Research Article

iMedPub Journals
www.imedpub.com

DOI: 10.21767/2473-6457.10026

Journal of Heavy Metal Toxicity and Diseases
ISSN 2473-6457

2019
Vol.4 No.1:1

# Seasonal Variation of Fe, Mn and Cu in the Tissues of Two Fish Species from Lake Qarun, Egypt

**Amal S. Mohamed[1]*, Mohamed A. El- Desoky[2] and Nahed S. Gad[1]**

1 National Institute of Oceanography and Fisheries, Cairo, Egypt
2 Faculty of Science, Cairo University, Egypt

***Corresponding author:** Amal S. Mohamed

adelaml@yahoo.com

National Institute of Oceanography and Fisheries, Cairo, Egypt.

**Citation:** Mohamed AS, El- Desoky MA, Gad NS (2018) Seasonal Variation of Fe, Mn and Cu in the Tissues of Two Fish Species from Lake Qarun, Egypt. J Heavy Met Toxicity Dis Vol.4 No.1:1

## Abstract

The current investigation aimed to determine the accumulated levels of heavy metals (Fe, Mn and Cu) in fish (*T. zilii* and *M. capito)* organs (muscles, liver and gill) collected from different sites of Lake Qarun in four seasons (August 2014 to May 2015). Metal concentrations in fish species tissues from the eastern part of the lake followed an abundance of: Fe>Mn>Cu. However, metal concentrations from the middle and west of the lake followed an abundance of: Fe>Cu>Mn. Tissues showed different capacities for accumulating heavy metals, the lowest values of accumulated heavy metals were recorded in the muscle, while the highest values recorded in the liver in two fish species. Also, heavy metals accumulation in the tissue of two fish species followed the order: liver< gill < muscle. *M. capito* accumulate heavy metals higher than *T. zilli*.

**Keywords:** Heavy metal; *T. ziliii; M. capito*; Lake Qarun

**Received:** December 17, 2018; **Accepted:** December 31, 2018; **Published:** January 07, 2019

## Introduction

Heavy metals are considered the hazardous inorganic pollutants in the aquatic environment and their concentrations in the various parts of organisms are determined primarily indicative of the level of the pollution in the environment [1]. Heavy metal pollutants have become a global phenomenon because of its toxicity, persistence for several decades, non-degradable in the aquatic environment, bioaccumulation and biomagnification in the food chain [2].

Heavy metals can be classified as essential (copper, zinc, manganese and iron) since they play an important role in biological systems [3]. Potentially toxic (arsenic, cadmium, aluminum, lead and mercury [4]. The heavy metals can also produce toxic effects at high concentration and low or high trace element unbalances can be considered as risk factors for several diseases [5].

The heavy metals discharged into aquatic environmental (seas, rivers and lakes) can damage aquatic species, diversity and ecosystem. These toxic heavy metals have changed the quality of water that affects aquatic biota and fish. Fish in ponds, rivers and lakes cannot avoid exposure to these toxic that suspended or dissolved in water, being less than land animals to move to favorable regions to avoid unfavorable conditions [6]. Transport of metals in fish occurs through blood and the metals are brought into contact with the organs and the tissues of the fish and consequently accumulated to different extents [7]. Prolonged exposures to trace elements even in very low concentrations have been reported to induce morphological, histological and biochemical alterations in the tissues that may critically influence fish quality [8]. Fish are integral components of aquatic ecosystems. In addition to being a source of high protein content and low saturated fat which contains omega fatty acids known to support good health [9], they play an important role in energy flows nutrient cycling and maintaining community balance in this ecosystem [10].

Fishes are considered as one of the most significant bio monitors in an aquatic system for the estimation of metal pollution concentration [11]. They offer several specific advantages in describing the natural characteristics of aquatic systems and in assessing changes observed in habitats [12]. Fishes are sensitive to any type of human disturbance such as industrial effluents, municipal waste, and river discharge and strongly influence the distribution, migration, colonization of fishes. In addition, fish are located at the end of the aquatic food chain and may accumulate metals and pass them to human beings through consumption causing chronic or acute diseases [13]. So this study aimed to determine the accumulated levels of heavy metal (Fe, Mn and Cu) in fish (*T. zilii* and *M. capito)* organs (muscles, liver and gill) collected from different sites of Lake Qarun in four seasons (August 2014 to May 2015). Also to compare between such levels and the world standard allowable limits to reveal their possible risk to human health for the fish consumers.

