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Liver Enzyme Activity of *Tilapia zillii* and *Mugil capito* Collected Seasonally from Qarun Lake, Egypt

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Abstract

Lake Qarun is an inland closed basin, located about 80 Kms south west of Cairo. It suffers from a serious water pollution problem which is due to uncontrolled solid and liquid domestic, in addition to agrochemical contamination and lack of sustainable wastewater management. The present study aimed to follow up the changes in the activities of liver enzymes (ALT, AST, and ALP) in fish (*T. zillii* and *M. capito*) Collected from different sites (east, middle and west) of the lake in four seasons. The results showed that in the two fish species at the studied sites, aspartate aminotransferase (AST) activity in the liver showed decreased values in comparison with the control fish samples collected from unpolluted site (fish farm) with percentage ranged between 10.86%-45.56%. Also, alanine aminotransferase (ALT) activity in the liver decreased significantly in comparison with the control fish samples with percentage ranged between 10.23%-54.07%. The alkaline phosphatase (ALP) activity in the liver decreased in comparison with the control fish samples with percentage ranged between 16.34%-49.54%.

Keywords: Alanine aminotransferase (ALT); Aspartate aminotransferase (AST); Alkaline phosphatase (ALP); Qarun Lake; Water pollution

Introduction

Aquatic pollution can easily be detected through biomarkers, as the latter are sensitive indicators demonstrating that toxicants have entered organisms that have been distributed between tissues and are eliciting a toxic effect at critical targets. Biomarkers are measurable responses to the exposure of an organism to xenobiotic as well as very good biosensors of aquatic contaminants. Biomarkers are measurements in body fluids, cells or tissues indicating biochemical or cellular modifications due to the presence and magnitude of toxicants, or of host response [1]. Fish have been proposed as indicators for monitoring land-based pollution because they may concentrate indicative pollutants in their tissue, directly from water through respiration and also through their diet. Fish are frequently subjected to pro-oxidant effects of different pollutants often present in the aquatic environment [2].

All chemical reactions in the cells are catalyzed by enzyme and introduction of foreign chemicals in the cell generally disturbed enzyme functions. Enzyme activities are considered as sensitive biochemical indicators before hazardous effects occur in fish, Changes in Enzymes activities in fish have been used frequently as indicators of intoxication and water pollution [3]. Transaminases are important enzymes known to play a key role in mobilizing L-amino acids for gluconeogenesis and function as links between carbohydrate and protein metabolism under altered physiological, pathological conditions [4]. Alanine aminotransferase (ALT) catalyses the transfer of the amino group from alanine to α-ketoglutarate to form glutamate and pyruvate while aspartate aminotransferase (AST) catalyses the transfer of the amino group from aspartate to α-ketoglutarate to form glutamate and oxaloacetate [5]. Alanine is a non-essential amino acid that plays a key role in the glucose-alanine cycle between muscle tissue and the liver. Aspartate, the carboxylate anion of aspartic acid, is an acidic, non-essential amino acid involved in protein synthesis and multiple other cellular biochemical pathways.

Aminotransferase links carbohydrate and protein metabolism as it catalyzes their inter-conversion. The activities of these enzymes are directly proportional to the level of total protein and inversely proportional to cholesterol level, an indication that the enzymes are catalyzing the inter-conversion of carbohydrate to protein in the liver [6]. Also, transaminases are biomarker enzymes endogenous in the liver responsible for the transformation of protein to glycogen [7]. ALT is the most specific enzyme for the liver.

Alkaline phosphatase (ALP) catalyzes the hydrolysis of a wide variety of physiologic and non-physiologic phosphoric acid esters in alkaline medium (pH optimum 10). ALP is employed to assess the integrity of plasma membrane and endoplasmic reticulum [8]. The liver and biliary tracts are the sources of alkaline phosphatase. ALP is one of the tests of choice for evaluating cholestasis and obstructive jaundice. Tissue distribution of alkaline phosphatase is virtually ubiquitous especially within cell membranes and would easily leak out of the cell in pollutants-induced tissue damage [9]. ALP is composed of several isoenzymes that are present in practically all tissues of the body, especially in cell membranes. It catalyses the hydrolysis of monophosphate esters and has a wide substrate specificity [10]. Fish *T. zillii* and *M. capito* were chosen in the present study due to their sensitivity to environmental changes and the common of appearing in lake Qarun. Also, liver is the most sensitive organ in the body of fish. So the objective of the present study is to follow up the changes in the activities of liver enzymes (ALT, AST, and ALP) in fish (*T. zillii* and *M. capito*) Collected from different sites (east, middle and west) of the lake in four seasons.

