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HEAVY METALS CONTENT AND WATER QUALITY OF LAKE MARYOUT AND THEIR IMPACTS ON TILAPIA CONTAMINATION AND PHYSIOLOGY

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ABSTRACT

The aim of the present work is to assess water quality, heavy metals content in lake Maryout water and in edible muscles of *Oreochromis aureus*, and to study the impact of pollution stress on fish body characteristics and physiology. There is no significant difference among the mean water selenium contents in the four basins. The overall average of selenium over the lake was 0.08 µg / l. The northwest basin contains the highest water lead content (5.99 ± 0.37 µg / l). The highest water cadmium and iron levels were recorded in samples of the main basin (1.6 ± 0.10 µg / l and 1.21 ± 0.09 mg / l respectively) while the lowest cadmium level was recorded at the fishery basin (0.44 ± 0.21µg / l). The southeastern basin showed the highest *arsenic level* (0.38 ± 0.15 µg / l). *The fishery* and the southeast basins showed the highest chromium levels (11.13 ± 0.76 and 10.94 ± 0.2 µg / l, respectively). The fishery basin was found to contain the highest nickel content (15.22 ± 1.02 µg / l), while the southeast basin showed the lowest nickel level (6.87 ± 0.51 µg / l). The highest water copper was recorded in fishery basin (8.53 ± 0.20 µg / l). The pH of the main basin showed the lowest values with a mean of 7.11 ± 0.18. Sulfides values recorded at the main basin were drastically variable (0.0 – 14.2) with a mean of 4.48 ± 0.86 mg / l. The highest sulfate level was recorded at the fishery and the northwest basins (1870.6 ± 170.7 and 1846 ± 140.6 mg / l, respectively). The lowest sulfate value was recorded at the main basin (631.9 ± 36.4 mg / l). The highest fish muscle lead content was observed in the southeast basin (23.97 ± 5.15 µg / kg) and the lowest was recorded in the northwestern (3.83 ± 1.28 µg / kg). There were no significant differences in the mean cadmium, arsenic and nickel contents in *Oreochromis aureus muscles of the four basins. The highest chromium content was* found in fish muscles of the southeast basin (754.9 ± 19.2 µg / kg). The highest Copper contents were recorded in fish muscles of southeast and the northwest basins (481.5±10.64 and 470.4 ±8.22 µg / kg, respectively). The highest muscles iron content was recorded in fish muscles of the northwest and the main basin (313.4 ± 3.39 and 311.4 ± 2.87 mg / kg respectively). Fish caught from the main basin and from the fishery basin showed significantly higher condition factor than those caught from the northeast and southeast basins. The highest moisture content was noticed in flesh of main basin. The highest protein percent was recorded in fish muscles of the fishery basin. There were no significant differences in hepatosomatic indices of fish of the four basins. Fish caught from the southeast basin showed the highest relative gall bladder weights. Fish of the southeast basin showed the highest activity of liver (GOT), (GPT), and (ALP) followed by those of the main basin and the northwest *basin. The fishery basin tilapia exhibited the lowest activities of the three mentioned* enzymes. The main basin tilapia showed the least brain (AChE) activity of the enzyme followed by those of the Southeast basin The highest (AChE) activity was recorded at the northwest basin.

Keywords: Lake Maryout: *Oreochromis aureus*, pollution; water quality; heavy metals, liver and brain enzymes.

INTRODUCTION

Lake Maryout lies in the north of Egypt at Latitude 31° 10' N and *Longitude 29° 57' E. The Lake is one of four freshwater and brackish water* lakes in the Nile Delta near the shore of the Mediterranean Sea. Lake Maryout is adjacent to large urban area and consequently heavily affected by domestic and industrial pollution. It ranges in depth from 1 to 3 m. The lake consists of five basins with a total area of 15000 feddan. The main sources of water to the lake are Nubareia canal, discharges of domestic wastewater of Alexandria, El-Omoum drain coming from Behera Governorate and the under ground water. The main basin has an area of about 5000 feddan after the filling of an area of about 1000 feddan for El-Qabbary high way and bridge, (El-Sharkawy, 2000). It is receiving numerous domestic, agricultural and industrial discharges. The fisheries basin (1000 feddan) was designed to be a fish farm. It receives very little direct inflow. The northwest basin (3000 feddan) is adjacent to big petroleum refineries, which discharge their *wastewater directly into the basin; it also receives some agricultural drainage* waters form El-Omoum drain. The southeast basin (5000 feddan) is totally separated from the lake. The main sources of water to the basin are the ground water and agricultural drainage. It is extremely shallow. The basin is considered the least polluted although it receives the discharges of the cooling pipes of El-Nasr Petroleum Company that increases values of mineral oil and grease in water, Samaan and Abdel-Monem (1986). Lake Maryout used to contribute with a major portion of fish consumption of Alexandria. The lake fisheries have been extensively described by El-Shazly (1993), Anonymous (1995, 2002) and *EA-ESTI* (1997). Fish production of Lake Maryout decrease sharply from 14059 ton in year 1980 to about 5100 ton in year 2000. On the other hand, less tolerant high-valued fish decreased or completely disappeared due to the enormous increase of industrial wastes and *sewage discharged into the Lake. Approximately 75 percent of the total* fish catch is from tilapia. *Oreochromis aureus* is one of the important and abundant tilapia species in the lake (about 45 %) due to its higher tolerance of salinity and pollution stresses (Essa and Faltas, 1997).

The aim of the present work is to assess water quality, heavy metals content in lake Maryout water and in edible muscles of *Oreochromis aureus*, and to study the impact of pollution stress on fish body characteristics and physiology.

MATERIALS AND METHODS

1- Sampling:

Water samples were collected from 13 stations shown on the image (Figure 1) according to procedures of UNEP (1990 and 1993). Samples were kept in clean bottles and preservation of nitrite and ammonia was carried out according to Lenore *et al.* (1998). Fish samples were collected using regular fishermen nets. *Oreochromis aureus* individuals were picked out and kept in containers that contain some of the lake water to keep fish alive till reach the lab.