# Materials and Methods

## Fish samples collection

Samples of fish *T. zilii and M. capito* were collected seasonally (August 2014 to May 2015) from the east, middle and west of Lake Qarun **(Figure 1)**.

**The four seasons were:**

1) Summer season (21/6 to 21/ 9) ; samples were collected in 8/2014
2) Autumn season (21/9 to 21/12) ; samples were collected in 11/2014
3) Winter season (21/12 to 21/3) ; samples were collected in 2/2015
4) Spring season (21/3 to 21/6) ; samples were collected in 5/2015

The fish measured about (12 to 15) and (20 to 24 cm) in total length and (40 to 67) and (81 to 110 g) in weight respectively.

After the dissection of fish samples, gills, liver and muscles were carefully removed and prepared for heavy metals study.

**Heavy metals analysis in fish tissue:** Tissue samples (liver, muscle and gill) were dried in an oven at 105 Co (about 5 g of fresh fish tissue) for 48 hours and then grounded to a fine powder. The dried samples were digested after drying according to the method described by [14] in which 1.0 g (dry powder) was digested in a solution of (5 ml nitric acid + 5 ml perchloric acid), boiled on hot pate at 80-90 CO until the sample become clear. After cooling, the solution was filtrated and transferred to 25 ml volumetric flask and fill up to the level with de-ionized water. The digests were kept in plastic bottles and later; the concentrations of Fe, Cu and Mn in liver, muscle and gill were measured by GBC atomic absorption spectrophotometer Savanta AA The results are expressed in (μg/g dry wt.).

**Statistically analysis:** Analysis of variance (One-way ANOVA) was used to indicate significant differences among the different sites in heavy metal levels.

# Results

## Iron (Fe)

The maximum value of Fe concentrations (117.8 ± 3.15 μg/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 Fe (17 ± 0.46 μg/g dry wt.) was recorded in fish muscle collected from middle part of the lake in winter **Table 1**. Also, The maximum value of Fe concentrations (131.4 ± 1.63 μg/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 (21 ± 0.72 μg/g dry wt.) was recorded in the muscle of *M. capito* collected from middle part of the lake in winter season **Table 2**. The trend of the accumulation of Fe in liver, muscle and gill of *T. zilli* and *M. capito* from Lake Qarun followed the order: eastern part > middle part > western part in summer and spring, while followed the order: eastern part > western part > middle in autumn and winter.

