Biochemistry Letters, 14(1) 2019, pages 1-15

Scientific Research & Studies Center-Faculty of Science- Zagazig University- Egypt

Biochemistry Letters

Journal home page:

Hematological changes induced by heavy metals bioaccumulation in *Clarias gariepinus* fish at Fayoum Governorate, Egypt

Khalid H. Zaghloul*, Heba A. Mohamed* and Mohamed W. Khalil*

* Zoology Department, Faculty of Science, Fayoum University

ARTICLE INFO

Key words: Water pollution, *Clarias gariepinus*, metals bioaccumulation, blood parameters.

ABSTRACT

Background: The main drains at Fayoum governorate, El-Bats and El-Wadi loaded by salts and heavy metals as a result of the huge amount of the agricultural, waste municipal and industrial efflluents discharged.. **Aim:** The present investigation aims to determine the effect of water quality including heavy metals (zinc, copper, lead and cadmium) on hematological changes of the Nile catfish; *Clarias gariepinus* collected from a branch of the river Nile (El-Lahon canal) and two main drains (El-Bats and El-Wadi) at Fayoum governorate. **Materials and methods:** water and fish samples collected from the two main drains and the branch of the river Nile at Fayoum governorate to follow the effect of water deterioration and heavy metals bioaccumulation on fish blood parameters. **Results:** Highly significant increase in values of ammonia, nitrite, heavy metals (Cu, Zn, Pb and Cd) and a decrease in dissolved oxygen content in water samples collected from the main drains (El-Bats and El-Wadi) in comparision with that of samples collected from the branch of the river Nile. Moreover, bioaccumulation of the studied heavy metals in the main vital organs , gills , liver , kidney and muscles of *Clarias gariepinus* collected from the main drains at El-Fayoum governorate is accompanied by a significant decrease in RBCs , Hb content and PCV values but significant increase in MCV , MCH and MCHC WBCs of fish collected from El-Fayoum drainage canals (El-Bats and El-Wadi) than that of fish collected from the river Nile branch , El-Lahon that showed more or less normal values. **Conclusion:** Generally, the results highlights on the importance of taking action through the political authorities towards quality of the drainage water resources that fed fish farms by law and its fauna that could play a role as a main source of protein for human beings.

Corresponding author: Khalid H. Zaghloul, E-mail address: khz00@fayoum.edu.eg ,

Biochemistry letters, 14(1) 2019, Pages: 1-15

INTRODUCTION

Healthy Fish are important members of aquatic ecosystems and an important source of human food. However, fish distribution data in Egypt indicate a reduction in the commercially desirable fish species as the water conditions deteriorate. The agricultural, waste municipal and industrial effluents discharged directly to the natural water resources have been found to cause heavy fish mortality due to hypoxia, high levels of organic substances, inorganic salts and heavy metals[1,2,3,4].

Two major drains called El-Bats and El-Wadi drains at El-Fayoum governorate receives agricultural drainage water, waste municipal and industrial effluents without prior treatments. The drainage water was estimated as 390 million cubic meters annually[5]. Increasing land reclamation in El-Fayoum governorate has led to increase the amount of drainage water which goes to El-Wadi and El-Bats drainages loaded by salts and heavy metals[3].

The agricultural run-offs have cumulatively negative effects on the environmental quality of water in which decreased biodiversity and accidental fish die-offs have occurred. Water quality of the aquatic ecosystem is considered as the main factor controlling the state of health and disease in both cultured and wild fish[2,5,6,7] .

El-Fayoum fish farms play an important role as an alternative solution for increasing fish yield. But, due to the regulation rules for use of water resources in El-Fayoum province, fish farms which mainly established around El-Bats and El-Wadi drainage canals are allowed only to use water from the drainage network around [8]. Thus, these fish farms using agricultural drainage water may face the danger of negative effects on their cultured fish species[9,10].