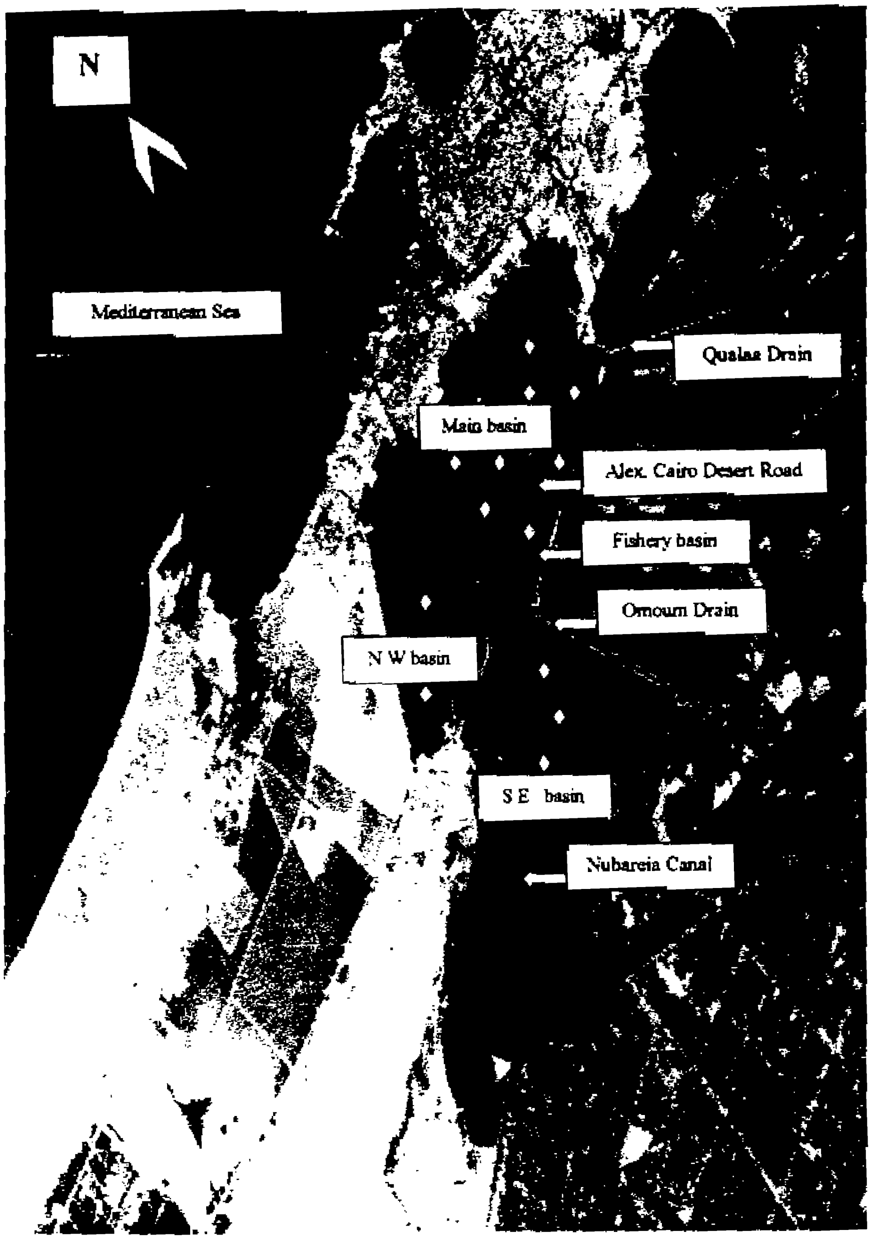

Figure 1: Satellite image of Alexandria 2001 showing the lake basins and the 13 sampling stations ◇

2- Chemical Analysis:

a- Water quality parameters:

The pH values and concentrations of dissolved oxygen were measured using pH and dissolved oxygen meters. Sulfides and sulfate were determined according to Lenore et al. (1998). Sulfides were measured by the iodometric titration method onsite to avoid losses through bubbling or oxidation by ambient air. Sulfate was determined by the turbidimetric method using barium chloride. Nitrate and nitrite in water samples were estimated according to Harold et al. (1981). Nitrite was assayed using the colorimetric sulfanilamide di-azo die reaction method at the Central Lab. For Food and Feed, Agricultural Research Center, Alexandria by a *Spectronic - 21 D UV / Vis.* spectrophotometer. Nitrate and ammonia were determined using Orion ion-selective electrodes at the Department of Environmental Studies, Institute of Graduate Studies and Research, Alexandria.

b- Heavy metals determination in water and fish muscles:

One hundred ml of each water sample and 2 g of dried fish muscles of each location were completely digested by wet ashing using nitric and perchloric acids and were concentrated to a final volume of 20 ml. Heavy metals including selenium, lead, cadmium, arsenic, chromium, nickel copper and iron contents were determined according to AOAC (1994) using *Perken Elmer* atomic absorption *3300 spectrophotometer* and *Zeman* atomic absorption spectrophotometer (graphite furnace) 4100 *ZL Perkin Elmer* at the Central Laboratory for Food and Feed, Agricultural Research Center, Giza.

3- Fish body characteristics:

Fish were gutted individually, and then weighed. Length was measured. Liver and gall bladder were separated and weighed. The coefficient of condition (K) (Fulton condition factor) was calculated for each individual using the equation $K = W / L^3$ where W is the gutted weight in grams, L = length in millimeters. The gutted weight was used to exclude the effect of stomach contents and weight of gonads (Lagler, 1956 and Ricker, 1975). Dorsal muscles of skinned fish were oven dried at 80° C until complete dryness. Crude protein and moisture were determined according to AMC (1979).

4- Enzyme assays:

Fish liver and brain were then immediately washed by formal saline solution. Livers were homogenized in 10 volume (w/v) of 0.1M phosphate buffer of pH 7.4 using polytron homogenizer for thirty seconds. The homogenates were then centrifuged at 6000 x G for 20 minute at 4 ° C. The supernatants were stored at -20° C until protein determination and enzyme assays. The supernatants protein was determined using the method of Bradford (1976). The activities of glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) were assayed using the commercially available kit supplied by Bio Mérieux Co. according to the colorimetric method of Reitman and Frankel (1957). The activity of hepatic alkaline phosphatase was determined according to Rec. G. (1972) using

Diamond Diagnostics Kits. Liver acid phosphatase activity was measured according to Moss (1984) by kits supplied by Quimica Clinica Aplicada S.A. The activity of the enzymes was calculated as U/L of the homogenate and then converted into U / mg protein. Brain cholinesterase activity was assayed according to the colorimetric method of Ellman *et al.*, (1961). All colorimetric measurements of enzyme assays were carried out at the Central Lab. For Food and Feed, Agricultural Research Center, Alexandria using a *Spectronic - 21 D UV / Vis.* spectrophotometer.