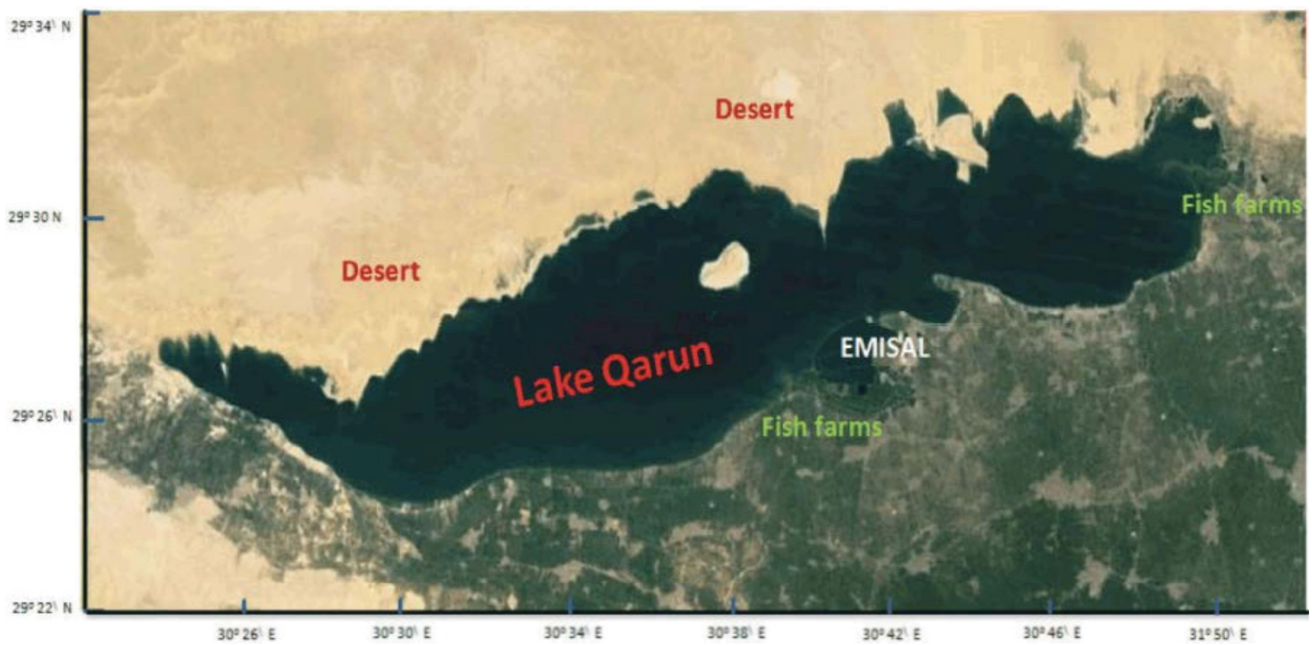


**Figure 1** Lake Qarun.

**Table 1** Seasonal variation of iron (Fe) concentration (µg/g dry wt.) (Means ± SE) in fish *T. zilli* collected from different sites of lake Qarun.

| Site | East | | | | | middle | | | | | west | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | P value |
| **summer** | 117.8 ± 3.15 | 39.5 ± 0.84 | 61.9 ± 2.43 | 73.08 ± 23.2 | 27.53 | 116.3 ± 3.74 | 25.4 ± 0.93 | 70.9 ± 2.68 | 70.86 ± 26.2 | 89.16 | 112.6 ± 2.23 | 22.7 ± 0.55 | 46.8 ± 1.72 | 60.7 ± 26.8 | 52.39 | 0.936 |
| **autumn** | 102 ± 3.96 | 21.8 ± 0.65 | 58.8 ± 2.22 | 60.86 ± 23.1 | 6.21 | 61.6 ± 1.50 | 20 ± 1.11 | 37.2 ± 0.56 | 39.6 ± 12.06 | 5.71 | 64.8 ± 1.43 | 21 ± 0.54 | 42 ± 1.41 | 42.6 ± 12.6 | 6.95 | 0.645 |
| **winter** | 99.9 ± 1.77 | 18.7 ± 0.65 | 53.5 ± 1.36 | 57.3 ± 23.5 | – | 59.6 ± 1.18 | 17 ± 0.46 | 35.8 ± 0.44 | 37.46 ± 21.3 | – | 62.2 ± 1.27 | 18.3 ± 0.46 | 39 ± 0.88 | 39.83 ± 21.9 | – | 0.683 |
| **spring** | 115.2 ± 1.46 | 28.1 ± 0.57 | 54.8 ± 1.10 | 66.03 ± 25.0 | 15.23 | 69.8 ± 1.66 | 17.3 ± 0.31 | 58.9 ± 1.15 | 48.68 ± 16.0 | 29.95 | 63.8 ± 1.73 | 19.2 ± 0.75 | 43.8 ± 0.94 | 42.26 ± 12.8 | 6.1 | 0.676 |

-Data are presented as mean ± SE of 6 fish. – M ± SE: mean ± standard error for (liver, muscle and gill) tissue.
-% percentage of change related to the lowest mean tissue value from season (-) -The mean difference is significant at ($p \le 0.05$).

**Table 2** Seasonal variation of iron (Fe) concentration (µg/g dry wt.) (Means ± SE) in fish M. capito collected from different sites of lake Qarun.