Among the various toxic pollutants, heavy metals represent a very interesting group of elements due to their strong impact on stability of aquatic ecosystems, bioaccumulation in living organisms[11], toxicity persistence and tendency to accumulate in water and sediments[12]. Heavy metals are used as indicators of pollution in the ecosystem, and have recently came to the forefront of dangerous substances causing serious health hazards for humans and other organisms[13,14].

It has been observed that through biological amplification, some aquatic organisms may concentrate metals present in low concentration in the environment to levels that exceed standards and are harmful to organisms. Fish likewise other aquatic organisms, are greatly affected with chemical pollutants present in the ecosystem[15]. Haematological investigations have been developed for evaluation of fish health conditions[16]. As a matter of fact, blood serves as the most convenient indicator of the general condition of the animal body. Subsequently, haematological studies are promising tools for investigating physiological changes caused by environmental irritants[17].

So, the present study was conducted to provide comparable data of water quality as well as the selected fish species Nile catfish, *Clarias gariepinus* collected from three different aquatic habitats (El-Lahon canal, river Nile branch and the main drains at El-Fayoum governorate, El-Bats and El-Wadi). This could be achieved through monitoring the residual heavy metals (Cu, Zn, Pb and Cd) in some selected vital organs of fish (Gills, liver, kidney and muscles) and follow up its physiological status through investigating fish blood picture.

Biochemistry letters, 14(1) 2019, Pages: 1-15

MATERIALS AND METHODS:

The present field study was carried out on water and Nile catfish; *Clarias gariepinus*. Samples collected directly from three different studied aquatic habitats at El-Fayoum governorate.

Description of the studied sites of collection :

Site (1): Area of the river Nile at Fayoum governorate, El-Lahon canal.

Site (2): El-Bats drainage canal at El-Fayoum governorate where agricultural and waste municipal water discharged.

Site (3): El-Wadi drainage canal at El-Fayoum governorate where agricultural drainage water discharged.

Water and fish sampling: Water and fish samples were collected at summer season of 2016 from each site for the following investigations.

I. Water sampling and analysis: *Water samples were collected approximately 20 cm below the surface water[18], and kept in 500 ml sterile plastic containers. Samples were filtered in the field and acidified with 10% HNO_3 for preservation, placed in an ice bath and brought to the laboratory.*

a) Physicochemical analysis of water: The water samples collected from different locations in the studied ecosystems were subjected to a number of physicochemical analyses as mentioned below :-

● pH was measured at the sampling site by means of a pocket-pH meter (Micro Checkit ® pH+, Lovibond, England).

● Dissolved oxygen (mg/l) concentration was determined at the sampling site by means of Oxygen meter (model, YSI58).

● Salinity was measured by using a salinity-conductivity meter (model, YSI 58).

●Total hardness and total alkalinity were measured by titration method according to the American Public Health Association standard methods[19].

● Ammonia and nitrite were measured according to the method described by the American Public Health Association standard methods[19].

b). water analysis for heavy metals: Heavy metal concentrations in water were determined by atomic absorption spectrophotometer (Perkin Elmer, 2280). The samples were prepared and analyzed sequentialy for zinc, copper, lead and cadmium according to the American Public Health Association standard methods[19]. To 50 ml of water sample (in 500 ml Taylor flask), 0.50 ml of concentrated sulphuric acid was added, This was boiled down to obtain white fumes, cooled and 1.0 ml of 60% $HClO_3$ and 5.0 ml of concentrated HNO_3 were added, The resulting mixture was digested until a clear digest was obtained. This was cooled, filtered (No. 44 Whatman paper) into 500 ml volumetric flask, diluted to volume and mixed.

Heavy metal concentration (ppm) = reading of atomic absorption ×volume of diluted solution divided by Volume of water sample.