5 - Statistical analyses:

Statistical analyses of the results were carried by estimating the statistical significance of the difference in values among the four basins of the lake using the (F) test. Also, correlation coefficient (r) was calculated between values of metals in water and in fish muscles of the same basin according to Steel and Torrie (1981).

RESULTS AND DISCUSSION

1-Heavy metals content in waters of Lake Maryout:

Table 1 presents the means of heavy metals content of the four studied basins water of Lake Maryout. There were no significant differences ($p > 0.05$) among the mean water selenium contents in the four basins. The overall average of selenium over the lake was 0.076 µg / l. which is much lower than that recorded by WWCG (1994) that recorded the main basin water selenium as 25 µg / l. *EA-ESTI* (1997) detected selenium range in the lake as 2 – 4 µg / l. This means that water selenium content showed a significant decrease than before.

Table 1: Water heavy metals contents in Lake Maryout

Basin	Se	Pb**	Cd**	As*	Cr**	Ni**	Cu**	Fe**
	µg / L							mg / L
1- Main basin	0.20 ± 0.14	3.20 ± 0.29 ^{b}	1.63 ± 0.10 ^{a}	0.04 ± 0.02 ^{b}	8.41 ± 0.39 ^{c}	9.94 ± 0.75 ^{b}	4.33 ± 1.06 ^{b}	1.21 ± 0.09 ^{a}
2- Fishery basin	0.06 ± 0.04	3.64 ± 0.40 ^{b}	0.44 ± 0.21 ^{c}	0.12 ± 0.10 ^{b}	11.13 ± 0.76 ^{a}	15.22 ± 1.02 ^{a}	8.53 ± 0.20 ^{a}	1.02 ± 0.21 ^{b}
3- North west basin	0.043 ± 0.039	5.99 ± 0.37 ^{a}	1.048 ± 0.106 ^{b}	0.00 ± 0.0 ^{b}	9.58 ± 0.19 ^{b}	8.038 ± 0.28 ^{c}	8.51 ± 0.23 ^{a}	0.58 ± 0.03 ^{c}
4- South east basin	0 .0 ± 0.0	3.19 ± 0.72 ^{b}	1.23 ± 0.25 ^{b}	0.38 ± 0.15 ^{a}	10.94 ± 0.20 ^{a}	6.87 ± 0.51 ^{d}	8.38 ± 0.45 ^{a}	0.67 ± 0.03 ^{c}
LSD among basins	0.104598936	0.713880048	0 264017966	0 136883783	0.642614119	1 003570162	0.857492104	0 163166722

Mean ± SE of 6 samples in each station.
*** = Significant difference at 0.05 level of significance.**
**** = Highly significant difference at 0.01 level of significance.**
Means of superscript litter (a) is significantly higher than that of (b) then (c).

Table 1 also shows that there is a highly significant variation ($P < 0.01$) in the mean lead content in the water of the four basins. The northwest basin was found to have the highest water lead content, while the other three basins showed no significant difference in water lead content. The mean lead content allover the lake basins was 4.05 μg / l. Mostafa (1994) and WWCG (1994) recorded the range of lead content of the main basin as 4 – 20 μg / l. *EA-ESTI* (1997) detected a lead range in the lake as 2 – 4 μg / l which is similar to data of the present work.

Cadmium content showed a highly significant ($p<0.01$) variation among the four basins. The highest cadmium level was recorded in samples of the main basin (1.63 ± 0.10 μg / l); the lowest cadmium level was recorded at the fishery basin (0.44 ± 0.21μg / l) while there was no significant difference between northwest and southeast basins in the water cadmium content. Both showed intermediate values of cadmium. El-Rayis *et al.* (1994) reported that water cadmium of the main basin ranged from 0.49 to 0.81 μg / l through the period of 1979 to 1992. WWCG (1994) found that cadmium level in the northwest basin is less than 5 μg / l.

A significant difference ($p< 0.05$) was also found in the mean water arsenic content of the lake basins. The southeastern basin showed the highest arsenic level (0.38 ± 0.15 μg / l) while there was no significant difference among the other three basins. Values of water arsenic in Table 1 are lower than those of *EA-ESTI* (1997) that recorded a range of water arsenic of 1.2 – 5 μg / l in Lake Maryout.

From Table 1 it was also revealed that there is a highly significant ($p<0.01$) variation among the mean water chromium contents of the four basins. The fishery and the southeastern basins showed the highest chromium levels (11.13 ± 0.76 and 10.94 ± 0.20 μg / l, respectively). The main basin showed the least chromium content (8.41 ± 0.39 μg / l). WWCG (1994) recorded water chromium content of the main and northwest basins as less than 6 μg / l. Mostafa (1994) recorded a water chromium range of 4 – 41 μg / l at the main basin.

Highly significant ($p< 0.01$) differences were recorded among the mean water nickel content. The fishery basin was found to contain the highest nickel content (15.22 ± 1.02 μg / l). On the other hand, the southeastern basin showed the least nickel level (6.87 ± 0.51 μg / l). Nickel levels recorded in water of the main and the northwest basins were 9.94 ± 0.75 μg / l and 8.04 ± 0.28 μg / l, respectively. Mostafa (1994) recorded a range of 30 – 156 μg / l of nickel in the main basin. WWCG (1994) recorded water nickel content of the main and northwest basins as 15 μg / l. *EA-ESTI* (1997) found a mean water nickel of 13.5 μg / l in the main basin.