| Site | East | | | | | middle | | | | | west | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | P value |
| **summer** | 131.4 ± 1.63 | 88.6 ± 1.39 | 105.1 ± 1.31 | 108.36 ± 12.4 | 63.2 | 124.1 ± 2.78 | 44.3 ± 1.57 | 101.8 ± 0.50 | 90.06 ± 23.7 | 52.3 | 118.6 ± 3.30 | 39.7 ± 2.38 | 89.5 ± 2.33 | 82.6 ± 23.0 | 35.9 | 0.674 |
| **autumn** | 113.2 ± 4.23 | 26.9 ± 1.06 | 68.2 ± 2.12 | 69.43 ± 24.9 | 4.6 | 103 ± 1.63 | 23.6 ± 0.94 | 59.1 ± 2.38 | 61.9 ± 22.9 | 4.68 | 105.6 ± 1.31 | 24.2 ± 0.51 | 63.2 ± 0.93 | 64.33 ± 23.5 | 5.8 | 0.974 |
| **winter** | 111.1 ± 2.85 | 23.7± 0.75 | 64.3 ± 0.85 | 66.36 ± 25.25 | – | 99.2 ± 2.12 | 21 ± 0.72 | 57.2 ± 1.87 | 59.13 ± 22.59 | – | 102 ± 0.84 | 21.3 ± 1.33 | 59 ± 0.46 | 60.76 ± 23.3 | – | 0.975 |
| **spring** | 118.3 ± 1.11 | 45.6 ± 0.44 | 65.9 ± 0.54 | 76.6 ± 21.65 | 15.4 | 111.4 ± 0.67 | 33.9 ± 0.78 | 65.8 ± 0.50 | 70.36 ± 22.48 | 18.9 | 108.2 ± 0.57 | 30.3 ± 0.59 | 60 ± 2.88 | 66.16 ± 22.6 | 8.8 | 0.947 |

-Data are presented as mean ± SE of 6 fish. – M ± SE: mean ± standard error for (liver, muscle and gill) tissue.
-% percentage of change related to the lowest mean tissue value from season (-) -The mean difference is significant at ($p \le 0.05$).

## Copper (Cu)

The maximum value of Cu concentrations (8.2 ± 0.10 µg/g dry wt.) was recorded in the liver of fish *T. zilli* collected from middle part of the lake in summer season while minimum concentration of Cu (1.8 ± 0.09 µg/g dry wt.) was recorded in fish muscle collected from eastern part of the lake in winter **Table 3**. Also, The maximum value of Cu concentrations (11.7 ± 0.57 µg/g dry wt.) was recorded in the liver of fish *M. capito* collected from middle part of the lake in summer season, while minimum value (1.9 ± 0.19 µg/g dry wt.) was recorded in the muscle of *M. capito* collected from eastern part of the lake in winter season **Table 4**. Cu accumulation in *T. zilli* and *M. capito* tissues (liver, muscle and gills) collected from different sites of Lake Qarun was in the following order: middle part > western part > eastern part in summer and autumn season. In general, The lowest value of accumulated Cu was recorded in the muscle, while the highest values recorded in the liver in two fish species. Also Cu accumulation in the tissue of the two fish species followed the order: liver< gill <muscle. *M. capito* were accumulate Cu higher than *T. zill.*

## Manganese (Mn)

The maximum value of Mn concentrations (5.9 ± 0.24 µg/g dry wt.) was recorded in the liver of fish *T. zilli* collected from eastern part of lake Qarun in summer season while minimum concentration of Mn (0.20 ± 0.03 µg/g dry wt.) was recorded in fish muscle collected from middle part of the lake in winter. The results were clearly demonstrated in **Table 5**. Also, The maximum value of Mn concentrations (7.8 ± 0.80 µg/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 (1.01 ± 0.22 µg/g dry wt.) was recorded in the muscle of *M. capito* collected from middle part of the lake in winter season. **Table 6**. Mn accumulation in *T. zilli* and *M. capito* tissues (liver, muscle and gills) collected from different sites of Lake Qarun was in the following order: eastern part > western part > middle part in summer season, while following the order: western >eastern> middle part in spring except gill tissue. In general, the lowest value of accumulated Mn was recorded in the muscle, while the highest values recorded in the liver in two fish species. Also Mn accumulation in the tissue of the two fish species followed the order: liver< gill <muscle. *M. capito* was accumulating Mn higher than *T. zilli.*

## Discussion

The results of the present study revealed that the level of detected metals (Fe, Mn, and Cu) in the (muscle, liver and gills) of tested fish *T. zilli* and *M. capito* collected from lake Qarun tended to vary from season to another. The reason of seasonal variation may be the result of multiple factors. a) Fish activity and metabolism rates in four seasons; b) pollution sources activity in four seasons; c) fresh water input to the lake in four seasons.

