Water quality and heavy metals monitoring in water and tissues of Nile tilapia fish from different governorates "Egyptian Aquaculture farms"

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ABSTRACT

All aquatic organisms are directly or indirectly affected by the physico-chemical characteristics of their environment, especially the chemical composition of the water, where it is the main factor affecting the cultured fish. So, the present study investigated the quality of water ponds and their impacts on fish reared in three different farms at Sahl El-Hussaynia, Sharkia governorate, Kafr El-Sheikh, governorate and at Sahl El-Tinna, Port-Saeed governorate, Egypt. Water and fish samples were taken during summer to evaluate the physico-chemical characteristics and heavy metals distribution in water and fish tissues (muscles, gill and liver). Moreover, the effect of accumulated heavy metals on glucose, total proteins and the activities of transaminases (AST and ALT) in the fish muscles was studied. Also, Physical and chemical characteristics of water (water temperature, pH, DO, NH_3, No_3, total alkalinity, total hardness and phosphate) were measured.

Heavy metals varied depending upon the organs and location. Also, the order of occurrence of heavy metals in water ranked at the following order; Zn> Fe> Cu> Cd at Sahl El-Hussaynia and Sahl El-Tinna farm but at Kafr El-Shiekh farm the order was Fe> Zn> Cu> Cd. Pb metal was not detected in the three farms. In the same time, the heavy metals were found in muscles, gills, and liver in the order Fe> Zn> Cu in the three fish farms, but Pb and Cd were not detected. In the liver, levels of the heavy metals exceeded the permissible limits according to WHO (1989). Moreover, in gills the levels of Zn exceeded the permissible limits at El–Hussaynia and Kafr El-Shiekh farms, but in muscles didn't exceed the permissible limits, except the Fe. The results of glucose, total protein, and activities of AST and ALT had some fluctuations in the serum among the studied fish.

Keywords: Aquaculture, heavy metals, physico-chemical characters.

INTRODUCTION

Aquaculture is considered as one of the most important sources of animal protein production in Egypt for meeting the increasing demand for protein (Konswa, 2007). Egypt's fish farms act as temporary reservoirs for drainage water (Osman *et al.*, 2010), where the aquatic environment with its water quality is considered the main factor controlling the state of health or disease in both cultured and wild fishes. Pollution of the aquatic environment by inorganic and organic chemicals is one of the major factors that threat the aquatic organisms (Saeed & Shaker, 2008). Water quality is a critical limiting factor for fish life and fish flesh quality, so water physico-chemical parameters should be closely monitored and the optimal limits should at all time be provided to the cultured organisms for optimum performance as well as profitability of fish production venture (Onada *et al.*, 2015).

Water pollution is a series environmental problem in the world. It is the degradation of the quality of water that renders water unsuitable for its intended purpose. Anything which degrades the quality of water is termed as a pollutant. Water pollutant can be broadly classified as major categories namely organic, inorganic, suspended solids and sediments, heavy metals, radioactive materials and heat (Botikin and keller, 2008).

In fishes, it is observed that the external organs are affected due to the toxic chemicals including the heavy metals, causing loss of equilibrium, increased opercular movement, irregular vertical movements, finally leading to death. Cadmium, lead, mercury and arsenic cause severe damage to the renal and nervous systems of fish as well as gill damage; severe destructive pathological changes i.e. structural lesions; (Larse, 2003; Velcheya *et al.*, 2010; Deore and Wagh, 2012; Mahino and Nazura, 2013).

There was a strong evidence of a correlation between heavy metals concentrations in different fish tissue and those of the surface water of the polluted areas. The accumulation of metals in fish tissues depends on numerous factors, such as environmental concentrations, environmental conditions (pH, water temperature, hardness….etc), exposure duration and feeding habits. In recent years, the anthropogenic pollution of aquatic ecosystem increased the need for studies to identify the impact of heavy metals on the species living there. Monitoring programs for bioaccumulation measurements serve as a biomarker for fish from contaminated places and provide information about the environmental conditions (Zeitoun and Mehana, 2014).

Fish are often at the top of aquatic food chain and metals are accumulated in them to concentration much time higher than that present in water and sediment. Fish can absorb heavy metals through epithelial or mucosal surface of the skin, gills and gastrointestinal (Jovanovic *et al*., 2011).

Biochemical studies proved that, fish which were subjected to the heavy metals, showed severe reduction in the proteins, lipids levels and transaminases activities in the muscles (Almeida *et al*., 2001; Atli and Canli, 2007; Mohamed and Gad 2008).

Accordingly, the present study aimed to investigate the physical, chemical characteristics of water and accumulation of heavy metals in fish and water of three different fish farms and its effect on some biochemical parameter.

MATERIALS AND METHODS

Samples of water and *Oreochromis niloticus* fish were collected during summer (June to September) of 2014 from three different fish farms:-

1- A private fish farm at El-Hussaynia, Sharkia governorate (three earthen ponds supplied with water driven from Bahr El- Bakar canal (sewage water).