Water copper content showed a highly significant ($p<0.01$) variation among the four basins. The main basin contains the lowest water copper content (4.33 ± 1.06 μg / l, while there was no significant difference among the other three basins. The highest values were recorded in fishery basin (8.53 ± 0.20 μg / l). Hafez (1982) and El-Rayis and Saad (1990) recorded a mean dissolved copper in the main basin as 6 μg / l. But both Mostafa (1994) and WWCG (1994) had recorded a very wide range (5 – 124 μg / l) of copper in the main basin. *EA-ESTI* (1997) found a mean water copper content of 8 μg / l in the main basin which is quite near to the results obtained in the present study.

There is a highly significant ($p<0.01$) difference among the mean water Iron content of the four basins. The main basin contains the highest water iron content (1.21 ± 0.09 mg / l). The fishery basin water contains (1.02 ± 0.21 mg / l). The northwest and southeast basins were found to contain the lowest iron levels (0.58 ± 0.03 and 0.67 ± 0.03 mg / l, respectively). Hafez (1982) estimated the main basin water iron content as 0.59 mg / l. WWCG (1994) had recorded a very wide range of Iron in the main basin (0.133 – 2.48 mg / l).

2- Water quality of Lake Maryout:

Table 2 represents variation recorded in water quality parameters among the four basins. The pH of the main basin showed the lowest values ranging from 6.69 to 7.91 with a mean of 7.11 ± 0.18. Sulfide values recorded at the main basin were drastically variable from one station to the other. This made the range very wide (0.0 – 14.2 mg / l). Areas in front of Qalaa drain outfall and around the discharge of the west treatment plant showed very high sulfide and very low dissolved oxygen values.

The southwestern side of the main basin is of better water quality with respect to sulfides and dissolved oxygen. This is due to the nourishment of fresh water through Nubareia canal and Omum drain. Sulfide is formed in surface water due to anaerobic bacterial decay of organic substances thrown to the main basin from Qalaa drain and west treatment plant (Anonymous, 2002). The lowest sulfide value detected was that of the southeast basin (0.62 ± 0.08 mg / l). It should be mentioned that, the standard water quality required for fish farms should contain less than 0.003 mg / l of hydrogen sulfide because it is a potent toxicant for many species (Abdel-Hakeem *et al.*, 2002). The highest sulfate level was recorded at the fishery and the northwest basins (1870.6 ± 170.7 and 1846 ± 140.6 mg / l, respectively). The lowest sulfate value was recorded at the main basin (631.9 ± 36.4 mg / l). This is most probably because of the lowered salinity of the main basin due to domestic and agricultural drainage into the basin and also due to the anaerobic bacterial action accompanying the heavy organic load which reduces sulfate and nitrate ions to sulfides and nitrite. The overall mean of nitrate concentration in the lake is 11.3 mg / l which is lower than that recorded by Anonymous (2002) as 19.56 mg / l. The highest ammonia level was recorded in the main basin (0.7 ± 0.6 mg / l). This is in agreement with the results of Essa and Faltas (1997). El-Sharkawy (2000) also reported that the highest mean ammonia concentration was (about 3.7 mg / l) recorded at the main basin with a range from 1.8 mg / l beside Nubareia canal and Omoum drain connections to the basin to 5.6 mg / l in front of Qalaa outfall and west treatment plant. Abdel-Hakeem *et al.* (2002) reported that ammonia (NH_3) short-term toxicity levels range from 0.6 to 2 mg/l. Its toxicity increases exponentially with decreasing dissolved oxygen in water.

Table 2: Water quality parameters of Lake Maryout basins

Basin		PH value	Sulfides mg / l	Sulfate mg / l	Nitrate mg / l	Nitrite mg / l	Dissolved Oxygen mg / l	Ammonia mg / l
Main basin	Mean ± SE	7.11 ± 0.18	4.46 ± 0.86	631.9 ± 36.4	11.9 ± 1.23	0.191 ± 0.03	2.1 ± 0.42	0.7 ± 0.11
	Range	6.69-7.91	0.0 – 14.2	61 – 1900	0.3 – 18.0	0.0 – 0.36	0.1 – 6.2	0.03 – 1.0
Fishery basin	Mean ± SE	8.23 ± 0.06	1.36 ± 0.13	1870.6 ± 170.7	10.32 ± 1.69	0.029 ± 0.003	4.26 ± 0.73	0.383 ± 0 .12
	Range	7.8 – 8.1	0.0 – 1.0 2.8	1119 - 3100	0.0 – 18.0	0.0-0.1	3.5 – 7.6	0.01– 0 020.51
Northwest basin	Mean ± SE	7.89 ± 0.02	1.6 ± .25	1846 ± 140.6	8.87 ± 0.89	0.042 ± 0.006	5.61 ± 0.66	0.51 ± 0.06
	Range	7.80 – 8.0	0.0 – 1.0 2.1	1405 - 2900	2.1 – 10.9	0.0-0.08	2.6 – 6.8	0.01– 0.020.79
Southeast basin	Mean ± SE	8.0 ± 0.05	0 62 ± 0.08	1839 ± 152.9	14.1 ± 0.95	0.111 ± 0.004	4.8 ± 0.62	0.295 ± 0.1
	Range	7.51 - 8.2	0.0 – 1.0 2.0	908.6 - 2450	1.0 – 18.2	0.0-0.12	3.5 – 6.7	0.0 – 1.0 1.0

Mean ± SE of 6 samples in each station.

3- Heavy metals content in fish muscles in Lake Maryout:

Table 3 represents heavy metal concentrations detected in *Oreochromis aureus* fish of Lake Maryout. It was found that selenium was below the detection limit in fish muscles of the four basins. Highly significant ($p<0.01$) variations were detected among the mean lead content in muscles of fish of the four basins. The highest fish muscles lead content was observed in the southeast basin and the lowest was recorded in the northwest one. The main basin and the fishery basin showed intermediate values.

There were no significant differences ($p> 0.05$) in the mean cadmium, arsenic and nickel contents in *Oreochromis aureus* muscles of the four basins.