II. Fish sampling and analysis: A total number of 90 adult fish of Nile catfish; *Clarias gariepinus* (30 fish/site), fishes were collected with the help of local fishermen.

a) Residual heavy metals in some selected vital organs of the studied Fishes : Thirty fish from *Clarias gariepinus* were collected at summer season of 2016 from each site for residual heavy metal analysis. The collected fish were dissected for its gills, liver, kidney and muscles tissues then , washed with de-ionized water, put in cleaned plastic bags and stored frozen until analysis was carried out. Known weight of the prepared tissue sample (wet weight) was dried at 65 °C until they reached to a constant weight. All samples were ashed in a muffle furnace for 6 hours at 650 °C. The tissue ash were then dissolved and diluted to 25 ml with 0.1 N hydrochloric acid. The chemicals used for sample dissolution were analytical grade. Heavy metal

Biochemistry letters, 14(1) 2019, Pages: 1-15

concentrations were determined using an atomic absorption spectrophotometer.

Heavy metal concentration (µg/g) = reading of atomic absorption X volume of diluted solution / Weight of sample (g).

b). Blood sampling and analyses:

- **Blood sampling:** The fishes, *Clarias gariepinus* for blood analysis were brought to the laboratory alive in an aerated tank. Blood samples were withdrawn from the arterial caudalies, sucked into the syringes. Sodium citrate is the most satisfactory anticoagulant since heparine and oxalate were found to be unsatisfactory in completely preventing coagulation[20,21]. Blood samples examined for the following hematological analyses:

1. **Red and white blood cells count,** The total number of erythrocytes (RBCs) and leukocytes (WBCs) were carried according to the procedure described[20]**.**
2. **Hemoglobin content** was estimated by using Cyanmethmoglobin method [22].
3. **Hematocrite value:** The packed cell volume (PCV) was performed in a simple hematocrite graduated tube, upon hematocrite centrifuge at 3000 rpm for about 10 minutes.
4. **Blood indices:** Blood indices were calculated[23] as follow:
   a) Mean corpuscular volume (μm^3/cell)

$$\mathbf{MCV} = \frac{\mathbf{P.C.V.\ (\%)}}{\mathbf{RBCs\ (10^6/mm^3)}} \times 10$$

   b) Mean corpuscular hemoglobin (pg / cell)

$$\mathbf{MCH} = \frac{\mathbf{Hb}\ \text{(gm/100ml. blood)}}{\mathbf{RBCs\ (10^6/mm^3)}} \times 10$$

C) Mean corpuscular hemoglobin concentration (g/dl):

$$\mathbf{MCHC} = \frac{\mathbf{Hb}\ \text{(gm/100ml. blood)}}{\mathbf{P.C.V.\ (\%)}} \times 100$$

III). Statistical analysis:

The results were statistically analyzed using analysis of variance (F-test) followed by Duncan's multiple range test to determine differences in means using Statistical Analysis Systems, Version 6.2 (SAS, 2000) [24].

RESULTS:

Physicochemical properties of water from the locations of the different studied aquatic ecosystems are illustrated in table (1). It is clear that, analysis of variance (F-values) showed highly significant differences ($p < 0.01$) in the values of pH, oxygen content, total hardness, total alkalinity, salinity, ammonia and nitrite among the different studied sites (F-values = 79.9, 386, 401, 1002, 331, 516 and 291 respectively). It is evident from table (1) that, the highest value of dissolved oxygen (7.89±0.02) was recorded at the studied area of the river Nile at Fayoum governorate and decreased in the main drainage canals, El-Bats and El-Wadi (5.75±0.09 and 5.36±0.07) respectively.

The present data (Table 1) also showed high values of water ammonia (4.19 ±0.11 and 3.15 ±0.11 respectively) and nitrite (0.65 ±0.03, 0.41±0.01 respectively) in water samples collected from El-Wadi and El-Bats drains at El-Fayoum governorate and the lowest values were recorded at El-Lahon canal, the studied site of the river Nile at Fayoum governorate (0.28±0.02 and 0.03±0.004 respectively). However, higher water salinity was recorded at El-Bats (10.5 ± 0.42 g/l) and El-Wadi drains (3.87 ± 0.27 g/l)