Our results revealed that the tissues of fish *M. capito* accumulated heavy metals more than *T. zilli* collected from Lake Qarun. These observations may be due to different in fish habitat and the influence of the surrounding ecosystem statues. Also, the difference in the pattern of metals distribution in the fish species might be a result of their difference in many factors

**Table 3** Seasonal variation of Copper (Cu) concentration (µg/g dry wt.) (Means ± SE) in fish *T. zilli* collected from different sites of lake Qarun.

| Site | East | | | | | middle | | | | | west | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | P value |
| **summer** | 5.3 ± 0.10 | 2.9 ± 0.23 | 3.8 ± 0.24 | 4.00 ± .70 | 42.8 | 8.2 ± 0.10 | 3.4 ± 0.08 | 4.95 ± 0.36 | 8.02 ± .291 | 99 | 6.2 ± 0.29 | 2.9 ± 0.12 | 4.9 ± 0.26 | 4.66 ± .959 | 50.3 | 0.014 |
| **autumn** | 3.9 ± 0.14 | 2.1 ± 0.23 | 3.3 ± 0.10 | 3.10 ± .52 | 10.7 | 6.5 ± 0.29 | 2.9 ± 0.08 | 3.6 ± 0.16 | 4.33 ± 1.10 | 7.4 | 4.6 ± 0.49 | 2.4 ± 0.22 | 3.4 ± 0.12 | 3.46 ± .635 | 11.6 | 0.563 |
| **winter** | 3.7 ± 0.13 | 1.8 ± 0.09 | 2.9 ± 0.15 | 2.80 ± .55 | – | 6.3 ± 0.19 | 2.7 ± 0.08 | 3.1 ± 0.24 | 4.03 ± 1.13 | – | 4.3 ± 0.12 | 2.1 ± 0.08 | 2.9 ± 0.12 | 3.1 ± .642 | – | 0.571 |
| **spring** | 4.1 ± 0.16 | 2.9 ± 0.13 | 3.1 ± 0.13 | 3.36 ± .37 | 20 | 6.9 ± 0.29 | 3.1 ± 0.11 | 4.3 ± 0.28 | 4.76 ± 1.94 | 18.1 | 5.9 ± 0.12 | 2.6 ± 0.11 | 3.95 ± 0.12 | 4.15 ± 0.957 | 33.8 | 0.561 |

-Data are presented as mean ± SE of 6 fish. – M ± SE: mean ± standard error for (liver, muscle and gill) tissue.
-% percentage of change related to the lowest mean tissue value from season (-) -The mean difference is significant at ($p \leq 0.05$).

**Table 4** Seasonal variation of Copper (Cu) concentration (µg/g dry wt.) (Means ± SE) in fish *M. capito* collected from different sites of lake Qarun.

| Site | East | | | | | middle | | | | | west | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | P value |
| **summer** | 6.1 ± 0.33 | 3.3 ± 0.26 | 3.9 ± 0.28 | 4.43 ± .85 | 54.8 | 11.7 ± 0.57 | 4.9 ± 0.34 | 6.4 ± 0.53 | 7.66 ± 2.06 | 52.2 | 6.2 ± 0.30 | 4.2 ± 0.57 | 5.95 ± 0.31 | 5.45 ± .629 | 60.2 | 0.291 |
| **autumn** | 4.05± 0.33 | 2.1 ± 0.15 | 3.4 ± 0.26 | 3.18 ± .57 | 11.1 | 8.9 ± 0.56 | 2.9 ± 0.27 | 3.9 ± 0.27 | 5.23 ± 1.85 | 3.9 | 5.3 ± 0.19 | 2.8 ± 0.21 | 3.6 ± 0.27 | 3.9 ± .737 | 14.7 | 0.511 |
| **winter** | 3.8 ± 0.46 | 1.9 ± 0.19 | 2.9 ± 0.22 | 2.86 ± .54 | – | 8.7 ± 0.31 | 2.65 ± 0.17 | 3.75 ± 0.32 | 5.03 ± 1.86 | – | 4.9 ± 0.52 | 2.2 ± 0.31 | 3.1 ± 0.25 | 3.4 ± .793 | – | 0.466 |
| **spring** | 5.5 ± 0.40 | 2.8 ± 0.43 | 3.1 ± 0.25 | 3.80 ± .85 | 32.8 | 8.8 ± 0.80 | 3.98 ± 0.25 | 6.02 ± 0.29 | 6.26 ± 1.39 | 24.4 | 6 ± 0.45 | 3.85 ± 0.33 | 5.2 ± 0.57 | 5.01 ± .627 | 47.3 | 0.299 |

--Data are presented as mean ± SE of 6 fish. – M ± SE: mean ± standard error for (liver, muscle and gill) tissue.
-% percentage of change related to the lowest mean tissue value from season (-) -The mean difference is significant at ($p \leq 0.05$).