Table 3: Heavy metals content (dry weight basis) in Fish muscles Lake Maryout

Basin	Se	Pb**	Cd	As	Cr**	Ni	Cu**	Fe*
	µg / kg							mg / kg
1- Main basin	0.0	9.18 ± 3.31 ^{b}	14.7 ± 1.72	25.6 ± 13.15	392.6 ± 25.39 ^{c}	303.8 ± 18.12	421.0 ± 22.85 ^{b}	311.4 ± 2.87 ^{a}
2- Fishery basin	0.0	9.53 ± 3.18 ^{b}	29.6 ± 2.23	0.0	427.1 ± 18.43 ^{b}	326.0 ± 20.56	408.2 ± 13.11 ^{b}	293.1 ± 9.82 ^{b}
3- North west basin	0.0.	3.83 ± 1.28 ^{c}	35.53 ± 9.25	8.82 ± 4.87	395.8 ± 8.98 ^{c}	235.6 ± 22.96	470.4± 3.35 ^{a}	313.4 ± 3.39 ^{a}
4- South east basin	0.0	23.97 ± 5.15 ^{a}	22.6 ± 1.04	0.0	754.9 ± 19.20 ^{a}	313.9 ± 75.7	481.5 ± 4.34 ^{a}	293.0 ± 4.75 ^{b}
LSD among basins	_	5.330804088	7.515975578	10.03624127	28.20578428	64.59366842	19.54947854	9.07816615

Mean ± SE of 6 samples in each station.
* = Significant difference at 0.05 level of significance.
** = Highly significant difference at 0.01 level of significance.
Means of superscript litter (a) is significantly ($p <0.05$) higher than that of (b) then (c).

The overall mean of fish muscle cadmium content was 25.53 μg / kg on dry basis. Saad *et al.* (1981) reported that cadmium level ranges from 120 to 340 μg / kg in tilapia flesh. *EA-ESTI* (1997) detected a cadmium range in the muscles of tilapia of the main basin as 50 - 180 μg / kg. Decreases in cadmium level in the present study than in previous works may be due to collecting and treatment of the industrial effluents of El-Qabbary and Ghiet El-Enab in the west treatment plant before discharging into the main basin. There is a highly significant ($p<0.01$) difference in the mean chromium content in muscles of fish of the four basins. The highest chromium content was in fish muscles of the southeast basin (754.9 ±19.20 μg / kg), followed by that of the fishery basin (427.1 ± 18.43 μg / kg). *EA-ESTI* (1997) reported that the highest chromium level (550 μg / kg) was in tilapia flesh of the northwest basin. A highly significant ($p< 0.01$) variation was also recorded in the mean copper contents in muscles of fish of the four basins. The highest copper contents were recorded in fish muscles of the southeast and the northwest basins (481.5 ± 4.34 and 470.4 ± 3.35 μg / kg respectively), while the lowest was recorded in the fishery basin (408.2 ± 13.11 μg / kg). *EA-ESTI* (1997) had estimated copper in tilapia of the main basin as 770 μg / kg. Comparing with this and many previous studies, it was noted that there is a trend of decrease in copper levels in fish muscles in the four basins. Fish muscles iron content of the four basins showed a significant difference ($p<0.05$). The highest muscles iron content was recorded in tilapia of the northwest and the main basins (313.4 ± 3.39 and 311.4 ± 2.87 mg / kg dry weight respectively). The lowest iron content was that of fish of southeast basin (293.0 ± 4.75 mg / kg dry weight).

It should be mentioned that there is a positive correlation between both chromium ($r = 0.38$ **) and iron ($r = 0.192$*) concentrations in water and their levels in fish muscles. On the other hand the other estimated metals showed conflicting values of correlation coefficient (r). This could be due to the fact that water heavy metal contamination is accidental the way such that sometimes the effluents and discharges into the lake accidentally contain high concentrations of the studied metals that increase metal levels in fish muscles. The other possible cause of such conflicting results may be due to low bioaccumulation factors of the studied metals in the fish muscles.

4- Fish body characteristics of Lake Maryout:

Table 4 illustrates variations in body characteristics among Lake Maryout four basins. It was noted that there is a significant ($p<0.05$) difference among the mean fish coefficient of condition (K) factor of the four basins. Fish caught from the main basin and from the fishery basin showed significantly higher condition factor than those caught from the northwest and southeast basins.

The condition factor of the fish is proportional to fish health and well-being, Bakhoum (1994). It can be used to indicate the suitability of an environment for a certain fish species by comparison with another environment, Ricker (1975). Results of the condition factor presented in Table 4 contradict those reported by Bakhoum (1994) who found that the condition factor of *Oreochromis aureus* of the southeast basin is higher than that of those of the main basin. This is because we found fish catch in the main basin is restricted to areas near the fresh water nourishment from Nubareia canal and Omoum drain (south west of the main basin).

Table 4: Fish body characteristics in Lake Maryout basins:

Basin	Fish condition Factor *	% Flesh moisture content **	% Flesh crude protein (Dry weight) **	% Relative liver weight	% Relative gall bladder weight **
1- Main basin	1.6 ± 0.04 [a]	82.30 ± 0.03 [a]	88.30 ± 0.09 [b]	2.24 ± 0.16	0.21 ± 0.03 [c]
2- Fishery basin	1.57 ± 0.04 [a]	81.20 ± 0.02 [c]	88.50 ± 0.16 [a]	2.13 ± 0.16	0.47 ± 0.04 [b]
3- Northwest basin	1.48 ± 0.04 [b]	80.76± 0.05 [d]	88.18 ± 0.10 [b]	2.27 ± 0.15	0.22 ± 0.02 [c]
4- Southeast basin	1.47 ± 0.03 [b]	81.40 ± 0. 1 [b]	88.01 ± 0.05 [c]	1.79 ± .12	0.68 ± 0.05 [a]
LSD among basins	0.051126	0.07548527	0.14257962	0.1968	0.196777

Mean ± SE of 6 specimens in each station excluding stations 1,2.
*** = Significant difference at 0.05 level of significance.**
**** = Highly significant difference at 0.01 level of significance.**
Means of superscript litter (a) is significantly higher (P <0.05) than that of (b) then (c).

The northern and northeastern parts of the basin were found to be almost devoid of fish (sampling stations 1&2). This is due to the heavy organic load discharged into the main basin from Qalaa drain and West Treatment Plant. Moreover, excavation works took place by the local authority to remove reed plants in front of Qalaa drain outfall. This raises sulfides and suspended solids levels and reduces dissolved oxygen, which makes it unsuitable environment for fish living.