Comparing average concentrations of heavy metals (Zn^{++}, Cu^{++} , Pb^{++} and Cd^{++}) in water from the different locations, the results revealed the presence of metals as follows (Table 1):

Zinc: El-Bats drain > El-Wadi drain > River Nile Branch (El-Lahon)
Copper: El-Bats drain> El-Wadi drain > River Nile Branch (El-Lahon)
Lead: El-Wadi drain > El-Bats drain > River Nile Branch (El-Lahon)
Cadmium: El-Bats drain> El-Wadi drain> River Nile Branch (El-Lahon)

The results declared that in presence of the industrial and agricultural effluents which discharged directly to the main drains at El-Fayoum governorate (El-Bats and El-Wadi drains), the concentrations of zinc, copper, lead and cadmium in water were higher than that of water samples collected from the branch of the river Nile (El-Lahon canal) at Fayoum governorate.

Residual heavy metals:

Generally, the concentrations of the studied heavy metals (Zn^{++} , Cu^{++}, , Pb^{++} and Cd^{++}) in some selected vital organs (gills, liver, kidney and muscles) of the Nile catfish; *Clarias gariepinus* collected from the different studied aquatic ecosystems at Fayoum governorate are shown in tables(2, 3, 4 & 5). It is clear from the present results that the highest concentrations of the different recorded heavy metals were found in fish tissues collected from the El-Bats and El-Wadi drains at El- Fayoum governorate and exhibit the following order:

Gills > liver > kidney > muscles in case of zinc bioaccumulation;

liver > kidneys > gills > muscles in case of copper bioaccumulation.

Gills > liver > kidney > muscles in case of lead bioaccumulation;

Gills > kidney > liver > muscles in case of cadmium bioaccumulation.

The results also declared that the lowest concentrations of the studied heavy metals were recorded in tissues of fish collected from the river Nile branch at El-Fayoum governorate (El-Lahon canal).

Blood parameters

Data representing blood parameters of the Nile catfish; *Clarias gariepinus* collected from the different studied aquatic ecosystems at Fayoum governorate are given in table (6). They include the red blood cell counts (RBCs), haemoglobin content (Hb), haematocrit value (Ht), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and white blood cell counts (WBCs).

Red blood cell count: Comparison of the red blood cell counts of *Clarias gariepinus* (Table 6), the present results revealed that analysis of variance showed highly significant difference in RBCs of fish collected from the different studied sites (F-value= 44). Table (6) also declared that, fish collected from the El-Fayoum drainage canals, El-Bats and El-Wadi showed a significant decrease in RBCs count, than that of fish collected from the river Nile branch , El-Lahon at Fayoum sector.

Haemoglobin content: Regarding the haemoglobin content of *Clarias gariepinus* (Table 6), it was found that, there was highly significant difference in haemoglobin content (F-value = 11) of fish collected from the different studied sites of aquatic habitats. Moreover, fish collected from the studied drainage canals, El-Bats and El-Wadi at Fayoum governorate showed a significant decrease in haemoglobin content than that collected from the river Nile branch at Fayoum sector (10.85±0.28).

Packed cell volume : Concerning the Packed cell volume values of the Nile catfish; *Clarias gariepinus* (Table 6), there was highly significant difference among fish collected from the different studied aquatic habitats (F- value=52). Table (6) also declared that, fish collected from El-Fayoum drainage canals showed a significant decrease in Packed cell volume value than that of fish collected from the

Biochemistry letters, 14(1) 2019, Pages: 1-15

river Nile branch, El-Lahon at Fayoum sector (31.3±1.36).

Calculated blood parameters (MCV, MCH and MCHC): Regarding the mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) of the Nile catfish; *Clarias gariepinus* collected from the different studied sites (Table 6), there were highly significant differences in MCV, MCH and MCHC of fish from the different studied aquatic habitats. Moreover, table (6) clarified that, fish collected from El- Fayoum drainage canals showed significant increase in the calculated blood parameters , MCV, MCH and MCHC.

