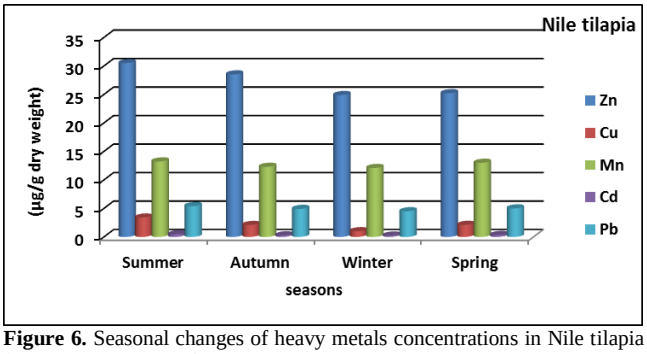

Figure 6. Seasonal changes of heavy metals concentrations in Nile tilapia fish muscles samples from Abu Za'baal lakes

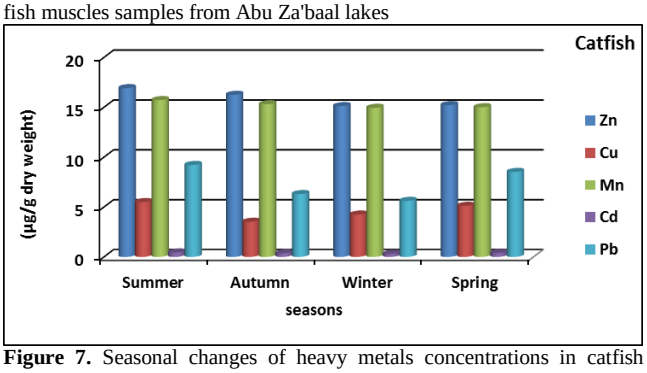

Figure 7. Seasonal changes of heavy metals concentrations in catfish muscles samples from Abu Za'baal lakes.

The average concentrations of cadmium were 0.65 and 0.96 µg/g dry weight for *Oreochromis niloticus* and (1.30-1.42 µg/g dry weight) for *Clarias gariepinus*. Lead recorded 4.51 and 5.41 µg/g dry weight for *Oreochromis niloticus* and (5.62-9.22 µg/g dry weight) for *Clarias gariepinus*. A comparison between the present data and those of others was carried out in table (2).

Biochemical quality changes

Proximate composition

Table (3) showed the proximate composition in muscles of *Oreochromis niloticus* and *Clarias gariepinus* during different seasons. The average values of proximate composition for *Oreochromis niloticus* was as follows: moisture content (80.01-80.55%), protein content (16.50-17.15%), fat content (1.20-1.50%), ash content (1.15-1.36%) and carbohydrates content (0.04-0.92%) on wet wt. basis. The average proximate composition of *Clarias gariepinus* was as follows: moisture content (76.91-78.45%), protein content (19.28-20.54%), fat content (0.95-1.42%), ash content (1.08-1.19%) and carbohydrates content (0.04-0.92%) on wet weight basis.

Physicochemical quality properties of fish

Physicochemical aspects of *Oreochromis niloticus* and *Clarias gariepinus* fish muscles during different seasons of the present study were represented in table (4). The minimum and maximum values of pH value for *Oreochromis niloticus* and *Clarias gariepinus* were (6.85-7.11) and (6.25-7.01); TVB-N (16.01-17.20) and (18.12-

19.27) mg/100g; TMA (0.45-0.95) and (0.85-0.91) mg/100g; TBA (0.50-0.80) and (0.40-0.76) mg malonaldh-yde/kg, Total plate count (2.50-2.65) and (2.70-2.90) log_{10} cfu/g sample, respectively (Table 4).

Table 2. Metal concentrations in water (mg/l) and tissue (µg/g dry weight) of fishes collected from Abu Za'baal lakes during summer 2012 to spring 2013, and the comparison with permissible upper limits of heavy metals in various standards.

