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Research Article

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Changes in the activity of antioxidant enzymes during four seasons in Mugil capito fish from Qarun Lake, Egypt

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Abstract
Superoxide dismutase (SOD) and catalase (CAT) enzymes activity of Mugil.capito fish were chosen as bio indicators for pollution in the Qarun Lake. Fish (Mugil.capito) were collected from Qarun Lake seasonally during (August 2014 to May 2015) to determine the activities of antioxidant defense enzymes (SOD and CAT) in the liver and performing meat quality of fish through analysis of total proteins and total lipids in muscles. The results showed that SOD activity in the liver of M.capito fish collected from eastern, middle, and western part of the lake was increased significantly (p≤05) compared to the control value seasonally. Catalase Activity in the liver of M.capito fish from the eastern and middle part of the lake showed significant increased compared with control value (p≤.0.05) in summer, autumn and spring and insignificant in winter season. While samples of M.capito from the western part of the lake showed significant increase in autumn and insignificant increase in summer, winter and spring season.Total protein levels in the muscle decreased significantly (p≤0.05) reaching its minimum value in the muscle of fish from the eastern part of the lake. While, total lipid content in the muscle was increased significantly (p<.05) reaching its maximum value in the muscle of fish from the eastern part of the lake.

Keywords: Antioxidant, SOD, CAT, *M.capito*, Qarun Lake, Pollution

Introduction
Pollution is now regarded as a global problem since pollutants can cross borders with the help of wind and water. Environmental pollution is insidious and its harmful effects only become apparent after periods of exposure. For this reason environmental monitoring is recognized as being vitally important in detecting the level and types of pollutants, and their source. Furthermore this monitoring helps to take measures to mitigate the effect in those seriously polluted areas.Lake qarun receives the agricultural and sewage drainage waters through a system of twelve drains, most of the drainage water reaches the Lake by two main drains, Al Batts and Al Wadi drain. The Lake received annually about 450 million cubic meters of agriculture drainage water. These pollutants have serious effects on the aquatic ecosystem, including fish, since these wastes contain a variety of toxic organic as well as inorganic compounds [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 prooxidant effects of different pollutants often present in the aquatic environment [2].

Several classes of pollutants, including trace metals and organic compounds, are known to enhance the formation of ROS resulting from xenobiotic redox cycling. A battery of enzymes and molecules plays important roles in detoxifying xenobiotics and ROS, thus it has been applied as a biomarker for environmental risks in fish [4]. The use of a battery of biomarkers will provide a more complete picture of various effects on oxidative stress in the cells of an organism [3].

Oxidative stress is more often used as a biomarker of the effects of exposure to environmental pollution in aquatic environments. Antioxidants are defined as compounds that can inhibit or prevent the oxidation of oxidizable materials by scavenging free radicals and diminishing oxidative stress. Many pollutants (or their metabolites) may exert toxicity related to oxidative stress. Several classes of pollutants, including trace metals and organic compounds, are known to enhance the formation of ROS resulting from xenobiotic redox cycling. A battery of enzymes and molecules plays important roles in detoxifying xenobiotics and ROS, thus it has been applied as a biomarker for environmental risks in fish. The use of a battery of biomarkers will provide a more complete picture of various effects on oxidative stress in the cells of an organism [3, 4].

Qarun Lake has the attentions of many authors including ecological studies on zooplankton of the lake, phytoplankton composition, bacterial indices, heavy metals in benthic invertebrate, water, fish and sediment, the impact of the environmental pollution of lake Qarun on water quality and fish biochemistry [1,5-10]. Only one recent study has showed the effect of pollution on antioxidant defence system of *T. zillii* fish from Lake Qarun Also, no information was available on antioxidant enzymes of *M.capito* fish of Lake Qarun [11]. So the main objectives of this study are to determine the changes in the activities of antioxidant defense enzymes (superoxide dismutase and catalase) and meat quality of the collected *M.capito* fish through analysis of total proteins and total lipids in muscles.

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 80km Southwest of Cairo. It has an irregular shape of about 40km length and about 6 km mean width, with an average area of about 240 square km. The lake is shallow, with a mean depth of 4.2 m and about 20% of the lake's area has a depth ranging from 5 to 8 meters. The water level of the lake fluctuated between 43 to 45m below mean sea level [7].

Sampling

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

Biochemical Measurements

Superoxide dismutase (SOD) activity in the liver tissues was determined according to the method of Nishikimi et al. [12]. The activity of catalase (CAT) in the liver was determined according to the method of Aebi [13]. Total protein in the muscle tissue was determined according to the method of Bradford [14]. Total lipid content in the muscle tissue was determined according to the method described by Lutzke and Brauler [15].

Statistically Analysis

The significance between the 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

Biochemical analysis of fish Tissues

Changes in the biochemical parameters in *M.capito* fish collected from different sites of Lake Qarun during the study period (August 2014 to May 2015) were presented in Figure (1-4).

