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Accumulation of Zn and Pb in the Tissues of T. Zilii and M. Capito Fish of Qarun Lake, Egypt

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Abstract

The accumulated levels of Zn and Pb were determined in organs (muscles, liver and gill) of fish (T. zilii and M. capito) caught from eastern, middle and western part of Qarun lake in four seasons. Results revealed that Zn concentrations were greater than Pb in fish species tissues from the eastern, middle and western part. The lowest accumulated values of Zn and Pb were in the muscle, while the highest values were in the liver in two fish species. Also, accumulation of Zn and Pb in the tissue of both fish species takes the order: liver< gill <muscle. M. capito fish accumulate Zn and Pb more than T. zilli.

Keywords: Fish; Zn; Pb; Lake Qarun; M. capito

Introduction

Recently, there were witnessed significant attract being paid to the problems of environmental pollution by a variety of chemical pollutants such as the trace metals) [1]. Metals have particular concern among environmental pollutants, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems [2]. Living organisms affected by chemicals through an important process of bioaccumulation. An increase in the ratio of a chemical in a biological organism over time may occur compared to chemicals ratio in the environment. Bioaccumulation occurs when an organism absorbs a toxic substance at a rate greater than that at which the substance is lost. Bioaccumulation occurs from a dynamic equilibrium between exposure to the external environment and uptake, storage and extraction within an organism [3]. The top of the aquatic food chain are often fish that accumulate large amounts of metals in their tissues to concentrations many times more than water or sediment [4]. Also, Mohamed FAS 2008 [5] reported that fish can accumulate significant concentrations of metals even in water in which those metals are below the detection limit in routine water samples Metals in natural waters occur in particulates or insoluble forms, including labile and non-labile fractions. The most dangerous to fish are the labile metal compounds. They include various ionic forms of different availability to fish. The amounts of metals in the labile fraction and the share of various metal ions strongly depend on environmental conditions [6]. Various metals are accumulated in the fish body in different amounts. These differences result from the different affinity of metals to fish tissues, different uptake deposition and excretion [7]. Fish living in polluted water tend to concentrate trace metals in their organs. Generally, accumulation of heavy metal depends on metal concentration, time of exposure, a way of metal uptake, environmental conditions (water temperature, pH, hardness and salinity). Also fish can take trace metals through the epithelial or mucosal surface of the skin, gills and gastrointestinal tract [8]. Fish can regulate metal concentrations to a certain extent, after the occurrence of bioaccumulation [9]. Therefore, the ability of each tissue to either regulate or accumulate metals can be directly related to the total amount of metals accumulated in that specific tissue. Fish bioaccumulate metals and subsequent distribution in tissues is greatly inter-specific. Many factors may affect on metal uptake such as age, sex, size, reproductive cycle, feeding behavior, swimming patterns, and living environment (i.e., geographical location) [10]. When metals reach sufficiently high concentrations in body cells they can alter the physiological functioning of the fish [11]. Filipovic V, et al. [12] stated that the organisms produced a protective defense against the deleterious effects of essential and nonessential trace metals and other xenobiotics that make degenerative changes such as oxidative stress in the body.

Materials and Methods

Study Area

Sabae S, et al. [13] reported that Qarun lake is a closed elongated basin site between longitudes 30°24´ & 30°49´E and latitudes of 29°24´ & 29°33´N in the lowest part in Fayoum depression, about 80km Southwest from Cairo. It has an irregular shape with an average area of about 240 km where about 40km in length and about 6 km mean in width. The lake is shallow that has a mean depth of 4.2 m and about 20% of the lake's area has a depth between 5 to 8 meters. The level of lake water ranged between 43 to 45m under mean sea level (Figure 1).

Samples Collection

T. zilii and M. capito fish were caught from the eastern, middle and western part of Qarun lake Figure 1 Measuring of fish give about (12 to 15) and (20 to 24cm) in total length and (40 to 67) and (81 to 110g) in weight respectively. Fish samples, liver, gill and muscles were carefully removed by the dissection and prepared for studying of heavy metals.

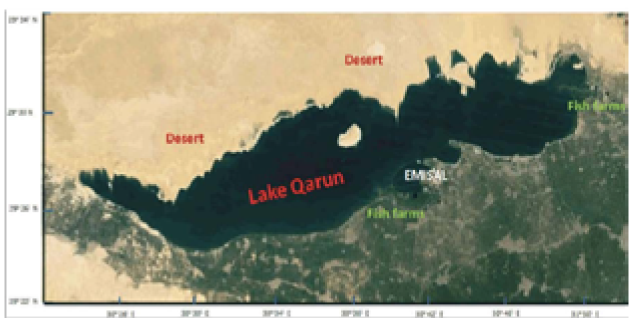

Figure1: Lake Qarun

Analysis of Heavy Metals in the Tissues of Fish

Liver, muscle and gill samples were dried in an oven at 105°C (about 5 g of fresh fish tissue) for 2 days and then grounded to a fine powder. Digestion of samples after drying according to the method of Ghazally KS [14] in which 1.0g (dry powder) was digested in a solution of (5 ml nitric acid + 5 ml perchloric acid), then boiling at 80-90°C on hot plate until clear sample. After cooling, make filtration and transferring of solution to 25 ml volumetric flask and fill up to the level with de-ionized water. Kept the digests in plastic bottles and then; the ratio of Fe, Cu and Mn in liver, gill and Muscle were measured by GBC atomic absorption spectrophotometer Savanta AA. The results were expressed in (µg/g dry wt).

Statistically Analysis

(One-way ANOVA) Analysis was used to indicate significant differences between the different sites in levels of trace metal.