Standards	Zn	Cu	Mn	Cd	Pb	References
Water (mg/l)						
Egyptian Ministry of Water Resources and irrigation, law 48/1982	0.01	0.01	0.20	0.001	0.01	Agrama and El-Sayed (2013)
WHO, (2011)	3	2	0.40	0.003	0.01	Saeed and Mohammed (2012)
Maximum values	0.25	0.26	1.50	0.07	0.74	present study
Fish (µg/g dry weight)**						
WHO, (1993)	40	5	100	0.5	2	Authman, et al., (2012)
Nile tilapia (maximum values)	30.50	3.41	13.25	0.48	5.41	present study
Catfish (maximum values)	16.92	5.50	15.72	0.45	9.22	present study

Table 3. Proximate chemical composition [a] (g/100 g of wet weight) in the muscles of Nile tilapia and catfish collected from Abu Za'baal lakes during summer 2012 to spring 2013

Composition	Species	Summer	Autumn	Winter	Spring
Moisture	Nile tilapia	80.55±0.75	80.25±0.57	80.15±0.77	80.01±0.61
	Catfish	76.91±0.71	78.45±0.65	77.69±0.62	77.40±0.55
Protein	Nile tilapia	16.50±0.15	16.95±0.14	17.15±0.11	16.85±0.11
	Catfish	20.54±0.19	19.28±0.13	19.58±0.13	19.54±0.12
Fat	Nile tilapia	1.40±0.01	1.25±0.01	1.20±0.04	1.50±0.02
	Catfish	1.25±0.03	1.15±0.02	1.42±0.21	0.95±0.01
Ash	Nile tilapia	1.25±0.02	1.30±0.01	1.15±0.02	1.36±0.03
	Catfish	1.15±0.01	1.08±0.02	1.14±0.03	1.19±0.02
Carbohydrates	Nile tilapia	0.30±0.20	0.25±0.15	0.35±0.11	0.28±0.19
	Catfish	0.15±0.21	0.04±0.19	0.17±0.15	0.95±0.11
Calorific values	Nile tilapia	79.80±1.87	80.05±1.50	80.80±1.44	82.02±1.20
	Catfish	94.01±1.75	87.63±1.60	91.78±1.39	90.51±1.88

[a] Values represent the mean of three determinations ± SD

Table 4. Physicochemical properties [a] (g/100 g of wet weight) in the muscles of Nile tilapia and catfish collected from Abu Za'baal lakes during summer 2012 to spring 2013.

Parameters	Species	Summer	Autumn	Winter	Spring
pH value	Nile tilapia	6.85±0.01	7.11±0.02	7.05±0.01	6.90±0.04
	Catfish	6.26±0.03	7.01±0.01	6.32±0.01	6.25±0.02
TVB-N (mg/100g flesh)	Nile tilapia	17.20±0.15	16.25±0.12	16.01±0.14	16.15±0.11
	Catfish	19.27±0.19	18.41±0.11	18.20±0.16	18.12±0.10
TMA (mg/100g flesh)	Nile tilapia	0.95±0.05	0.65±0.01	0.45±0.02	0.70±0.04
	Catfish	0.90±0.04	0.85±0.03	0.89±0.01	0.91±0.02
TBA (mg MDA/kg flesh)	Nile tilapia	0.80±0.01	0.75±0.02	0.50±0.05	0.55±0.03
	Catfish	0.76±0.03	0.70±0.05	0.40±0.04	0.45±0.02
TBC (log10 cfu/g sample)	Nile tilapia	2.60±0.16	2.65±0.62	2.50±0.22	2.50±0.13
	Catfish	2.75±0.11	2.80±0.14	2.70±0.31	2.90±0.19

[a] Values represent the mean of three determinations ± SD

4. Discussion

Physicochemical characteristics of water are important parameters as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals and considered as the most important principles for the nature, quality and type of the water for any aquatic ecosystem **(Abdo, 2004, Ekubo and Abowei, 2011 and Moses, 1983).** Electrical conductivity is a measure of the ability of water to conduct an electrical current **(Entz, 1973).** The values of electrical conductivity in the three lakes of the present work were higher than those of freshwater. The obtained results are in parallel with those reported by