2- A private fish farm at Kafr El-Shiekh governorate, (three earthen ponds supplied with a mix of water driven from El-Gharbia drain (three earthen ponds supplied with agriculture drainage, industrial and sewage water).

3- A private fish farm at Sahl El-Teinna, Port Saeed governorate and had its water supply from Bahr El-Bakar which includes domestic, agricultural and industrial waste water.

Water quality parameters

Water samples were collected from each pond to be analyzed for different water physico-chemical parameters; temperature, dissolved oxygen, pH, alkalinity, total hardness, unionized ammonia (NH_3), nitrate (NO_3) and phosphate (PO_4). Water samples were analyzed according to methods described by Boyd and Tucker (1992).

Fish samples collection

Random **s**amples of *Oreochromis niloticus* were collected from 3 earthen fish ponds for analysis. The **s**amples collected were labeled with an identification number, the date and place of collection, before transporting in ice packed plastic coolers to the laboratory for analysis.

Heavy metal analysis

For the determination of heavy metals, fish samples were carefully dissected to remove the liver and parts of the muscles. Livers and pieces of edible muscle tissues were oven dried at 85^{o}C until constant weight (about 18 hours). A 1.0 g dry weight of tissue was ashed in muffle furnace (Thermolyne Corporation, Dubuque, Iowa, USA) for 6 hours. Ash was digested with conc. nitric acids, and diluted with 2N HCL to a constant volume. The samples were filtered into acid-washed volumetric flasks and diluted to 50 ml for elemental analysis. Concentrations of cadmium, copper, iron, lead, and zinc were then determined according to APHA (1998) using atomic absorption spectrophotometer (Thermo 6600 Thermo Electron Corporation, Cambridge, UK).

Bioaccumulation factor (BAF)

The bioaccumulation factor (BAF) is the ratio between the accumulated concentration of a given pollutant in any organ and its dissolved concentration in water according to Authman and Abbas (2007) using the following equation:

BAF = pollutant concentration in fish tissue (mg/kg)/pollutant (mg/l) in water or sediment.

Biochemical Analyses

Serum samples were used to estimate the biochemical parameters. The glucose was estimated according to the method of Trinder (1969), while total protein was determined according to young (2001). Aspartate amino transferase (AST) and Alanine amino transferase (ALT) were determined according to the method of Reitman and Frankel (1957).

Statistical analysis

One way ANOVA and Duncan multiple range test were applied to test whether differences among sites and time were significant at $P \leq 0.05$. Correlation coefficients; Pearson correlation (r), between the different parameters were computed. Correlation and all statistical analyses were done using SPSS for windows version 10 (SPSS, Richmond) as described by Dytham (1999).

RESULTS AND DISCUSSION

Water temperature

The highest water temperature was recorded at ponds of El-Hussaynia farm (Table 1) and the lowest was at ponds of Kafr El-Shiekh. These variations were mainly due to the differences of location; this attributed to the shallowness of most tropical fish ponds. These results were in accordance with Ali (2007).

Hydrogen ion concentration (pH)

The value of pH lies on the alkaline side at all sites, with total mean of 7.50 ± 0.02, 7.65 ± 0.01 and 7.07 ± 0.07 in Sahl El-Hussaynia, Kafr El-Shiekhand Sahl El-Tinna farms, respectively. On the other hand, the increase of pH value in Kafr El-Shiekh may be due to increase of photosynthesis activity by phytoplankton. This may be attributed to the wide variation of phytoplankton between feeder/drains and fishponds, where pH changes in surface water result from the interaction of various biotic and abiotic processes (Konsowa, 2007).

Table 1: Mean concentration of physico–chemical characters in water of Sahl El-Hussaynia, Kafr El-Sheikh and Sahl El-Tinna private fish farms during June to September 2014

Locations Items	Sahl El- Hussaynia	Kafr El-Shiekh	Sahl El-Tinna
Temperature (^{o}C)	31.33± 0.77 A	26.68± 2.53 A	29.43± 0.20 A
pH	7.65 ± 0.01 A	7.50± 0.02 A	7.07± 0.07 A
DO (mg/l)	6.43± 1.52 B	7.50± 0.02 A	4.28± 0.42 C
T. alkalinity (mg/l)	246.67± 8.80 B	240.01± 2.02 B	366.67± 16.69 A
T. hardness (mg/l)	263.30± 16.45 C	683.30±43.38 B	1513.30± 13.35 A
NO_3 (mg/l)	0.12± 0.01C	0.26 ± 0.01 B	1.08± 0.05 A
NO_2 (mg/l)	0.32± 0.02 A	0.26± 0.02 A	0.06± 0.01 B
NH_3 (mg/l)	0.07±0.02 B	0.49±0.04A	0.05±0.01 B
PO_4 (mg/l)	0.03±0.01 C	0.24+ 0.04 B	0.64± 0.06 A

*Means with the same letter within the same row are not significantly different

Dissolved Oxygen

Values of DO during the study period were 6.43±1.52, 7.50±0.02 and 4.28±0.42 mg/l at Sahl El-Hussaynia, Kafr El-Shiekh, and Sahl El-Tinna fish farms, respectively (Table 1). The low value of DO was at Sahl El-Tinna; this may be due to the presence of organic matter loaded by the higher amounts of drainage water discharged in these areas but the high value was recorded at ponds of Kafr El-Shiekh, attributed to the high level of agriculture drainage water in these ponds caused abundance of phytoplankton communities.