Results

Zinc (Zn)

The maximum value of Zn concentrations (21.5±0.78µg/g dry wt.) was found in liver of T. zilli fish caught from eastern part of the lake in summer season whereas the lowest Zn concentration (6.1±0.21µg/g dry wt.) was found in muscle of middle part of the lake in winter (Table S1). In addition, The highest value of Zn concentrations (22.1±1.29µg/g dry wt.) was found in the liver of M. capito fish from the eastern part of the lake in summer season, but the lowest value (6.1±0.28µg/g dry wt.) was in the muscle of M. capito caught from middle part of the lake in spring season (Table S2). The accumulation pattern of Zn in muscle, liver and gill of T. zillii and M. capito from Qarun lake followed the order: eastern part > middle part > western part in summer ,but in autumn , winter and spring followed the order: eastern part > western part > middle part except (the liver of T. zillii in spring). In general, The lowest concentrations of Zn were found in the muscle, while the maximum ones were recorded in the liver that followed the order liver< gill < muscle in eastern , middle and western part in two fish species . Also, Zn accumulation in fish M. capito was higher than T. zilli. Insignificant differences for Zn concentration in fish T. zilli and M. capito were observed between the three sites (east, middle and west) when compared to each other in four seasons (Table S1, Table S2).

Lead (Pb)

The highest value of Pb concentrations (2.03±0.02µg/g dry wt.) was recorded in liver of fish T. zilli collected from eastern part of the lake in summer season, while minimum concentration of Pb (0.23±0.02µg/g dry wt.) was found in fish muscle caught from western part of the lake in autumn. Lead was not detected (ND) in fish muscle caught from western part in winter under the instrument detection limit (0.1-20 ppm). The results were presented in (Table S3). Also, The maximum value of Pb concentrations (4.3±0.19µg/g dry wt.) was recorded in the liver of fish M. capito collected from eastern part of the lake in summer season, while minimum value (0.29±0.03 µg/g dry wt.) was recorded in the muscle of M. capito caught from middle part of the lake in season of winter. Also, lead was not detected (ND) in fish muscle from western part in winter and autumn under the limit of instrument detection (0.1-20 ppm). The results were presented in (Table S4). Accumulation of lead in T. zilli from Qarun lake through summer season take the order: middle part > eastern part > western part in gill tissue, but it followed the order: east > middle > west in liver and muscle tissue. Also, Pb accumulation of liver, muscle and gill on T. zilli followed the order: middle part > eastern part > western part in autumn, winter and spring season. Lead concentration in tissues of M. capito fish followed the order: east > middle > west in spring and winter except gill tissue and eastern > western > middle part in season of summer. In brief, The minimum values of accumulated lead were found in the muscle, while the maximum values found in the liver of the two fish species. Also, accumulation of lead in two fish species takes the order: liver< gill <muscle. M. capito accumulate Pb higher than T. zilli. Insignificant differences for Pb concentration in fish T. zilli and M. capito were observed between the three sites (east, middle and west) when compared to each other in four seasons. (Table S3, Table S4).

Discussion

The results revealed that the liver of T. zilli and M. capito collected from different sites of lake Qarun were contain maximum values of Zn and Pb. This could be due to the fact that the major site for biotransformation and detoxification of different kinds of xenobiotics is the liver in fish as in other vertebrates. The first sensitive organ for accumulation of metal is the liver, because the accumulation of trace metals depended on the structure of organs and interaction between the target organs and metals [15]. Metallothionine content in tissues which has been mostly affective in the liver induced by metals. In the current study, the level of detected metals (Zn and Pb) in the (muscle, liver and gills) of tested fish T. zilli and M. capito collected from of lake Qarun tended to vary from season to another where the minimum values were recorded during winter and maximum were registered during summer. These results are probably attributed to the variation in temperature of water seasonally which control living organisms behaviours such as fish (Poi kilo thermic. Metabolism is related to water temperature, thus any changes in the temperature would affect the metabolism with subsequent influence on the ratio of detoxification and toxicant accumulation [16]. Also, EL-Fayoumi RI [17] stated that the acceleration of metabolic due to heat may accelerate accumulation of metal in liver, gills and muscles of fish While the decrease in the metabolic rates of fish occur because of the environment that became colder. Other explanation is that during winter (season of starvation), all metabolic activities are decreased, although during summer, fish pollution increased by increasing eating rate and increasing food source, as phytoplankton and alga that can strongly influence availably of metals in the tissues of fish. In the present work, concentrations of Zinc (Zn) in the tissue of the studied fish from Qarun Lake were under the permissible level (30 µg/g) according to [18]. The major sources of Zn pollution are mining swelling and sewage disposal. It is a common pollutant as well and it is taken up by fish directly from water especially by gill. Zinc accumulates in the gills of fish and this designates a depressing effect on tissue respiration leading to death by hypoxia. The danger of zinc is serious by its almost unlimited perseverance in the environment because it cannot be destroyed biologically but are only transformed from oxidation state or organic complex to another [19]. In the current study, lead (Pb) concentrations in of fish caught from different sites of Qarun lake were lower than the maximum lead levels permitted for fish tissues (2 µg/g) according to Egyptian Organization for Standardization [20] except some liver samples in both fish species which were greater than permissible limit. Maximum concentrations of Pb in liver samples are may be related to detoxification that occur in this organ. Pb is toxic, even at low concentrations, the bad effects and the hazards of Pb are not only due to their high toxicity, but also to the low rate of elimination from the consumer's body, as well as its persistence unchanged for long periods [21].

Conclusion

The eastern part of the lake Qarun was contain the most highly polluted fish with heavy metals compared to middle and western part. The increase in heavy metal levels in eastern part of the lake may be because of influence of pollution sources in this site which discharged its wastes that come from two drains in this site and anthropogenic activities.

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