A highly significant ($p<0.01$) difference was found in flesh moisture contents among the four basins of the lake. The highest moisture content was noticed in flesh of main basin tilapia (82.3 ± 0.03 %) followed by those of the southeast basin (81.4 ± 0. 1 %), then those of the fishery basin. The northwest basin showed the least fish flesh moisture content (80.76 ± 0.05 %). Fish muscles crude protein content also showed a highly significant ($p<0.01$) variation among the lake basins. The highest protein percent was recorded in fish muscles of the fishery basin (88.5 ± 0.16 %). The lowest protein was found in muscles of the southeast basin (88.01 ± 0.05 %).

Ghoneim (1989) studied the chronic effect of pollutants (organic and inorganic) on the composition of the fish flesh and reported that pollution affects the total protein, fat, ash and moisture contents of fish flesh, where total protein content of fish flesh sampled from polluted water of Lake Maryout was reduced compared to those sampled from non-polluted water. Moisture content increased in fish sampled from the polluted water.

It was also revealed that there are no significant ($p>0.05$) differences among the mean percent relative liver weight of fish of the four basins. On the other hand, Table 4 showed that there is a highly significant ($p<0.01$) difference among the mean fish relative gall bladder weights of the four basins. Fish caught from the southeast basin showed the highest relative gall bladder weights, followed by those of the fishery basin, the northwest and the main basin showed the lowest values of relative gall bladder weights.

5- Fish liver and brain enzymes activity in the lake four basins:

Table 5 presents activities of four liver enzymes (GOT, (GPT), (ALP) and (ACP)) in *Oreochromis aureus* caught from the four basin of Lake Maryout. It was found that there is a highly significant ($P<0.01$) difference in the activity of fish liver enzymes among the four basins. Fish of the southeast basin showed the highest activity of (GOT), (GPT), and (ALP) followed by the main basin and the northwest basin. The fishery basin tilapia exhibited the lowest activities of the three mentioned enzymes. Tilapia liver (ACP) activity also varied significantly ($p<0.01$) among the four basins but in a different manner. The highest activity was recorded in fish livers of the northwest basin, followed by those of the main basin then the fishery basin. The southeast basin fish showed the least (ACP) activity.

Table 5: Activity of some liver and brain enzymes in *Oreochromis aureus* of Lake Maryout basins

Basin	GOT** U / g protein	GPT** U / g protein	ALP** U / g protein	ACP** U / g protein	AChE** Optical density / mg protein / min
1- Main basin	231.84 ± 15.10^{b}	824.98 ± 92.55^{b}	59.48 ± 5.94^{b}	29.15 ± 1.32^{b}	0.25 ± 0.02^{d}
2- Fishery basin	70.82 ± 5.22^{c}	179.12 ± 18.98^{d}	29.69 ± 1.26^{c}	17.22 ± 1.20^{c}	0.64 ± 0.03^{b}
3- Northwest basin	223.63 ± 17.75^{b}	623.09 ± 108.92^{c}	31.15 ± 7.31^{c}	39.31 ± 3.88^{a}	1.41 ± 0.10^{a}
4- Southeast basin	279.68 ± 14.52^{a}	2072.08 ± 96.92^{a}	82.50 ± 8.89^{a}	12.35 ± 1.65^{d}	0.51 ± 03^{c}
LSD among basins	18.2388	113.616	7.88436	2.71038	0.06163

Mean ± Se of 6 specimens in each station excluding stations 1,2.
** = Highly significant difference at 0.01 level of significance.
Means of superscript litter (a) is significantly higher than that of (b) then (c).

Thus, fishery basin tilapia showed the most impaired liver enzymes, which indicate the higher pollution stress in this basin rather than the other three basins. This is most probably due to the fact that the fishery basin is bounded with the solid wastes landfill eastwards. This may cause discharges and run-off of many hazardous substances into the basin. El-Okazy *et al.* (1999) suggested that toxicity induces alterations in the metabolism of the hepatocytes, which lead to accumulation of lipids and glycogen in the liver. These alterations may also cause or be accompanied with impaired cell membrane permeability and osmosis. Through late stages of hepatotoxicity, some cells may explode and discharge their contents and enzymes into extracrellular compartments. This cau0ses the increased levels of liver enzymes in serum and decreased them in liver tissue. Adham *et al.* (2001) reported that high concentrations of ammonia, manganese, nickel, cadmium, lead and mercury dramatically affect liver physiology of *Oreochromis sp.* in Lake Maryout and impair their liver enzymes.

As presented in Table 5, the activity of tilapia brain (AChE) in lake Maryout four basins. showed a highly significant ($p<0.01$) difference in levels of brain (AChE) among the four basins. The main basin tilapia showed the least activity of the enzyme followed by those of the southeast basin. The highest (AChE) activity was recorded at the northwest basin. This is due to the agricultural drainage discharging into the main and the southeast basins through the Omoum drain and Nubareia canal. These waters contain high concentrations of pesticides. Many pesticides are potential cholinesterase inhibitors such as carbamates and organophosph-orus compounds (O'Brien, 1969).

CONCLUSIONS

From the present study it could be concluded that:

- Compared with the range of results obtained through the last decade about heavy metals concentrations in water of Lake Maryout, there are notable decreases in selenium and arsenic and a significant increase in chromium levels in water, while lead, cadmium, nickel, copper and iron levels showed no significant changes.
- Water quality parameters of the main basin are still out of the acceptable limits required for fish survival except areas beside Nubareia canal and Omoum drain. So, the local authority proposed project of bypassing Omoum drain to Qalaa drain through the fishery basin will nourish the main basin with water of much better quality that may cause some improvement in the basin condition especially with respect to sulfides and dissolved oxygen.
- It is difficult to correlate *Oreochromes aureus* liver enzyme and brain acetyl cholinesterase activities with water heavy metal contents or using them as biomonitors for Lake Maryout pollution because of the accidental nature and the diversity of sources of pollution in the lake.

REFERENCES

Abdel-Hakeem, N. F.; M. N.Bakeer and M. A. Sultan (2002). Fish Culture Aquatic Environment. Egypt S.B.N. 4774/2002, I.S.B.N. 977-298-228-5. p 61-70.