Total alkalinity

The highest value (366.67±16.69 mg/l) was observed in ponds of Sahl El-Tinna, while the the lowest value was found at Kafr El-Shiekh ponds with mean values of 240.01±2.02 and 246.67±8.80 mg/l, in Sahl El-Hussaynia fish farms, respectively (Table1).The highest value in ponds of Sahl El-Tinna may be attributed to feeding and organic fertilization in them.This is because bacteria generated Co_2 from feed metabolism and manure decomposition dissolved calcium and magnesium carbonate present in the pond sediments (Boyd, 1990). The results were in accordance with the study of Ezzat *et al*. (2012), who reported that the range of total alkalinity values was 282.5 to 426.5 mg/l in drains water.

Total Hardness

The maximum value was recorded at Sahl El-Tinna (1513.30±13.35 mg/l) and the minimum was at ponds of Sahl El-Hussaynia with mean of 263.30±16.45 and 683.30±43.38 mg/l at Kafr El Shiekh farms, respectively (Table 1). The increasing total hardness values at Sahl El-Tinna may be due to the increasing of salinity that led to increase of hardness. These results were in agreement with that observed by Adham (2001).

Nitrate (NO_3)

Its concentrations decreased in ponds of Sahl El-Hussaynia and increased in ponds of Sahl El-Tinna with mean values of 0.12±0.01 and 1.08±0.05 mg/l (Table 1). This may be related to different sewage effluents that contain nitrate which originated from domestic and agricultural wastes, especially from N-containing fertilizers. Similar observations were recorded in fish ponds and El-Berka drain in Fayoum by Konsowa (2007).

Nitrite (NO_2)

High nitrite concentrations deactivate hemoglobin in the blood of fish, thus causing hypoxia (Mansour, 2009). Nitrite toxicity is affected by many chemical factors as calcium, bicarbonate…ect. It is rarely a problem in salt water and brackish water (Boyd, 1990). The levels of nitrite in this study were 0.32±0.02, 0.26±0.02, 0.06±0.01 mg/l in Sahl El-Hussaynia, Kafr El-Shiekh and Sahl EL-Tinna fish farms, respectively. The nitrite was relatively low in Sahl El-Tinna fish ponds as a result of high value of nitrate-reducing bacteria (Koussa, 2000). Moreover, the highest concentration was recorded at Sahl El-Hussaynia which may be attributed to the direct impact of domestic and agricultural sewage discharged in these areas.

Ammonia (NH_3)

Unionized ammonia (NH_3) is extremely toxic substance to aquatic animals that retards fish growth and may increase their susceptibility to other unfavorable conditions in fish culture system (Boyd, 1990). The European Inland Fisheries Advisory Commission (EIFAC, 1973) stated that the toxic concentration of unionized ammonia to freshwater fish for short term exposure is ranged from 0.7 to 2.7mg/l. The highest value was observed in ponds of Kafr El-Shiekh (0.49±0.04 mg/l), due to higher pH. At high pH, more and toxic ammonia is released to critical levels (Boyd, 1990). The present results agreed with those of Meade (1985) and Konsowa (2007).

Orthophosphate (PO_4)

The lowest value of phosphate concentration was recorded in ponds of Sahl El-Hussaynia and the highest was in Sahl El-Tinna, with mean values of 0.03±0.01 and 0.64±0.06 mg/l, respectively. This may be due to agricultural run-off containing phosphate fertilizers as well as wastewater (domestic) containing detergents. The values of phosphate were similar with the study of Ali (2007) in fish ponds.

Heavy metals are the most dangerous contaminants, since they are persistent and accumulate in water, sediments and tissues of the living organisms, through bio-concentration (uptake from the ambient environment) and bio-magnification (uptake through the food chain) (Chaphekar, 1991). As a part of the aquatic environment, fish could accumulate heavy metals and acted as indicator of pollution (Mersch *et al*. 1993).

In Table (2), results of heavy metals in water samples showed some variations in their concentrations among the three fish farms. It is clear that iron, copper and cadmium showed the highest values at Kafr El-Shiekh farm (1.49±0.16, 0.06±0.01 and 0.003±0.001 mg/l, respectively), while Zinc showed its highest level in Sahl El-Hussaynia farm (1.12±0.16 mg/l). In addition, the water of Sahl El-Tinna maintained generally lower metal contents than Sahl El-Hussaynia and Kafr El-Shiekh farm water except for zinc concentration. This may be attributed to the higher hardness and alkalinity (Malcolm, 1995) who revealed that at higher values of these variables the metals bind to form hydroxide and carbonate complexes which are considered less toxic to fish rather than the metal ions.