White blood cell counts: Comparison of the white blood cell counts of the Nile catfish; Clarias gariepinus (Table 6), declared that, there was highly significant difference in WBCs of fish collected from the different studied aquatic habitats (F-value=65). Moreover, table (6) also declared that, fish collected from El-Fayoum drainage canals, El-Bats and El-Wadi showed a significant increase in WBCs count, than that of fish collected from the river Nile branch at Fayoum sector , El-Lahon.

DISCUSSION:

Degradation of the aquatic environment through industrial, waste municipal and agricultural effluents is a significant concern about the health of fish[25]. Fish consumption is an important avenue for pathogen and heavy metal exposure to man[26, 27, 28, 29]. Therefore, fish could serve as biological indicator for pollutants and environmental degradation. Bioaccumulation of trace heavy metals can be harmful to aquatic organisms causing adverse effects on human health and the aquatic ecosystem[4, 30].

Deterioration of the natural water resources conditions by the action of effluents affect the quality and quantity of the fish[29, 31, 32,33]. The present study revealed highly significant differences in water quality among the different studied sites of collection. The recorded rises in pH and consequently in values of total hardness and total alkalinity (as $CaCO_3$) as indicated in the present study of water samples collected from the main drains at Fayoum governorate, El-Bats and El-Wadi may be attributed to water deteioration and removal of CO_2 as previously reported[34]. However, the lowest mean value of dissolved oxygen was observed in El-Bats drainage and El-Wadi drainage could be attributed to agricultural, industrial, and waste municipal effluents which characterized by high load of organic wastes and the microbial activity that degraded the organic matter led to the oxygen consumption.

The highest ammonia concentration recorded in the two main drains El Bats and El Wadi may be due to the impact of the agriculture waste effluents to El-Wadi drain as a common source of these salts and many decayed dead animals that found in El Bats drain. These result may causes a bad impact on the water quality and decrease of dissolved oxygen as a result of oxygen consumption in decomposing organic matter and the oxidation of chemical constituents as previously reported[9, 35].

Heavy metals are widely distributed in aquatic system due to industrial development and the wide use of chemicals in agriculture. They may lead to either an increase or decrease in growth of various fishes and within their permissible level, play an important role in biological systems, however, higher concentration of heavy metals beyond the tolerance limit of fishes affect fish populations, reducing their growth, reproduction and/or survival and may even kill fishes[36, 37].

Relative to water, metals are adsorbed on sediment and bioaccumulated in fish. Fish may absorb dissolved elements and trace metals from water and sediments then accumulate it in various tissues in significant amounts above those found in their environment and are eliciting toxicological effects at target criteria[29, 30, 32]. Toxic elements that accumulate in various tissues of fish can be transported to human upon consumption of such edible tissues and this can lead to many imaginable adverse health effects to human[30, 38, 39].

Bioaccumulation of metals in tissues varies from metal to metal and among different organs of the same organism[40]. Gills are in direct contact with the aquatic medium; therefore, metal concentrations in this organ reflect their concentrations in the external environment. Also, in the present study, the lowest bioaccumulated heavy metals in muscles may be correlated with the fat-content in muscle tissues, low fat affinity to combine with heavy metals, and/or low metabolic activity of muscle[41, 42].

Metal exposure can result in gill damage, which in turn can affect blood parameters[43]. Fish blood parameters are often determined as an index of their health status[16] to detect physiological changes following different stress conditions like exposure to pollutants, diseases, metals, hypoxia etc. [17]. As a matter of fact, blood serves as the most convenient indicator of the general condition of the animal body. Subsequently Haematological studies are promising tools for investigating physiological changes caused by environmental pollutants[44].

Blood parameters of fish collected from the unpolluted area of the river Nile are within the normal range as previously reported[45] in case of *Clarias gariepinus*. However, fish collected from El-Fayoum drainage canals where the effluents of industrial and agricultural discharged showed significant decrease in red blood cells count, haemoglobin content and haematocrite values. The changes in red blood cell parameters suggest a compensatory response to the disruption of structural integrity of gills with consequent reduction of respiratory surface (tissue damage and cell proliferation), in order to increase O_2 carrying-capacity and maintain the level of oxygen transference from water to tissues[46].