Adham, G. Kh.; S. Sh Hamed; M H. Ibrahim; and A. R. Saleh (2001). Impaired functions in Nile tilapia, *Oreochromis niloticus* (Linnaeus, 1757), from polluted waters. Acta Hydrochem, Hydrobiol., 29 (5):278-288.

AMC (Analytical Methods Committee) (1979). Recommended methods for the examination of fish and fish products. Analyst, 104: 434.

Anonymous (1995). Center of Information and Decision Support of *Alexandria, Lake Maryout Pollution. The Library of Alexandria* Governorate Head Quarter.

Anonymous (2002). Primary restoration and development of Lake Maryout. Final Report. Environmental Studies Department, Institute of Graduate Studies and Research, Alexandria University. University Supreme Council, FRCU, LPII Project no 418.

AOAC (1994). Association of Official Analysis Chemists: Official methods of analysis, Inc., 16th Edition. Arlington Virginia 22201,USA.

Bakhoum Sh. A. (1994). Comparative study on length-weight relationship and condition factor of the genus *Oreochromis* in polluted and non-polluted parts of Lake Mariut Egypt. Bull. Nat. Inst. Oceanogr. & Fish., A.R.E.20(1): 201-210.

Bradford, M. M. (1976). A rapid and sensitive method for the quantitative microgram quantities of protein utilizing the principle of protein - dye binding. Anal. Biochem., 72: 248 -- 254.

EA-ESTI (EA Engineering, Science, and Technology) (1997). Environmental Technical Report 8, Chemical and Biological Characterization of Lake Maryout - Final report, Alexandria Wastewater Project- Phase II.

Ellman, G. L.;V. Jr Andress and R. M. Featherstone (1961). A new and rapid colorimetric determination of acetylcholinesterase activity. Biochem. Pharmacol., 7: 88-95.

El-Okazy, A. M.; H. Z. Ibrahim; S. Helmi and A. S.Hamza (1999). Combined toxic effect of tin chloride and lambda cyhalothrin on rabbits. International Conference on Environmental Management and Sustainable Development. IGSR Alexandria University.

El-Rayis, O. A.; M. El-Sabrouti and H. Hanafy (1994).Some hydrochemical observations from Lake Mariut prior to diversion of sewage of eastern districts of Alexandria. First Arab. Conf. Mar. Environ. Protic., Arab Maritime Transport Academy, Alex. 5-7 Feb. p 191-204.

El-Rayis, O. A.and M. A. Saad (1990). Heavy metal pollution in lagoon Mariut on the southern coast of the MediterraneanSea. Bull. K.A. U. Mar. Sci. Jeddah, 1:17-26.

El-Sharkawy, M. F. (2000). Rehabilitation of Lake Maryout. The 18th Annual Conference of The Egyptian Society of Medicine and Law on Citizen's Rights in Clean Environment. June 20-22, Alexandria.

El-Shazly, A. R. (1993). Biological studies on four cichlidae fish *Tilapia niloticus, T. galilaeeus, and T. zillii* in Lake Maryout. M. Sc. Thesis, Faculty of Science, Zagazig Univ., Egypt.

Essa, M. A. and S. N. Faltas (1997). Impact of pollution problems on some fishery aspects of tilapias in Lake Mariut basins, Egypt. Proceeding of the 7th International Conference on Environmental Protection is a Must, National Institute of Oceanography and Fisheries and International Scientists Association.

Ghoneim, E. H. (1989). Alterations in the pattern and nutritional value of fish living in polluted waters. Ph D. thesis. High Institute of Public Health, Alexandria University.

Hafez, H. A. (1982). Distribution of heavy metals in Lake Mariut and Nozha Hydrodrome and their accumulation in fish. M.Sc. thesis. Alex. Univ., Egypt.

Harold, E.; S. K. Ronald and S. Ronald (1981). Persons Chemical Analysis of Foods, 8th Ed. Churchill Livingston, Edinburgh – London – Melbourne and New York. P. 66-70.

Lagler, K. F. (1956). Fresh Water Fishery Biology. Ed. W.M. C. Brown Comp., Dubuque, Iowa, p 421.

Lenore, S. C.; E. G.Arnold and D. E. Andrew (1998). Standard Methods for the Examination of *Water and Wastewater*. 20th *Ed. American* Public Health Association, Washington DC. 20005-2605 USA.

Moss, D. W. (1984). In: Methods of Enzymatic Analysis, Ed. Bergmeyer H.U.; Verlag-Chemie , 3rd Ed., 92--106.

Mostafa, A. H. (1994). Environmental Studies on the water and sediments of Lake Mariut, with reference to pollution *chemistry. Ph. D. Thesis,* Institute of Graduate Studies and Research, Alex. University. Egypt.

O'Brien, R. D.(1969). Biochemical Effects, Phosphorylation and Carbamylation of Cholinesterase. New York, Academic Science, 160: 204-214.

Rec. G.(DGKC) (1972). J.Clin. Chem. *Clin.* Biochem., 10: 182.

Reitman, S.and S. A. Frankel (1957) Am. J. Clin. Pathol., 28: 56 -63.

Ricker, W. E. (1975). Computation and interperetation of biological statistics for fish population. Bull. Fish. Res. Bd. Can., (119): 300

Saad, M. A.; A. A Ezzat; O. A. El-Rayis and H. Hafez (1981). Occurrence and distribution of chemical pollutants in Lake Maryout, Egypt. *Il Heavy* metals. Water, Air, Soil Pollution., 16:401-407.

Samaan, A. A. *and* M. A. Abdel-Monem (1986). Some physical features of the polluted basin and fish farm in Lake Maryout, Egypt. Bull. Inst. Oceanogr. Fish., ARE 12: 149-163.

Steel, R. G. and J. H Torrie (1981). Principles and Procedures of Statistics, 2nd Edition. Mc Graw – Hill, Inc., USA.

UNEP *(United Nation Environment Program)* (1990). Contaminant monitoring programes using marine organisms: Quality Assurance and good laboratory practice. Reference Methods for Marine Pollution Studies No. 57.

UNEP (United Nation Environment Program) (1993). Guidelines for monitoring *chemical contaminants in the sea using marin* organisms. Reference Methods for Marine Pollution Studies No. 6.