Abdel-Satar (2001 and 2005) and **Abdo (2004, 2006)** who classified Abu Za'baal lakes water as brackish one.

pH is a measure of whether water is acidic or basic **(Ekubo and Abowei, 2011).** The decrease in pH values during cold period, is mainly related to the high bicarbonate content, while the uptake of carbon dioxide by phytoplankton decrease as a result of increasing the concentration of bicarbonate **(Abdel-Satar, 2005 & El-Wakeel and Wahby, 1970).** The present results agree with that reported by **(Abd-Ellah, 2003 and Abdo, 2004, 2006).**

The amount of dissolved oxygen in water is very important for aquatic organisms which affect growth, survival, distribution, behavior and physiology of other aquatic organisms (**Solis, 1988**). The reduction in dissolved oxygen content may be due to decomposition of suspended organic matter of sewage in water **(Tayel, et al., 2007).**

Biochemical oxygen demand is used as a measure of the quantity of oxygen required for oxidation of biodegradable organic matter present in water by aerobic and anaerobic biochemical action (**Ekubo and Abowei 2011).** The highest values of BOD during hot period may be attributed to the photosynthetic activity and abundance of phytoplankton, especially in summer (Abdo 2002 and 2004). However, the increase in COD during hot period is mainly referred to the increase in the air and water temperatures, facilitating the decomposition and oxidation of organic matter **(Abdo 2002, 2005 and 2006).**

Heavy metal concentrations in lakes water were found in the following order: Mn> Pb> Zn> Cu> Cd. The maximum mean values of Mn, Cd and Pb exceeded the permissible limits (Table, 2). The highest levels of heavy metals in water were found during summer, while the lowest values occurred during winter. Similar results were obtained by **Bahnasawy and Khidr, (2011), Ibrahim and Omar, (2013) & Nwabueze and Oghenevwairhe, (2012).** The high levels of Pb in water could be attributed to industrial and agricultural discharges as well as from dust which holds a huge amount of lead from the combustion of petrol in various vehicles **(Hardman, et al., 1994 and Mason, 2002).** On the other side, the seasonal variations of heavy metals concentrations in water may be due to the fluctuation of the amount of agricultural drainage water, sewage effluents and industrial wastes discharged into the lakes **(Zyadah, 1995). Ali and Abdel-Satar (2005)** attributed the increase of metal concentrations in the water during hot seasons to the release of heavy metals from the sediment to the overlying water under the effect of both high temperature and fermentation process resulting from the decomposition of organic matter.

Fish are often at the top of aquatic food chain and may concentrate large amounts of some metals from the water **(Mathana, et al., 2012).** Metal bioaccumulation is largely attributed to differences in uptake and depuration period for various metals in different fish species (**Tawari-Fufeyin and Ekaye, 2007).** Multiple factors; including seasonal, physical and chemical properties of water (**Kargin, 1996 and Talab, et al., 2014),** can play a significant role in metal accumulation in different fish tissues.

Heavy metals concentrations were in the following order: Zn> Mn > Pb > Cu> Cd. It was proved that, *Clarias gariepinus* had higher concentrations of Cu, Mn and Pb than *Oreochromis niloticus*. The seasonal accumulation of all heavy metals were higher in summer, spring, autumn and winter. Their levels were significantly higher in fish muscles during summer which might be due to the increased metabolism as a result of high temperature. The low concentration of Cd might be due to its low tendency to bioaccumulation or good ability to it's excreting from the body **(Saeed, 2013).**

These results agree with **Ibrahim et al., (2008)** who reported that, fish caught during spring and summer seasons were more influenced by heavy metals than those during autumn and winter. The levels of Pb were exceeded the permissible limits (Table 2).