Materials and Methods

Study area

Qarun Lake is a closed elongated saline basin located between longitudes 30°24` & 30°49` E and latitudes of 29°24` & 29°33` N in the lowest part of El-Fayoum depression, about 80 kms Southwest of Cairo. It has an irregular shape of about 40 kms length and about 6 kms mean width, with an average area of about 240 kms. The lake is shallow, with a mean depth of 4.2 m and about 20% of the lake's area has a depth ranging between 5 m to 8 m. The water level of the lake fluctuates between 43 m to 45 m below mean sea level [11].

Sampling

Samples of fish *T. zillii* and *M. capito* were collected from the east, middle and west of Lake Qarun during four seasons. The fish measured about (12 cm to 15 cm) and (20 cm to 24 cm) in total length and (40 g to 67 g) and (81 g to 110 g) in weight respectively. They were collected seasonally during a period extending from (August 2014 to May 2015). After the dissection of fish samples, parts of liver were carefully removed and prepared for biochemical studies. Another fish samples were collected from fish farm (unpolluted farm near lake Qarun), to be used as a control group.

Biochemical measurements

AST and ALT activity in the liver tissue was determined using calorimetric assay according to the method of Bergmeyer et al. [12]. ALP activity in the liver was estimated by the method of Walter et al. [13].

Statistically analysis

The significant between control and results of the biochemical analysis will be analyzed statistically by Student's "t" Test to test the significance of the difference between the mean values of any two sets of observations using SPSS statistical package version 17. The data values were expressed as mean ± standard error (M ± SE).

Results

Aspartate aminotransferase (AST) activity

Aspartate aminotransferase activity in the liver of *T. zillii* and *M. capito* collected from (east, middle and west of Lake Qarun) during four seasons were represented in Tables 1 and 2. In the two fish species at the studied sites, AST activity in the liver showed decreased values in comparison with the control fish samples collected from unpolluted site (fish farm) with percentage ranged between 10.86%-45.56%.

The lowest values of AST in the liver of *T. zillii* and *M. capito* were (135 ± 1.06) mU/ml and (135 ± 1.31) mU/ml respectively recorded during summer in eastern and western part respectively. While, the highest values were (205 ± 1.52) mU/ml and (218 ± 1.41) mU/ml respectively recorded in western part during winter and spring respectively. In general, AST activity in the liver of *T. zillii* and *M. capito* was decreased significantly ($p \leq 0.05$) compared to the control.

Location/Season	Control	East	%Alteration	Middle	%Alteration	West	%Alteration
Summer	230 ± 2.73	135 ± 1.06*	-41.3	179 ± 2.03*	-22.17	187 ± 2.12*	-18.69
Autumn	225 ± 1.46	199 ± 1.15*	-11.55	176 ± 2.06*	-21.77	184 ± 1.23*	-18.22
Winter	230 ± 1.29	192 ± 1.46*	-16.52	178 ± 1.91*	-22.6	205 ± 1.52*	-10.86
Spring	228 ± 1.89	196 ± 1.39*	-14.03	180 ± 1.52*	-21.05	201 ± 1.06*	-11.84
Data are presented as mean ± SE of 6 fish; SE: Standard Error; %Alteration from control value; *Significant difference from control at ($p \leq 0.05$).							

Table 1: Aspartate aminotransferase (AST) (mU/ml) (Means ± SE) activity in the liver of *T. zillii* collected from Lake Qarun.