Table 2: Mean concentrations of heavy metals (mg/l) in water of Sahl El-Hussaynia, Kafr El-Sheikh and Sahl El-Tinna private fish farms during June to September 2014

Locations Items	Sahl El- Hussaynia	Kafr El-Shiekh	Sahl El-Tinna
Fe	0.95±0.29 A	1.49±0.16 A	0.73±0.02 B
Zn	1.12±0.16 B	0.73±0.02 C	1.61±0.18 A
Cu	0.05±0.01 A	0.06±0.01 A	0.02±0.01 B
Pb	ND	ND	ND
Mn	0.03±0.01 B	0.16±0.03 A	0.001±0.00 C
Cd	0.002±0.001 A	0.003±0.001 A	0.001±0.00 B

*Means with the same letter within the same row are not significantly different
*ND = not detected limits

Thus, there are reductions in levels of the metallic ions (which are more toxic) at high alkalinity and hardness values. However concentrations of heavy metals (Zn, Cu, Pb & Cd) in this study are below the permissible limits according to WHO (2011) and there no health based guideline–value for both Fe and Zn.

There was a positive correlation between total hardness, NO_3 and PO_4 with total alkalinity r = 0.875, 0.893 and 0.890, respectively, while a negative correlation was found between total alkalinity and total hardness with Fe r = - 0.843 and - 0.915, respectively. On the other hand, a negative correlation was recorded between total hardness and Cd, r = - 0.865 but the correlation between pH and NH_3 with Cu was positive, r = 0.937 and 0.905, respectively, where a negative correlation was found between Fe and Cd with NO_3, r = - 0.849 and - 0.820. Moreover, the correlation between Fe and Cd with PO_4 was negative, r = - 0.891 and - 0.842, respectively.

The correlation coefficient matrix of water physico–chemical parameters indicated that, pH had positive correlation with ammonia and Cu, where the toxicity of water depends on the amount of unionized ammonia present, which increases when pH increases. These results agreed with that observed by Mohamed (2005). Also, Pyle *et al*. (2005) reported that water hardness is an important factor, that decreasing heavy metals accumulation. Where the present results revealed that there was a negative correlation between hardness and Cd concentration.

Correlation between heavy metals and water quality parameters

	T. alk	T. hard	DO	pH	NH_3	Temp	NO_3	NO_2	PO_4	Fe	Zn	Cu	Cd
T. alk	1.00***	0.875**	-0.567	-0.714*	-0.560	0.224	0.893**	-0.640	0.890**	-0.843**	0.400	-0.774*	-0.660
T. hard		1.00***	-0.549	-0.454	-0.225	-0.132	0.975**	-0.616	0.971**	-0.915**	0.100	-0.525	-0.865**
DO			1.00***	0.726*	0.603	-0.069	-0.644	0.282	-0.527	0.240	-0.451	0.589	0.341
PH				1.00***	.954**	-0.472	-0.608	0.227	-0.425	0.318	-0.596	0.937**	0.156
NH_3					1.00***	-0.649	-0.403	0.180	-0.199	0.103	-0.558	0.905**	-0.037
Temp						1.00***	-.033	-0.463	-0.098	0.100	0.256	-0.432	0.374
NO_3							1.00***	-0.565	0.923**	-0.849**	0.143	-0.673*	-0.820**
NO_2								1.00***	-0.674*	0.582	-0.065	0.252	0.443
PO^4									1.00***	-0.891**	0.237	-0.472	-0.842**
Fe										1.00***	-0.020	0.437	0.766*
Zn											1.00***	-0.399	0.161
Cu												1.00***	0.340
Cd													1.00***

Fish are notorious for their ability to concentrate heavy metals in their tissues. The metals exist most probably as cationic complexes and accumulate in the internal organs of fish**.** Table (3) shows the mean concentrations of the analyzed metals in the tissue (muscles, gills & livers) and bioaccumulation factor of *O. niloticus* of El-Hussaynia, Kafr El-Sheikh and Sahl El-Tinna private fish farms during summer season (June to Sept., 2014). Iron was the most abundant metal in the studied tissues of the fish samples. Fe accumulation was the maximum in all the organs but its highest value was observed in the muscles of fish from Sahl El-Tinna and liver and gills of those from Kafr El-Sheikh farm. Ferric and ferrous compounds can affect gills and pond productivity by taking up phosphate and restricting plankton growth (WHO, 1984). However accumulation levels reported in the present study for liver and gills of Kafr El-Shiekh farm were 1554.00±21.90 and 385.27±38.11 mg \kg, respectively. Fe concentration in all organs of the three locations was higher than the permissible limits (30 mg/kg) that recorded by WHO (1989).