SOD Activity

The activity of SOD in the liver of *M.capito* fish collected from the eastern, middle and western part of the lake was increased significantly (p≤05) compared to the control value seasonally. The lowest value in the liver of *M. capito* was recorded during winter in the western part of the lake. While, the highest value was recorded during summer in the eastern part of the lake.

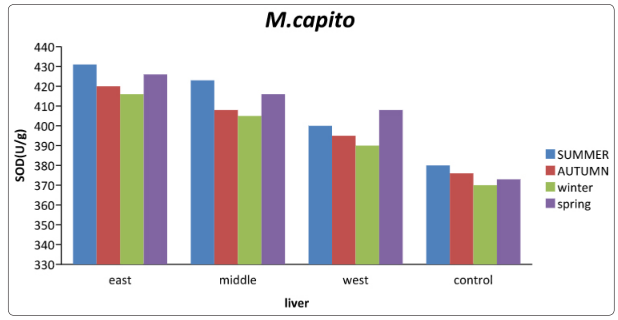

Figure 1: Superoxide dismutase (SOD) (U/g) (Means ± SE) activity in the liver of *M.capito* collected from lake Qarun

Catalase Activity

Catalase Activity in the liver of *M.capito* fish collected from the eastern and middle part of the lake showed significant increased compared with control value (p≤.0.05) in summer, autumn and spring and insignificant in winter season. While samples of *M.capito* collected from the western part of the lake showed significant increase in autumn and insignificant increase compared with control in summer, winter and spring season.. The lowest value in the liver of *M.capito* was recorded during winter in the western part of the lake. While, the highest value was recorded in summer in the eastern part of the lake.

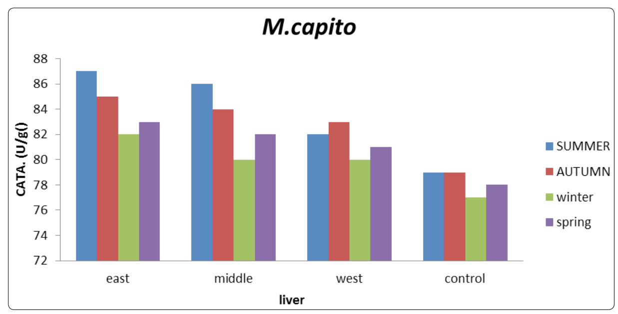

Figure 2: Catalase activity (U/g) (Means ± SE) in the liver of *M.capito* collected from lake Qarun

Total Protein Concentration

In general, total protein in the muscle of *M. capito* was decreased significantly (p≤0.05) compared to the control value during four seasons. Also, there is a difference between west, east and middle fish samples, where it followed the order: east < middle < west in the fish. The lowest value in the muscle of *M. capito* was recorded in winter in the eastern part of the lake.While, the highest value was recorded in the western part of the lake.

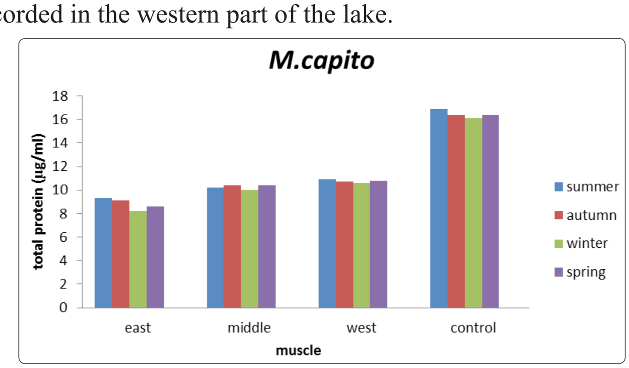

Figure 3: Total protein concentration (µg/ml) (Means ± SE) in the muscle of *M.capito* collected from Lake Qarun

Total lipid Concentration

Total lipid concentration in the muscle of *M.capito* was increased significantly ($p \leq 0.05$) compared to the control value, reaching its maximum during winter in the eastern part of the lake.

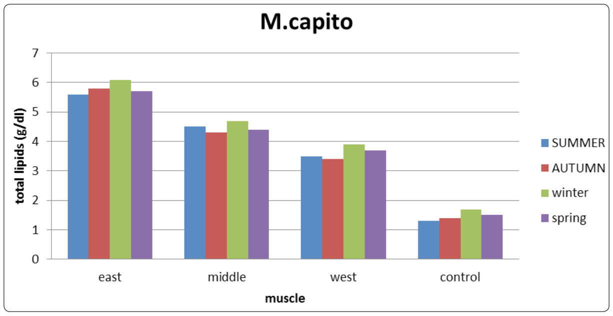

Figure 4: Total lipids concentration (µg/ml) (Means ± SE) in the muscle of *M.capito* collected from lake Qarun.