Location/Season	Control	East	%Alteration	Middle	%Alteration	West	%Alteration
Summer	248 ± 1.23	170 ± 2.38*	-31.45	141 ± 1.15*	-43.14	135 ± 1.31*	-45.56
Autumn	237 ± 1.52	175 ± 2.73*	-26.16	176 ± 2.58*	-25.73	179 ± 2.19*	-24.47
Winter	240 ± 1.57	177 ± 1.63*	-26.25	208 ± 1.65*	-13.33	184 ± 1.78*	-23.33
Spring	245 ± 0.966	170 ± 1.78*	-30.61	182 ± 2.01*	-25.71	218 ± 1.41*	-11.02
Data are presented as mean ± SE of 6 fish; SE: Standard Error; %Alteration from control value; *Significant difference from control at ($p \leq 0.05$).							

Table 2: Aspartate aminotransferase (AST) (mU/ml) (Means ± SE) activity in the liver of *M. capito* collected from Lake Qarun.

Alanine aminotransferase (ALT) activity

Alanine aminotransferase activity in the liver of *T. zillii* and *M. capito* collected from (east, middle and west of Lake Qarun) during four seasons were represented in Tables 3 and 4. In the two fish species at the studied sites, ALT activity in the liver showed decreased significantly in comparison with the control fish samples collected from unpolluted site (fish farm) with percentage ranged between 10.23%-54.07%. The lowest values in the liver of *T. zillii* and *M. capito* were (51.9 ± 0.74) mU/ml and (77 ± 0.32) mU/ml respectively) recorded in spring and summer in the eastern part of the lake. While, the highest values were (99 ± 1.87) mU/ml and (115 ± 0.81) mU/ml

respectively recorded during winter in the middle and western part of the lake.

In general, ALT activity in the liver of *T. zillii* and *M. capito* was decreased significantly ($p \leq 0.05$) compared to the control values.

Location/Season	Control	East	%Alteration	Middle	%Alteration	West	%Alteration
Summer	113 ± 1.06	57 ± 0.33*	-49.55	63.4 ± 0.13*	-43.89	77 ± 0.08*	-31.85
Autumn	112 ± 1.94	71.8 ± 0.79*	-35.89	94 ± 0.64*	-16.07	92.3 ± 1.72*	-17.58
Winter	114 ± 0.81	77 ± 0.48*	-32.45	99 ± 1.87*	-13.15	96 ± 1.06*	-15.78
Spring	113 ± 1.31	51.9 ± 0.74*	-54.07	96 ± 1.03*	-15.04	67 ± 1.36*	-40.7
Data are presented as mean ± SE of 6 fish; SE: Standard Error; %Alteration from control value; *Significant difference from control at ($p \leq 0.05$).							

Table 3: Alanine aminotransferase (AlT) (mU/ml) (Means ± SE) activity in the liver of *T. zillii* collected from Lake Qarun.

Location/Season	Control	East	%Alteration	Middle	%Alteration	West	%Alteration
Summer	127 ± 1.21	77 ± 0.32*	-39.37	86 ± 1.06*	-32.28	99 ± 2.16*	-22.04
Autumn	130 ± 4.93	97 ± 1.15*	-25.38	94 ± 0.81*	-27.69	113 ± 1.29*	-13.07
Winter	130 ± 2.90	104 ± 1.91*	-20	113 ± 1.06*	-13.07	115 ± 0.81*	-11.53
Spring	127 ± 5.75	98 ± 0.57*	-22.83	114 ± 1.52*	-10.23	107 ± 1.77*	-15.74
Data are presented as mean ± SE of 6 fish; SE: Standard Error; %Alteration from control value; *Significant difference from control at ($p \leq 0.05$).							

Table 4: Alanine aminotransferase (AlT) (mU/ml) (Means ± SE) activity in the liver of *M. capito* collected from Lake Qarun.

Alkaline phosphatase (ALP) activities

The change in the alkaline phosphatase activity in the liver of *T. zillii* and *M. capito* collected from (east, middle and west of Lake Qarun) during four seasons were represented in Tables 5 and 6. The results showed that in the two fish species at the studied sites, the alkaline phosphatase activity in the liver decreased values in comparison with the control fish samples collected from unpolluted site (fish farm) with percentage ranged between 16.34%-49.54%. The lowest values in the liver of *T. zillii* and *M. capito* were (55 ± 1.23) U/L and (76 ± 1.67) U/L respectively recorded in winter in the eastern part of lake ehile, the highest values were (87 ± 1.46) U/L and (104 ± 1.96) U/L respectively recorded in the western part.