Table 3: Mean concentrations of heavy metals (mg/kg) in muscles, gills and livers of *O. niloticus* collected from Sahl El-Hussaynia, Kafr El-Sheikh and Sahl El-Tinna private fish farms during June to September 2014

Metal	Organ	Sahl El-Hussaynia	BAF	Kafr El-Sheikh	BAF	Sahl El-Tinna	BAF
Fe	M	134.07 ±10.48 B	141.13	110.56 ±22.95CB	74.20	163.01 ±22.82 A	233.30
	G	350.50 ±10.81A	368.94	385.27 ±38.11A	258.57	369.3 ±72.53 A	505.80
	L	1447.00 ±82.34 A	1523.00	1554.00 ±21.90 A	1042.95	1388.00 ±180.10 A	1901.00
Cu	M	6.25 ±0.17 A	125.00	2.88 ±0.26 B	48.00	2.20 ±0.73 B	110.00
	G	10.10 ±0.67 A	202.00	11.04 ±2.84 A	184.00	4.49 ±0.38 B	224.50
	L	45.17 ±0.73 B	903.40	42.97 ±12.43 B	716.16	177.11 ±30.00 A	8855.50
Zn	M	88.30 ±4.43 A	78.83	28.22 ±2.84 B	38.66	29.10 ±2.88 B	18.07
	G	180.29 ±23.20 A	160.97	102.9 ±27.84 B	140.96	39.03 ±4.60 C	24.24
	L	272.60 ±2.60 A	243.39	258.6 ±35.04 AB	354.25	230.10 ±38.9 B	142.92
Cd and Pb were not detected							

*Means with the same letter within the same row are not significantly different
*BAF = Bioaccumulation Factor

The highest mean Bio-Accumulation Factor (BAF) of Fe in the muscle (233.3) was observed in fish of Sahl El-Tinna farm, while the lowest (74.2) was observed in Kafr El-Sheikh farm. In gills, the highest BAF (505.8) was observed in Sahl El-Tinna while the lowest (258.57) in Kafr El-Shiekh. In liver, the highest one (1901) was in Sahl El-Tinna, while the lowest one (1042) was in Kafr El-Shiekh. Low accumulation of metals in muscles may be due to lack of binding affinity of these metals with the proteins of muscles. This is particularly important because muscles contribute the greatest mass of the flesh that is consumed as food.

Copper is commonly a natural element in water and sediment. The metal is insoluble in water, but many of its salts are highly soluble. Copper is a fundamental micronutrient to all forms of life, in enzyme activity and random rearrangement of natural proteins (Bower, 1979). At slightly higher but sublethal concentrations, it causes chronic toxicity to aquatic life. Gainey and Kenyom (1990) mentioned that exposure of fishes to sublethal concentrations of copper leads to cardiac activity and reduction in heart rate. Dietary Cu level of 20 mg/Kg significantly reduced the weight gain of growing tilapia (Shiau and Nig, 2003).Chronic toxic effects may induce poor growth, decreased immune response, shortened life span, reproductive problems, low fertility and changes in appearance and behavior (Choongo *et al.*, 2005).

The mean values of copper in the fish organs followed the order: liver> gills> muscles. The concentrations of Cu in the muscles and gills of *O. niloticus* in the three different locations were lower than the permissible limits (20 mg/kg) reported by WHO (1989), while its concentrations in the liver were higher than the permissible limits. Gills accumulated lesser copper than liver .In the present study, the lowest concentrations of Cu were observed in the muscles of studied fish, similar to results recorded by Khaled (2004) and Abdo & Yacoub (2005). The highest BAF of Cu in muscle of fish were (220) recorded in Sahl El-Tinna farm and the lowest one (48) was observed in Kafr El-Sheikh, while the maximum value in gills (449) recorded in Sahl El-Tinna and the minimum value was (20) recorded in Sahl El-Hussaynia but in the liver the highest BAF was (716) recorded in Kafr El-Sheikh and the lowest one was (21) in Sahl El-Tinna.

Zinc is an essential element for normal growth, reproduction and longevity of animals (Sultana and Roa, 1998). Mining, smelting and sewage disposal are the major sources of zinc pollution (Skidmore, 1964). The mean values of zinc in fish liver were higher than those in gills and muscles. The maximum permissible level (MPL) of zinc is 50 ug/g dry wt according to Australian NHMRC (Bebbington *et al.*, 1977) and 40 µg/g dry wt according to Food and Agriculture Organization (FAO, 1983).The mean values of zinc in the gills, liver and muscles of *O. niloticus* in Sahl El-Hussaynia were significantly higher than (MPL), while in fish muscles of Kafr El-Sheikh and muscles, gills tissue of Sahl El-Tinna fish farm was lower than (MPL). The concentrations of heavy metals (Fe, Cu, Zn, Pb, and Cd) vary according to locality (Yacoub, 2007). Metal accumulation in tissues of fish is depend upon environmental factors such as temperature, total hardness, size and age of fish and processes of biotransformation and excretion (Zhou *et al.*, 2001).