**Table 5** Seasonal variation of Manganese (Mn) concentration (µg/g dry wt.) (Means ± SE) in fish *T. zilli* collected from different sites of lake Qarun.

| Site | East | | | | | middle | | | | | west | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | P value |
| **summer** | 5.9 ± 0.24 | 4.4 ± 0.15 | 4.7 ± 0.08 | 5.00 ± .45 | 143.9 | 4.5 ± 0.16 | 3.04 ± 0.19 | 4.1 ± 0.32 | 3.88 ± .435 | 187.4 | 5.7 ± 0.09 | 4.3 ± 0.15 | 4.4 ± 0.14 | 4.8 ± .450 | 224.3 | 0.248 |
| **autumn** | 3.2 ± 0.31 | 0.89 ± 0.07 | 2.78 ± 0.27 | 2.29 ± .71 | 11.7 | 2.1 ± 0.29 | 0.7 ± 0.08 | 2.46 ± 0.13 | 1.75 ± .536 | 29.6 | 2.7 ± 0.38 | 0.98 ± 0.08 | 2.9 ± 0.58 | 2.19 ± .609 | 47.9 | 0.816 |
| **winter** | 2.99± 0.10 | 0.66 ± 0.02 | 2.5 ± 0.04 | 2.05 ± .70 | – | 1.88 ± 0.12 | 0.2 ± 0.03 | 1.98 ± 0.05 | 1.35 ± .577 | – | 2.3 ± 0.06 | 0.76 ± 0.02 | 1.39 ± 0.02 | 1.48 ± .447 | – | 0.689 |
| **spring** | 3.1 ± 0.09 | 1.01 ± 0.04 | 2.3 ± 0.06 | 2.13 ± .60 | 3.9 | 2.9 ± 0.22 | 0.55 ± 0.01 | 3.4 ± 0.12 | 2.28 ± .878 | 68.8 | 4.6 ± 0.19 | 1.14 ± 0.07 | 3.1 ± 0.07 | 2.94 ± 1.00 | 98.6 | 0.779 |

-Data are presented as mean ± SE of 6 fish. – M ± SE: mean ± standard error for (liver, muscle and gill) tissue.
-% percentage of change related to the lowest mean tissue value from season (-) -The mean difference is significant at ($p \leq 0.05$).

**Table 6** Seasonal variation of Manganese (Mn) concentration (µg/g dry wt.) (Means ± SE) in fish *M. capito* collected from different sites of lake Qarun.

| Site | East | | | | | middle | | | | | west | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Season** | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | liver | muscle | gills | M ± SE | % | P value |
| **summer** | 7.8 ± 0.80 | 4.8 ± 0.55 | 5.1 ± 0.57 | 5.90 ± .95 | 137.9 | 5.4 ± 0.27 | 3.4 ± 0.73 | 4.3 ± 0.23 | 4.36 ± .578 | 99 | 6.1 ± 0.57 | 4.2 ± 0.13 | 5.1 ± 0.25 | 5.13 ± 0.25 | 67.6 | 0.38 |
| **autumn** | 3.9 ± 0.13 | 1.39 ± 0.26 | 3.2 ± 0.57 | 2.83 ± .74 | 14.1 | 3.3 ± 0.18 | 1.44 ± 0.27 | 3.12 ± 0.26 | 2.62 ± .592 | 19.6 | 3.45 ± 0.05 | 3.36 ± 0.54 | 3.76 ± 0.44 | 3.52 ± .121 | 15 | 0.522 |
| **winter** | 3.5 ± 0.40 | 1.05 ± 0.20 | 2.9 ± 0.40 | 2.48 ± .73 | – | 2.86 ± 0.30 | 1.01 ± 0.22 | 2.7 ± 0.29 | 2.19 ± .591 | – | 3.1 ± 0.18 | 2.9 ± 0.13 | 3.2 ± 0.31 | 3.06 ± .088 | – | 0.55 |
| **spring** | 4.1 ± 0.54 | 1.9 ± 0.09 | 3.03 ± 0.58 | 3.01 ± .63 | 21.3 | 3.94 ± 0.07 | 1.24 ± 0.26 | 3.6 ± 0.16 | 2.92 ± .849 | 33.3 | 5.9 ± 0.54 | 4 ± 0.13 | 4.3 ± 0.25 | 4.73 ± .589 | 54.5 | 0.201 |

-Data are presented as mean ± SE of 6 fish. – M ± SE: mean ± standard error for (liver, muscle and gill) tissue.
-% percentage of change related to the lowest mean tissue value from season (-) -The mean difference is significant at ($p \leq 0.05$).

such as feeding habitats, ecological needs, metabolism, and physiologically [15].