The highly significant decrease in RBCs, Hb and Ht values of fish collected from the main drains in relation to those of the fish collected from the river Nile branch, El-Lahon may be due to reduction in red blood corpuscles production in the hematopoietic organs under the action of high heavy metal concentrations recorded in water samples[46]. Such a reduction may be also due to the intrahepatic and intrasplenic haemorrage induced by the action of accumulated heavy metals. The decrease of Ht and RBCs may indicate a compensatory response to increase the blood's O_2 carrying capacity. Generating an internal hypoxia which may stimulate erythrocyte release stored in organs into the blood circulation by adrenergic stimulation[47]. The decrease in blood Hb is accompanied by an increase in mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH). This may be due to the hemolytic action that led to fluid loss to the tissues with subsequent decrease in plasma volume[48].

Leukocytosis recorded in the present study in case of fish collected from the main studied drains at Fayoum governorate may be attributed to increased leukocyte mobilization to protect the body against infections in metals-damaged tissue. This is in agreement with previous finding[47] in *Prochilodus scrofa* after acute exposure to copper. The increase in WBCs of fish was suggested to indicate alteration in defense mechanism against the action of the highly toxic and bioaccumulated heavy metals in fish tissues as previously reported[44, 46, 47].

The calculated blood indices; mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) have a particular importance in describing anemia in most animals[49].

The decrease in blood parameters (RBCs count, Hb and Ht values) of fish collected from El-Fayoum drainage canals is accompanied by an increase in MCV. The recorded macrocytic anemia in the present study could be attributed to RBCs haemolysis and the reduction of RBCs production in the haemopoietic tissues under the action of the bioaccumulated heavy metals.

CONCLUSION:

One could concluded that, preserving the environment is not an entertainment or luxury any more, yet it became crucial to protect our resources for the coming generations. Moreover, protecting the environment is a national duty and laws shall regulate the procedures of keeping good environment.

REFERENCES:

1] **Elghobashy, A.H.; Zaghloul, K.H. and Metwally, M.A. (2001):** Effect of some water pollutants on the Nile tilapia; *Oreochromis niloticus* collected from the river Nile and some Egyptian lakes. Egypt. J. Aquat. Biol. Fish., **5(4):** 251-279.

[2] Sabae, S. Z. and Mohamed, F. A. S.(2015): Effect of Environmental Pollution on the Health of Tilapia spp. from Lake Qarun. Global Veterinaria 14 (3): 304-328.

[3] El-Sherif, S. A. and Abd El-Ghafour, S. (2016): Investigation of quality properties and nutritional values of four fish species from lake Qaroun, Egypt. International Journal of Chem Tech Research, 9(4):16-26.

[4] Anghel A.M., Ilie M., Ghita G., Marinescu F., Deák Gy., (2017): Assessing the Aquatic Environment Quality Contaminated with Heavy Metals as a Result of Poly metallic Mining in the North West Region of Romania Using Pollution Indices, International Journal of Environmental Science and Development,8(2):111-115.

[5] Authman, M.M.N. and Abbas, H.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. *Pak. J. Biol. Sci*., 10(13): 2106-2122.

[6] Mansour, S. A. and Sidky, M. M. (2002): Ecotoxicological studies. 3. Heavy metals contaminating water and fish from Fayoum Governorate, Egypt. Food Chem., **78:** 15-22

[7] Fathi, A.A. and Flower, R.J. (2005): Water quality and phytoplankton communities in lake Qarun (Egypt). *Aquat. Sci*., 67: 350-362.

[8] Konsowa, A.H. (2007): Ecological studies on fish farms of El-Fayoum depression (Egypt). Egypt. J. Aqatic. Res., 33(1): 290-300.