Discussion

Fish as all other aerobic organisms generate endogenous reactive oxygen species (ROS) and other oxidants during aerobic metabolisms and energy production in the mitochondria. Under normal physiological status the antioxidant defense systems including SOD, CAT and GST can be induced by a slight oxidative as a compensatory response and thus the reactive oxygen species (ROS) can be removed to protect the organism from oxidative damage [16]. Pollutants with redox potential can produce increasing amount of ROS in aquatic organisms in polluted sites. These ROS can trigger oxidative damage to proteins, nucleic acid and lipids [17].

The liver is found to be stronger in view of oxidative stress than the other tissues with the highest SOD and CAT activities [18]. This could be related to the fact that the liver is the site of multiple oxidative reactions and maximal free radical generation; therefore, liver tissue was thought to be the best to present the response of CAT activity to metal exposure [19]. Antioxidant defense enzymes such as CAT and SOD have a remarkable importance for aquatic organisms because these enzymes protect them from free radicals that cause oxidative stress. Many environmental factors induce the production of reactive oxygen species (ROS). As temperature-dependent organisms, most fishes must routinely cope with fluctuations in environmental temperature and in the metabolic rate and consequently with oscillations in ROS levels. Therefore, ROS generation, oxidation rates and antioxidant status are directly related to ambient temperature or metabolic activity [20].

Increased SOD and CAT activities in the liver may be a response to oxidative stress. Elevated rates of idiopathic lesions and neoplasia among fish inhabiting polluted environments to be related to the increased oxidative stress associated with pollutant exposure (Winston and Di Giulio). Also, on seasonal basis in the present study, the highest values of SOD and CAT were recorded in summer comparing to other seasons.

The increase of these enzymes in summer comparing to other seasons in the current study is probably related to the higher ambient water temperature and therefore to the oxygen consumption and reactive oxygen species generation during the warm period followed by enhanced antioxidant capacity in fish [21]. Many environmental factors induce the production of reactive oxygen species (ROS). As temperature-dependent organisms, most fishes must routinely cope with fluctuations in environmental temperature and in the metabolic rate and consequently with oscillations in ROS levels. Therefore, ROS generation, oxidation rates and antioxidant status are directly related to ambient temperature or metabolic activity [20].

The induction of SOD and CAT in the current study suggests that oxidative stress response still works well under the current conditions, and the increase of antioxidative enzymes may be a physiological adaptation for the elimination of ROS generation (Gad). Defense system that tend to inhibit oxyradical formation include the antioxidant enzymes such as superoxide dismutase (SOD) and catalase (CAT) that are critically important in the detoxification of radicals to nonreactive molecules [4].

Proteins are the building units of the body and are also the most abundant macromolecules in the cells constituting half of their dry wt. Current data indicated marked depletion of total protein concentration in muscle of M. capito fish samples collected from different sites of lake Qarun when compared to the control samples reaching its minimum value in the winter season. The lower value of total protein in winter comparing other season suggest the different metabolic activity of the tissue with respect to season and probably depend on food availability and feeding behaviour. The lower temperature (onset of winter) may have affected feeding activity or caused a decrease in the protein assimilation efficiency.

The decreased total protein in the muscles of M. capito in the present study may be due to the over secretion of glucocorticoids in response to heavy metals stress and other pollutant. This promotes degradation of endogenous proteins, particularly in muscles to provide substances required to apply fish extra source of glucose to control energy required during stress [22]. Also, The decreased of total protein in muscle of studied fish show that the protein was taken as an alternative source of energy, due to high energy demand that induced by different pollutants in Lake Qarun as previously reported by Vutukuru; Durmaz. Also, the depletion in tissue proteins may be due to impair or low rate of protein synthesis due to their utilization in cell repair and organization and/or the decrease in uptake of amino acids into the polypeptide chain [23-25].

Lipid plays an important role in metabolic activities of animals because they are a source of energy and are involved in the building of cellular components. They are stored in the form of metabolites and provide energy when an organism faces adverse conditions. In the current study total lipid in fish tissues of M. capito collected from different sites of Lake Qarun markedly sensitive to the environmental pollution of the lake. There is a highly significant increase ($p< 0.05$) in all regions. The observed increased in total lipid in fish tissues may be due to the fact that excess energy reserves (as glucose, triglycerides and cholesterol) are required by organisms to mediate the effects of stress [26]. Also, the elevation in the lipid content may be attributed to enhanced lipid synthesis and/or reduced lipid catabolism [27]. There is a number of way by which toxic materials can elevate levels of total lipid in fish blood or tissues: 1) increase production by liver and other tissues, 2) release of lipids constituents from damaged cell membranes, 3) thyroid dysfunction 4) decreased activity of cytochrome P450 enzymes [28].

Conclusions

It was concluded that pollution of the lake adversely effect on enzymatic activities, physiological functions and meat quality of its fish fish through determination of total protein and total lipid. The present data showed an increase of superoxide dismutase and catalase activity in the liver samples. On the other hand, total lipid increased significantly but total protein decreased in the muscle samples and this indicated meat quality of fish.

Conflict of Interest

The authors have no competing interests.

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