The highest concentrations of these heavy metals were recorded in the liver while lowest concentration was recorded in muscle.

Various reasons may be attributed to the lower accumulation of heavy metals in the muscle: 1) the muscles does not come into direct contact with toxicant medium as it is totally covered by the skin. The presence mucous layer coating fish skin surface served as a barrier which protects the integrity of fish muscle tissue from surrounding contaminants. The mucous layer serves as the first line of defence against the entrance of heavy metals into fish flesh by forming complexes with the heavy metals and this in turn make the fish muscle tends to accumulate less concentration of metals compared with other fish organs as reported by Uysal, [16]. 2) The muscle is not an active site for detoxification [17]. Therefore, transport of heavy metals from other tissue to muscle does not occur.

On the other hand, our results showed that highest concentration of heavy metals were accumulated in the liver of *T. zilli* and *M. capito* collected from different sites of Lake Qarun. This may be due to the fact that the liver in fish as in other vertebrates is the major site for biotransformation and detoxification of different kinds of xenobiotic. Liver is the first sensitive organ for metal accumulation, since the accumulation of heavy metals not only depended on the structure of organs but also depended on interaction between metals and the target organs [18]. Metals induced metallothionine content in tissues which has been mostly affective in the liver.

The present study showed that Iron (Fe) recorded the highest concentrations among other metals in the liver, muscle and gill of studied fish (*T. zilli* and *M. capito*) collected from lake Qarun, its concentrations were higher than USFDA maximum permissible level for Fe (5 μg/g) cited by [19]. This high accumulation of Fe in the studied fish may be attributed to large quantities in water. Fe depending on the form of existence ion reacts directly with water to produce ferric hydroxide which makes the water body deficient in oxygen as results of its acidic characteristics there by creating anaerobic condition resulting to death of fish.

The current study showed that Copper (Cu) exhibited the highest level in liver and lowest in muscle of studied fish from lake Qarun. Its level in the studied fish are still below the permissible level for Cu (30 μg/g) reported by [20]. The highest level of Cu in liver may be due to specific metabolic process and enzyme catalyzed reaction involving Cu taking place in liver. The toxicity of Cu depends upon the hardness and pH of the water; it is more toxic in the soft water with low alkalinity [21]. The toxicity of copper in aquatic organisms is largely attributed to $Cu^{+2}$ that form complexes with other ions [22]. A reduction in water dissolved oxygen, hardness, temperature, pH and chelating agents can increase the toxicity of copper. Copper in water, particulate at high pH (alkaline) and is thus not toxic, while at low pH (acidic), it is mobile, soluble and toxic [23].

In the present study, the concentrations of Manganese (Mn) in the studied fish (*T. zilli* and *M. capito*) tissues were higher than the permissible level (2.5 μg/g) reported by [24], except some muscle and gill samples from the medium and west part of Lake Qarun. Also, the maximum value of Mn concentrations (5.9 ± 0.24 μg/g dry wt.) was recorded in the liver of fish *T. zilli* collected from eastern part of Lake Qarun in summer season. The elevation of Mn concentration in eastern part of the lake may be due to impact of pollution sources in this area which discharged its wastes coming from El-Batts Drain in this part and anthropogenic activities.

## Conclusion

The eastern part of the lake contained the most highly polluted fish with heavy metals compared to middle and western part. The elevation of heavy metal concentrations in eastern part of the lake may be due to impact of pollution sources in this area which discharged its wastes and anthropogenic activities.

## References

1 Sivakumar R, Natesan M (2011) Impact of metals on histopathology and expression of HSP 70 in different tissues of Milk fish (Chanos chanos) of Kaattuppalli Island, South East Coast, India. Chemosphere 83: 415-421.

2 Yang Z, Yi Y, Zhang Sh (2011) Ecological risk assessment of heavy metals in sediment and human health risk assessment of heavy metals in fishes in the middle and lower reaches of the Yangtze River basin. Environ Pollut 159: 2575-2585.