Table 4: Changes in serum glucose, total protein, AST and ALT of the *O. niloticus* collected from Sahl El-Hussaynia, Kafr El-Sheikh and Sahl El-Tinna private fish farms during June to September 2014

Locations / Parameters	Sahl El- Hussaynia	Kafr El-Shiekh	Sahl El-Tinna
Glucose	25.86±5.48 AB	13.50±1.00 B	32.14±2.89 A
Protein	1.93±0.15 AB	1.48±0.13 B	2.81±0.47 A
AST	53.92±11.99 A	36.12±5.90 A	35.24±1.70 A
ALT	16.83±0.71 A	17.43±1.54 A	6.92±.62 B

*Means with the same letter within the same row are not significantly different

Data in Table 4 shows fluctuations in glucose, total protein, AST and ALT in serum of *O. niloticus* through the different locations. However, these changes didn't take a certain or definite trend pattern. Edsall (1999) stated that biochemical characteristics of blood are important indices of the status of internal environment of the fish. Biochemical profile in fish has proved to be a sensitive index for evaluation of the fish metabolism under metallic stress. Almeida *et al*. (2001) proved that, fish subjected to metals showed reduced levels of proteins, ALT and AST activities in the fish muscles. Also, Loskova *et al*. (2002) mentioned that changes in the biochemical blood profile are mirror changes in metabolism and biochemical processes of the organism, resulting from the effect of pollutants such as the heavy metals.

Correlation between heavy metals in liver and blood parameters

	Fe	Cu	Zn	Cd	Glucose	T. pro	AST	ALT
Fe	1.000	-0.369	0.196	0.210	-0.241	-0.102	0.326	0.218
Cu		1.000	-0.363	-0.968**	0.678*	0.802**	-0.280	-0.810**
Zn			1.000	-0.194	-0.012	0.196	0.210	0.091
Cd				1.000	-0.787	0.870**	-0.337	-0.809**
Glucose					1.000	0.637	0.018	-0.573
T. pro						1.000	-0.055	-0.735*
AST							1.000	0.294
ALT								1.000

CONCLUSIONS

In conclusion, levels of heavy metals found in the edible tissues (muscle) of the examined fish samples of the three locations were within the safe limits for human health according to WHO (1989) except iron, zinc, while WHO (2011) reported that no health based guide line-value for both iron and zinc. In addition, it is necessary to exercise more cautions towards water resources in these areas to keep water suitability for aquaculture, or at least the production of good fish, which negatively affects the health of human being and general economy.

REFERENCES

Ali, N. A. (2007). Ecological study on some water characteristics used in fish farms and their relations to fish productivity. Ph. D. Thesis, Fac. Sci., Al-Azhar Univ.

Almeida, J. E.; Novelli, M.; Dal Pai Silva and Junior, R. (2001). Environmental cadmium exposure and metabolic responses of the Nile tilapia; *Oreochromis niloticus*. Environ. Pollut., 114:169-175.

Abdo, M. H. and Yacoub, A. M. (2005). Determination of some heavy metals in water and fish flesh of common species in Bardawil Lagoon, Egypt. Egypt. J. Anal. Chem., 14: 65-7.

Adham, K. G. (2001). Metallic micro pollutants in the harvest of *Oreochromins niloticus* (Linnaeus, 1757) from polluted waters: wild life and human concerns. Pakistan J. Bio., Sci., 4 (12): 1550-1558.

American Public Health Association (APHA, 1998). Standard methods for the examination of water andwastewater. In: Greenberg, A.E., Clesceri, L.S., Eaton, A.D. (Eds.), APHA, WE F and AWWA, 20th, Washington DC, USA, pp: 1193.

Authman, M. M. and Abbas, H. H. (2007). Accumulation and distribution of copper and zinc in both water and some vital tissues of two fish species (Tilapia zillii and Mugil cephalus) of Lake Qarun, Fayoum Province, Egypt. Pakistan J. Biol. Sci., 10(21): 06-21 22.

Atli, G. and Canli, M. (2007). Enzymatic responses to metals exposures in a fresh Water; *Oreochromis niloticus*. Comp. Biochem. Physiol. C. toxical. Pharmacol., 145: 282-287.

Bebbington, G. N.; Mackey, N.J.; Chvoike, R.; William, R. J.; Dunn, A. and Auty, E. H.(1977). Heavy metals (selenium and arsenic) in nine species of Australian Commercial Fish. Aust. J. Mar. Freshwater Res., 28: 277- 280.

Botkin, D. B. and Keller, E. D. (2008). Environmental Science Earth as a living planet. John Wiley and Son Inc. New York, USA. 7th ed pp 410-476.

Boyd, C. E. (1990). Water quality in ponds for aquaculture. Alabama Agricultural Experiment Station, Auburn University, Alabama, USA.

Boyed, C.E. and Tucker, C.S. (1992). Water quality and pond soil analysis for aquaculture. Alabama Agriculture Expermint Station. Auburn Univ. 183, pp.

Bower, J. J. M. (1979). Environmental chemistry of the elements. Academic Press, London.

Chaphekar, S. B. (1991). An overview on bioindicators, J. Environ. Biol., 12: 163-168.

Choongo, K. C.; Syakalina, M. S. and Mwase, M. (2005). Coefficient of condition in relation to copper levels in muscle of Serronochromis fish and sediment from the Kafue River, Zambia. Bull. Environ. Contam.Toxicol., 75: 645- 651.