In general, ALP activity in the liver of *T. zillii* and *M. capito* was decreased significantly ($p \leq 0.05$) compared to the control value.

Location/Season	Control	East	%Alteration	Middle	%Alteration	West	%Alteration
Summer	109 ± 3.65	55 ± 1.82*	-49.54	77 ± 2.55*	-29.35	82 ± 3.28*	-24.77
Autumn	104 ± 2.19	69 ± 1.28*	-33.65	82 ± 0.36*	-21.15	87 ± 1.46*	-16.34
Winter	104 ± 4.01	55 ± 1.23*	-47.11	65 ± 1.06*	-37.5	69 ± 1.64*	-33.65
Spring	109 ± 1.23	65 ± 1.31*	-40.36	82 ± 0.57*	-24.77	87 ± 1.31*	-20.18
Data are presented as mean ± SE of 6 fish; SE: Standard Error; %Alteration from control value; *Significant difference from control at ($p \leq 0.05$).							

Table 5: Alkaline phosphatase (ALP) (U/L) (Means ± SE) activity in the liver of *T. zillii* collected from Lake Qarun.

Location/Season	Control	East	%Alteration	Middle	%Alteration	West	%Alteration
Summer	130 ± 1.31	87 ± 1.15*	-33.07	93 ± 0.57*	-28.46	104 ± 1.06*	-20
Autumn	130 ± 2.38	87 ± 2.22*	-33.07	98 ± 0.57*	-24.61	104 ± 0.93*	-20
Winter	125 ± 2.20	76 ± 1.67*	-39.2	87 ± 1.57*	-30.4	93 ± 1.03*	-25.6
Spring	130 ± 1.39	87 ± 1.06*	-33.07	100 ± 1.78*	-23.07	104 ± 1.96*	-20

Data are presented as mean ± SE of 6 fish; SE: Standard Error. %Alteration from control value *Significant difference from control at ($p \leq 0.05$).

Table 6: Alkaline phosphatase (ALP) (U/L) (Means ± SE) activity in the liver of *M. capito* collected from Lake Qarun.

Discussion

Biochemical studies can be an available tool for identifying ecosystems contaminated by various pollutants or for following changes in such system through times [14]. Analysis of biochemical parameters could help to identify the target organs of toxicity as well as the general health status of animals. It may also provide an early warning signal in stressed organism [15]. Different concentrations of heavy metals were accumulated in the liver of *T. zillii* and *M. capito* collected from different sites of Lake Qarun [16]. In the current study, ALT and AST activities decreased significantly ($p \leq 0.05$) compared to the control value in the liver of *T. zillii* and *M. capito* collected from different sites of the lake. The decreased activities of ALT and AST in the present study could be attributed to the high accumulation of metals in fish tissues [17,18] . Also, the decreased value may be due to toxicants that can also inhibit the activity or synthesis of enzymes

On the other hand, the decreased activities of ALT and AST indicate disturbance in the structure and integrity of cell organelles, like endoplasmic reticulum and membrane transport system [19]. In addition, the results indicate that under the influence of different heavy metals or in a state of stress, the damage of tissues (liver) may occur with concomitant liberation of transaminases into the circulation [10]. In the present work, ALP activity in the liver of *T. zillii* and *M. capito* was decreased significantly ($p \leq 05$) compared to the control value. The decreases in the tissues of ALP activities may be attributed to the accumulation of the metals in the fish tissues [19] which affects the synthesis of enzyme protein directly or indirectly and/or increased metabolism due to an increase of toxic substances and the production of toxic metabolic products destructive to enzymes. Furthermore, decreases in the ALP activity might be due to the direct action of the pollutants on the enzyme and/or the toxic effects produced in the tissues.

Our results of ALT, AST and ALP activities in the present study were in agreement with the results obtained by Vinodhini et al. [10,20].

Conclusion

There were changes in the activities of liver enzymes. AST, ALT and ALP activity in *T. zillii* and *M. capito* collected from Qarun Lake. In general, Liver enzymes were decreased significantly ($p \leq 0.05$) compared to control.

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