WWCG (Wastewater Consultant Group), High institute of Public Health, Alex. University (1994). Report on Preliminary Investigations of Lake Maryout water Quality: Past, Present and Future. Prepared for The *ARE (AGOSD), Alexandria.*

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تأثير المعادن الثقيلة و خواص المياه ببحيرة مريوط علىتلوث و فسيولوجيا سمك البلطي الأزرق

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يهدف البحث لدراسة تركيز المعادن الثقيلة و خواص المياه في بحيرة مريوط و تأثيرها على محتوي المعادن بالعضلات وعلى الحالة الفسيولوجية لاسماك البلطي الأزرق التي تعد من أكثر أنواع البلطي انتشارا بالبحيرة. وقد تبين من الدراسة أن متوسط تركيز السلينيوم بمياه البحيرة ٠,٠٧٦ ميكروجرام / لتر ولا يوجد فرق معنوي بين تركيز السيلينيوم في أحواض البحيرة الأربعة التي تم دراستها. و كان أعلى تركيز للرصاص تم رصده في الحوض الشمالي الغربي(٥,٩٩ ± ٠,٣٧ ميكروجرام / لتر) ، أعلى تركيز للكادميوم و الحديد وجدت بالحوض الرئيسي (١,٦٣±٠,١٠ ميكروجرام / لتر و ١,٢١ ± ٠,٠٩ ملليجرام / لتر على الترتيب) ، أعلى تركيز للزرنيخ تم رصده في الحوض الجنوبي الشرقي (٠,٣٨± ٠,١٥ ميكروجرام / لتر)، أعلى تركيز للكروم و النيكل و النحاس وجدت في حوض الصيد (١١,١٣ ± ٠,٧٦ ، ١٥,٢٢ ± ١,٠٢ و ٨,٥٣ ± ٠,٢٠ ميكروجرام / لتر على الترتيب). و بمقارنة ما اسفرت عنه الدراسة من بيانات و المتوسطات العامة لما تم رصده خلال العشرة سنوات الأخيرة في دراسات سابقة تبين أن هناك انخفاضا عاما في تركيز السيلينيوم و الزرنيخ، و زيادة في تركيز الكروم. أما عناصر الرصاص و الكادميوم و النيكل و النحاس و الحديد فجاءت في نطاق ما ورد بالدراسات السابقة.

تم أيضا تقدير مجموعة عوامل خاصة بتلوث المياه هي الأس الهيدروجيني، و الكبريتيدات، الكبريتات، النيترات، النيتريت، الأكسجين الذائب و الأمونيا بأحواض البحيرة و تبين أن أقل متوسط أس هيدروجيني(٧,١١ ± ٠,١٨) و أقل تركيز للأكسجين الذائب (٢,١ ± ٠,٤٢ ملليجرام / لتر) و أعلى تركيز من النيتريت (٠,١٩١ ± ٠,٠٣ ملليجرام / لتر) و الأمونيا (٠,٧ ± ٠,١١ ملليجرام / لتر) بالحوض الرئيسي كما أن أعلى تركيز للكبريتيدات وجد بذات الحوض و كانت قيمها متفاوتة بدرجة كبيرة (من صفر الى ١٤,٤ ملليجرام / لتر). أعلى تركيز للكبريتات رصد في حوض الصيد (١٨٧٠,٦ ± ١٧٠,٧ ملليجرام / لتر) وأعلى تركيز للنيترات (١٤,١ ± ٠,٩٥ ملليجرام / لتر) وجد بالحوض الجنوبي الشرقي.

و بقياس تركيز المعادن الثقيلة في عضلات البلطي الأزرق وجد أن أسماك الحوض الجنوبي الشرقي تحتوي أعلى تركيز من الرصاص (٢٣,٩٧ ± ٥,١٥) و الكروم (٧٥٤,٩ ± ١٩,٢٠) و النحاس (٤٨١,٥ ± ٤,٣٤ ميكروجرام / كجم وزن جاف).و تحتوي أسماك حوض الصيد على أعلى تركيز من الحديد (٣٩٢,١ ± ٢٤,١ ملليجرام / كجم وزن جاف). و بصورة عامة تبين عدم وجود ارتباط بين تركيز المعادن في المياه و تركيزها في العضلات.

و بدراسة خواص جسم السمكة و علاقة الوزن بالطول (معامل فولتون) وجد أن اعلى قيمة لهذا المعامل و كذلك أعلى نسبة رطوبة في أسماك الحوض الرئيسي، و أعلى نسبة بروتين خام في اسماك حوض الصيد. لم يلاحظ فرق معنوي في الوزن النسبي للكبد بين أسماك الأحواض الأربعة، و لكن أسماك الحوض الجنوبي الشرقي أظهرت أعلى وزن نسبي للحوصلة المرارية. و أعلى نشاط في انزيمات الكبد (الجلوتاميك اكسالوأسيتيك ترانس أمينيز و الجلوتاميك بيروفيك ترانس أمينيز و الفوسفاتيز القلوي) و كان أقل نشاط لهذه الإنزيمات في أسماك حوض الصيد.كما أظهر إنزيم الأسيتيل كولين استريز بالمخ أعلى نشاط في أسماك الحوض الشمالي الغربي و أقل نشاط في اسماك الحوض الرئيسي.

و اتضح من الدراسة صعوبة ربط نشاط الانزيمات التي تم دراستها في البلطي الأزرق مع تركيز المعادن الثقيلة بالمياه أو استخدامها كدلائل حيوية للتلوث بالبحيرة.

و توضح الدراسة أن خواص المياه في الحوض الرئيسي مازالت بعيدة عن الظروف المناسبة لمعيشة الأسماك بالذات من ناحية الكبريتيدات و الأكسجين الذائب نتيجة الحمل العضوي الضخم الذي يصل الي الحوض فيما عدا مناطق شمال غرب ووسط الحوض التي تتجدد مياهها بما يرد اليها من ترعة النوبارية و مصرف العموم. و عليه فان مشروع خلط مياه مصرف العموم بمياه مصرف القلعة و الجاري تنفيذه من المتوقع أن يحدث تحسنا في خواص المياه بالحوض الرئيسي.