[9] Zaghloul, K. H.; Said, A. A.; El-Sayad, S. M. and Ali, G. S. (2016a): Assessment of fish farms water quality on the cultured *Oreochromis niloticus* and *Mugil cephalus* at El-Fayoum Governorate Egypt. *Egypt. J. Zool*. 66: 151 – 166 .

[10] Goher, M. E.; Abdo, M. H.; Bayoumy, W. A. and Mansour El-Ashkar, T. Y. (2017): Some heavy metal contents in surface water and sediment as a pollution index of El-Manzala lake, Egypt. Journal of Basic and Environmental Sciences, 2: 210-225.

[11] Abdel-khalek, A. A.; Elhaddad, E.; Mamdouh, S. and Marie, M-A. S. (2016): Assessment of metal pollution around sabal drainage in river Nile and its impacts on bioaccumulation level, metals correlation and Human risk hazard using *Oreochromis niloticus* as a bioindicator. Turkish J. of Fisheries and Aqua.Sci., 16: 227 – 239.

[12] Abdel-Baki, A.S., Dkhil, M.A., Al-Quraishy, S., (2011): Bioaccumulation of some heavy metals in tilapia fish relevant to their concentration in water and sediment of Wadi Hanifah, Saudi Arabia. Afr. J. Bio technol. 10, 2541–2547.

[13] David, M., H. Ramesh, V. Patil, S. Marigoudar and S. Chebbi, (2010):

Biochemistry letters, 14(1) 2019, Pages: 1-15

Sodium cyanide-induced modulations in the activities of some oxidative enzymes and metabolites in the fingerlings of *C. carpio* (L). Toxicological and Environmental Chemistry, 92: 1841-1849.

[14] Arya, A., (2014): Evaluation of biochemical and histochemical changes following the combined treatment of mercury and cadmium in a fresh water cat fish, Clarias batrachus. International Journal of Pharmacy and Pharmaceutical Sci., 6(10): 356-358.

[15] Abdel-Tawwab, M.; El-Sayed, G. O. and Shady, S. H. (2016): Growth, biochemical variables, and zinc bioaccumulation in Nile tilapia, *Oreochromis niloticus* (L.) as affected by water-born zinc toxicity and exposure period. Aqu. Res., 8(3): 197 – 206.

[16] Cogun, H. Y., and Şahin, M. (2013): The effect of lead and zeolite on hematological and some biochemical parameters in Nile fish (*Oreochromis niloticus*). Current Progress Biological Research, 12: 277-286.

[17] Singh, N. N., and Srivastava, A. K. (2010): Haematological parameters as bioindicators of insecticide exposure in teleosts. Ecotoxicology, 19(5): 838-854.

[18] Ndimele, P. E., and Kumolu-Johnson, C. A. (2012): Some aspects of the physic chemistry and heavy metal content of water, sediment and *Cynothriss amento* (Regan, 1917) from Badagry Creek, Lagos, Nigeria. Trends in Applied Sciences Research, 7(9), 724–736.

[19] APHA, (2005): Standard Methods for the Examination of Water & Wastewater. *American Public Health Association*.

[20] Hesser, E. F. (1960): Methods for Routine fish haematology. Prog. Fish. Cult. , 22:164-170.

[21] Falkner, N.W. and Houston , A.H. (1966): Some haematological responses to sublethal thermal skock in the Gold fish, *Cassius auratus* . J. Fish. Res. Bd. Can., 23 (8) : 1109-1113.

[22] Van Kampen, E.J. and Zijlstra, N.C. (1961): Determination of haemoglobin. Clin. Chem. Acta., 5: 719-720.

[23] Gupta, P.K.(1977): Haematological Techniques. 4 th ed. Syndicate, India, pp. 231.

[24] SAS (2000): Statistical Analysis, SAS/STAT user's guide, version 6.2, SAS Institute Inc., Cary, NC.