3 Rutkiewiez I, Namiesnik S (2009) Urine as a source of information on occupational exposer to metals, a review. Ecol Chem Eng Sci 16: 63-80.

4 Ganjavi M, Ezzatpanah H, Givianrad M, Shams A (2010) Effect of canned tuna fish processing steps on lead and cadmium contents of Iranian tuna fish. Food Chem 118: 525-528.

5 He Z, Song J, Zhang N, Zhang P, Xu Y (2009) Variation characteristics and ecological risk of heavy metals in the south yellow sea surface sediments. Environ Monit Assess 157: 515-528.

6 Gad NS (2009) Determination of glutathion related enzymes and cholenisterase activities in Oreochromis niloticus and clarias gariepinus as bioindicator for pollution of Lake Manzala. Glob Vet 2: 37-44.

7 Kalay M, Canli M (2000) Elimination of Essential (Cu, Zn) and Non-essential (Cd, Pb) Metals from Tissues of a Fresh Water Fish, Tillapia zilli. Turk J Zool 24: 429-436.

8 Kaoud HA, El-Dahshan AR (2010) Bioaccumulation and histopathological alterations of the heavy metals in oreochromis niloticus Fish. Nat Sci 8: 147-156.

9 Ikem A, Egiebor N (2005) Assessment of trace element in canned fish (Mackel, tuna, salamon, sardines and herrings) marketed in Georgia and Alabama. J Food Compos Anal 18: 771-787.

10 Chari KB, Abbasi SA (2005) A study on fish fauna of oussudu- a rare fresh water lake of South India. Int J Environ stud 62: 137-145.

11 Begum A, Amin Md N, Kaneco A, Ohta K (2005) Selected elemental composition of the muscle tissue of three species of fish, Tilapia nilotica, Cirrhina mrigala and Clarias batrachus, from the fresh water Dhanmondi Lake in Bangladesh. Food Chem 93: 439-443.

12 Lamas S, Fernàndez JA, Abdal JR, Carballeira A (2007) Testing the use of Juvenile Salmo trtta L. as biomonitors of heavy metal pollution in fresh water. Chemosphere 67: 221-228.

13 Al-Yousuf MH, El-Shahawi MS, Al-Ghais SM (2000) Trace metals in liver, skin and muscle of Lethrimus lentjan fish species in relation to body length and sex. Sci Total Environ 256: 87-94.

14 Ghazally KS (1988) The bioaccumulation of Egyptian edible marine animals. Part I Crustaceaus Bull Nat Inst Ocean and Fish ARE 14: 71-77.

15 Authman M, Abbas 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. Pak J Biol Sci 10: 2106-2122.

16 Uysal (2008) The determination of heavy metals accumulation ratio in muscle, skin and gills of some migratory fish species by inductively coupled plasma- optical emission spectrometry in Beymelek lagoon Antalya/ Turkey. Microchem J 90: 67-70.

17 Jagakumar P, Paul V (2006) Patterns of cadmium accumulation in selected tissues of the cat fish Clarius batruchus exposed to sub lethal concentration of Cadmium Chloride. Veterinarski Arhiv 76: 167-177.

18 Sorensen EM (1991) Metal poisoning in fish Ch. Vi. Cadmium CRC press Boca Raton Fx Pp: 175-234.

19 Adeyeye EI (1993) Trace heavy metals distribution in Illisha africana fish organs and tissue. II: Chromium, zinc, copper, iron and cobalt. Pak J Sci Res 36: 333-337.

20 FAO (1992) Committee for inland fishers of Africa; Working Party on Pollution and Fishers. FAO Fish Rep No 471.

21 Taha AA (2004) Pollution sources and related environmental impacts in the new communities Southeast Nile Delta, Egypt. Emirat J Eng Res 9: 35-49.

22 Olaifa F, Olaifa A, Adelja A, Owolabi A (2004) Heavy metals contamination in clarias gariapinus from alake and fish farm in Ibadan, Nigeria African J Bio med res 7: 145-148.

23 Nussey G (1998) Metal Ecotoxicology of the upper olifants River at selected lo calities and the effect of copper and Zinc on fish blood physiology. Ph.D. Thesis. Rand Afrikans University. S.A.

24 FAO (1983) Compilation of legal limits for hazardous substances in fish and fishery products. FAO Fish Circular 464: 5-100.