Deore, S.V. and Wagh, S. B. (2012). Heavy metal induced histopathological alterations in liver of Channagachua (Ham). Journal of Experimental Science, 3(3): 35-38.

Dytham, C. (1999). Choosing and using statistics: A Biologist's guide. Blackwell science Ltd., London, UK.

EIFAC (1973). Water Quality Criteria for European Freshwater Fish. Report on ammonia and inland fisheries. EIFAC tech. Pap. (11):12 p.

Ezzat, S. M.; Mahdy, H. M.; Abo-State, M. A.; Abd El-Shakour, E. H. and El- Bahnasauiy, M. A. (2012). Water quality assessment of River Nile at Rosetta bransh: Impact of drains discharge. Middle- East Journal of Scientific Research, 12 (4): 413-423.

Edsall, C. C. (1999). Journal of Aquatic Animal Health 11: 81–86.

Food Agricultural Organization (FAO, 1983). Compilation of legal limits for hazardous substances in fish and fishery products. FAO, Fishery circular, 464: 5-100.

Gainey, L. F. and Kenyom, J. R. (1990): The effects of reserpine on copper induced cardiac inhibition in *Mytilusedulis*. COMP. Biochem. Physiol., 95(2):177- 179.

Jovanovic B.; Mihaljev, E.; Maletin S. and Palic, D. (2011). Assessment of heavy metal load in chub liver (Cyprinida*: Leuciscuscephalus*) from the Nisava River (Serbia), Biologica Nyssana, 2(1):1-7.

Khaled, A. (2004). Heavy metals concentrations in certain tissues of five commercially important fishes from El Max Bay, Alexandria, Egypt. Egypt. J. Aquatic Biol. & Fish, 8(1): 51- 64.

Konsowa, A. H. (2007). Ecological studies on fish farms of El-Fayoum depression. E. J. Aquat. Res., 33(1): 290-299.

Koussa, A. A. (2000). Effect of Industrial and Organic Pollution on Potential Productivity and Fish Stock of lake maruit, with Apredictives Study of that Effect on the Lake. Ph.D. Thesis, fac. Sci., Ain Shams Univ.

Lars, J. (2003). Hazards of heavy metal contamination. British Medical Bulletin, 68 (1): 167-182.

Luskova, V.; Svodoba, M. and Kolářová, J. (2002). Acta Vet. Brno, 71: 117 – 123.

Mahino, F. and Nazura, U. (2013). Histopathology and Bioaccumulation of heavy metals (Cr, Ni and Pb) in fish (Channastriatus and Heteropneustesfossilis) tissue: A study for toxicity and Ecological impact. Pakistan Journal of Biological Science, 16: 412-420.

Mansour ,E. M. G. M. (2009). Water Quality Assessment of Some Drainage Canals in Sharkya governorate and their Effect on Fish . M.sc. Thesis, Fac. Sci., Benha Univ.

Malcolm, J. (1995). Test book of environmental biology of fishes. 1st ed.Printed in Great Britain by T.j. press (padstow) LTD. Padstow. Cornwall.

Meade, J. W. (1985). Allowable ammonia for fish culture, Prog. Fish-Cult., 47: 135- 145.

Mersch, J.; Dubost, N. & Pihan, J. (1993). Comparison of several inert and biological substrates to assess the trace metals concentration in the reservoir of nuclear power plant in Cattenon, France. Limno., 29: 325-337.

Mohamed, M. A. E. (2005). Impact the Disposal of Wastes from Drinking Water Treatment Plants of the River Nile Ecosystem. M.SC. Thesis, Inst. Env. Stud. & Res., Ain Shams, Univ.

Mohamed, F. A. and Gad, N. S. (2008). Environonmental pollution Biochemical induced changes in tissues of tilapia zilli Solea Vulgaris and *Mugil capito* from lake Qarun, Egypt. Global, Veterinaria, 2(6): 327-336.

Onada, O. A.; Akinwole, A. O. and Ajani, E. K. (2015). Study of interrelationship among water quality parameters in earthen pond and concrete tank. Peer J., reprints 3: e1045 https://dx.doi.org/10.7287/peerj.preprints.845v1(website).

Osman, M. A.; Mohamed, M. A.; Ali, M. H. and Al-Afify, A. D. (2010). Assessment of agriculture drainage water quality to be used for fish farm irrigation. Natu.and Sci. J., 8 (8): 60-74.

Pyle, G.,:Rajotte, J. and Couture, P. (2005). Effect of industrial metals on wild fish
populations a long a metal concentration gradient. Ecotoxicol.& Environ. Safety, 61: 287-312.

Saeed, S. M. and Shaker, I. M. (2008). Assessment of heavy metals pollution in water sediments and their effect on *Oreochromis niloticus* in the northern Delta lakes, Egypt. 8th international symposium on Tilapia in Aquaculture, pp. 475-490.

Shiau, S. Y. and Nig, Y. C. (2003). Estimation of dietary copper requirements of juvenile tilapia; *O. niloticus* and *O. aureus.* Anim. Sci., 77: 287- 292.