Biochemical composition of fish muscles is a good indicator for the fish quality, the physiological condition and habitat of fish. Fish of various species do not provide the same nutrient profile to their consumer and the nutritive value of a fish varies with season. So, biochemical evaluation is necessary to ensure the nutritional value of the fish (**Mathana, et al., 2012**). The chemical composition of fish varies greatly from an individual of a species to another depending on starvation plus intensive food intake periods and external factors such as temperature and salinity. Variations in percentage of fat should be reflected in the percentage of water, and the two normally constitute around 80% of the fillet (**Huss, 1995**).

According to the present results there was a significant ($P<0.05$) difference in the moisture content between the two fish species, where *Oreochromis niloticus* having the highest moisture content (80.55%), while *Clarias gariepinus* having moisture content of 78.45%. *Clarias gariepinus* was superior to *Oreochromis niloticus* with crude protein composition of 20.54% which is significantly ($P<0.05$) different from that of *Oreochromis niloticus* which is 17.15%. *Oreochromis niloticus* lipid is also significantly ($P<0.05$) different from that of *Clarias gariepinus.* The former has lipid content of 1.50%, while the latter having 1.42% lipid. However, there was no significant ($P<0.05$) difference in their ash content.

Generally, lipid content varies within species (1.46-5.77 g/100g) and is affected by the catching season (1.20-18.4 g/100g), (**Osman, et al., 2001). Mohamed and Gad (2005)** proved that, protein and lipid contents in the tissue of *Oreochromis niloticus and Clarias lazera* from Abu Za'baal lakes were (15.95-15.87) and (0.96-0.99) g/100 g wet weight, respectively. **Osibona et al., (2006)** found that *Clarias gariepinus* had mean protein content of 19.64%, lipid 1.15%, moisture 76.71% and ash 1.23%.

The results obtained are in agreement with those of **Ibrahim et al., (2008)** who reported that, the proximal analysis of tilapia fish muscles caught from Abu Za'baal lakes during different seasons ranged between 79.52-80.23% moisture, 16.71-17.56% protein, 1.18-1.83% lipid and 0.94-1.55% ash content (on wet wt. basis). Also, **Bouriga et al., (2012)** found that lipid and protein contents in fresh muscles of tilapia were 4.24 and 17.36 g/100g,

respectively. The highest level of protein during winter may be due to the increase of plankton concentration in the lakes. The amount of lipid in fish muscles is increasing prior to reproduction and decreasing during the spawning period. There is an inverse ratio between lipid and water, thus water content increased after the finishing of spawning period **(Tulgar and Berik, 2012). Ibrahim et al., (2008)** stated that, the quality criteria of tilapia species muscles caught during different seasons from Abu Za'baal lakes were as follows: pH range (6.70-7.21); TVB-N (16.00-17.50) mg/100g; TMA (0.57-1.27) mg/100g; TBA (0.50-1.73) mg malonaldhyde/kg and total viable count TVC (2.08-4.29) $\log_{10}$ cfu/g sample. In catfish, pH values have been reported ranging between 6 and 7 under different storage conditions, fluctuations during this period do not provide significant variations in degradation processes, but must correlate with the biochemical, microbiological and sensory analyses **(Pacheco, et al., 2010**).

The results indicated that the present level of the examined heavy metals in water and fish muscles from Abu Za'baal lakes did not exhibit any effect on proximate composition and physicochemical characteristics of fish muscles. This result is in agreement with (**Abdo, 2006, Ibrahim et al., 2008 & Mohamed and Gad 2005**).

5. Conclusion

The present study revealed that the heavy metals concentrations in water and the two fish species from Abu Za'baal lakes were affected by seasons, as summer season concentrations were significantly higher than other season's concentrations. Moreover the heavy metals concentrations especially Mn, Cd and Pb in water exceed the permissible levels, while Pb only exceed the permissible levels in fish. The present levels of tested heavy metals in water and fish had no effects on chemical composition and biochemical quality aspects of fish.

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