Skidmore, J. T. (1964). Toxicity of zinc compounds to aquatic animals with special references to fish. Quart. Rev. Biol., 39(3): 227- 248.

Sultana, R. and Roa, D. P. (1998). Bioaccumulation patterns of zinc, copper, lead and cadmium in grey mullet,Visakhapatnam, India. Bull. Environ. Contam. & Toxicol., 60: 949-955.

Trinder, P. (1959). Determination of blood glucose using 4-Aminophenazone. Journal of Clinical Pathology, 22: 246.

Reitman, S. and Frankel, S. (1957). Colorimetric determination of glutamic oxaloacetic and glutamic pyruvic transaminases. Am. J. Clin. Pathol., 28: 53-56.

World Health Organization (WHO, 1989). Guide lines for Drinking Water Quality, vol. (1), Recommendations, WHO, Geneva.

World Health Organization (WHO, 1984). Environment of health criteria 36, fluorin end fluoride. World Health Organization, Geneva.
WHO (World Health Organization) (2011): Guidelines for drinking water quality – 4th ed. WHO library Cataloguing- in- publication Data.
Velcheva, E.; Tomova, D.; Arnaudova, D. and Arnaudov, A. (2010). Morphological investigation on gills and liver of fresh water fish from Dam Lake "Studen Kladenets". Bulgarian Journal of Agriculture Sciences, 16(3): 364-368.
Yacoub, A. M. (2007). Study on some heavy metals accumulated in some organs of three River Nile fishes from Cairo and Kalubia governorates. African J. Biol. Sci., 3(3): 9-21.
Young, D. S. (2001). Effects of disease on Clinical Lab. Tests, 4th ed AACC.
Zeitoun, M. M. and Mehana, E.S. (2014). Impact of Water Pollution with Heavy Metals on Fish Health: Overview and Updates. Global Veterinaria, 12(2): 219-231.
Zhou, J. L.; Salvador, S. M.; Liu, Y. P. and Sequeria, M. (2001). Heavy metals in the tissues of common dolphin (*Delphinusdelphis*) stranded on the Portugese coast. Sci. Tot. Environ., 273: 61- 67.

ARABIC SUMMARY

تقييم نوعية المياه وتركيز المعادن الثقيلة في مياه وأنسجة البلطي النيلي في بعض المحافظات المصرية "مزارع تربية الأحياء المائية المصرية"

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تتأثر جميع الكائنات المائية بشكل مباشر أو غير مباشر من خلال خصائص بيئتهم الطبيعية والكيميائية ، ولا سيما التركيب الكيميائي للمياه حيث تعتبر العامل الرئيسي الذي يؤثر على الأسماك المستزرعة. لذلك كانت هذه الدراسة للتعرف على خصائص المياه وتأثيراتها على الأسماك المرباة في ثلاث مزارع مختلفة في سهل الحسينية بمحافظة الشرقية , ومحافظة كفر الشيخ وكذلك سهل الطينة بمحافظة بورسعيد، جمهورية مصرالعربية.

أظهرت الدراسة تباينا واضحا في الخصائص الفيزيائية والكيميائية (درجة حرارة الماء، ودرجة الحموضة، DO، NH_3، NO_3، القلوية الكلية، العسر الكلي والفوسفات) في عينات المياه خلال موسم الصيف لسنة ٢٠١٤ كذلك تباينت المعادن الثقيلة في المياه وأنسجة الأسماك (العضلات والخياشيم والكبد). كما تأثرت القياسات البيوكيميائية (الجلوكوز والبروتين الكلي وأنشطة انزيمات AST & ALT) في دم الأسماك سلبا.

في المياه كان الزنك> الحديد> النحاس> الكادميوم في سهل الحسينية وسهل الطينة، ولكن في كفر الشيخ كان الحديد> الزنك> النحاس> وفي العضلات، والخياشيم والكبد كان الحديد> الزنك> النحاس في الاماكن الثلاثة ، ولم يتم رصد الرصاص أو الكادميوم.

في الكبد تجاوزت مستويات المعادن الثقيلة الحدود المسموح بها وفقا لمنظمة الصحة العالمية (١٩٨٩). وفي الخياشيم تجاوزت مستويات الزنك الحدود الم بها في سهل الحسينية وكفر الشيخ أما في العضلات فلم تتجاوز الحدود المسموح بها باستثناء الحديد.

وبناء عليه يمكن أن نخلص إلى أن مستويات المعادن الثقيلة محل الدراسة في الأجزاء الصالحة للأكل (العضلات) في جميع المواقع كانت أقل من الحدود المسموح بها وتعتبر آمنة للاستهلاك البشري. بالإضافة إلى أنه من الضروري ممارسة المزيد من الإحتياطات تجاه الموارد المائية في هذه المناطق للحفاظ على صلاحيتها لتربية الأحياء المائية، أو على الأقل إنتاج أسماك جيدة حفاظا على صحة الإنسان والاقتصاد العام.