[25] Authman, M.M.N. and El-Sehamy, M.I.I. (2007): Pesticides residues in water and fish collected from Kafer Al-Zayat pesticides factory zone and their impact on human health. Egypt. J. Zool., **48:** 257-282.

[26] Musaiger, A.O. and D'Souza, R. (2008): Chemical composition of raw fish consumed in Bahrain. Pak. J. Biol. Sci., 11: 55-61.

[27] Christopher, A.E., O. Vincent, I. Grace, E. Rebecca and E. Joseph, (2009) : Distribution of heavy metals in bones, gills, livers and muscles of (Tilapia) *Oreochromis niloticus* from Henshaw Town Beach market in Calabar Nigeria. Pak. J. Nutr., 8: 1209-1211.

[28] Güngör, A. and Kara, D. (2018): Toxicities and risk assessment of heavy metals of the six most consumed fish from the Marmara Sea. Environ Sci Pollut Res (25): 2672–2682**.**

[29] Jia, Y.; Wang, L. ; Cao, J. ; Li, S. and Yang, Z. (2018): Trace elements in four freshwater fish from a mine-impacted river: spatial distribution, species-specific accumulation, and risk assessment. Environmental Science and Pollution Research (25): 8861–8870.

[30] Hossain, M. B. ; Ahmed, A-S. S. and Sarker, M. S. (2018): Human health risks of Hg, As, Mn, and Cr through consumption of fish, *Ticto barb* (Puntius ticto) from a tropical river, Bangladesh. Environ. Sci. and Pollu. Res., 25:31727–31736

[31] Zaghloul, K.H.; Hasheesh, W.S.; Zahran, I.A., and Marie, M.A.S. (2007) : Ecological and biological studies on the Nile tilapia; *Oreochromis niloticus* along different sites of lake Burullus. Egypt. J. Aquat. Biol. Fish.11(3):57-88.

[32] Yi, Y.-J. and Zhang, S.-H. (2012): Heavy metal (Cd, Cr, Cu, Hg, Pb, Zn) concentrations in seven fish species in relation to fish size and location along the Yangtze River. Environ. Sci. Pollut. Res. (19): 3989–3996

[33] Poonam T, Tanushree B, Sukalyan C (2013): Water quality indices-important tools for water quality assessment, a review. Intern JAdv Chem. (IJAC) 1(1):15–29.

[34] Cole, G.E. (1979): Textbook of limnology. 2nd edition. C.V. Mosby Company. St. Louis, Toronto, London.

[35] Ibrahim, L. A., and Ramzy, E. M. (2013): Water quality and its impact on *Tilapia zilli* (case study) Qarun lake-Egypt. International Water Technology Journal, 3(4): 170-191.

[36] Monikh FA, Safahieh A, Savari A, Ronagh MT, Doraghi A (2013): The relationship between heavy metal (Cd, Co, Cu, Ni and Pb) levels and the size of benthic, benthopelagic and pelagic fish species, Persian Gulf. Bull Environ Contam Toxicol 90:691–696.

[37] Abadi D. R. V., Dobaradaran S., Nabipour I., Lamani X., Ravanipour M., Tahmasebi R., Nazmara S. (2015): Comparative investigation of heavy metal, trace, and macro element contents in commercially valuable fish species harvested off from the Persian Gulf. Environ Sci Pollut Res 22:6670 – 6678.

[38] Arain, M.B., Kazi, T.G., Jamali, M.K., Jalbani, M., Afridi, H.I. and Shah, A.Q. (2008): Total dissolved and bio available elements in water and sediment samples and their accumulation in *Oreochromis mossambicus* of polluted Manchar Lake. Chemosphere.70:1845-1856**.**

[39] Ololade IA, Lajide **L, Amoo IA, Oladoja NA (2008):** Investigation of heavy metals contamination of edible marine seafood. Afr J Pure Appl Chem 2:121–131.

[40] Masoud MS, El-Samra MI, El-Sadawy MM (2007): Heavy-metal distribution and risk assessment of sediment and fish from El Mex Bay, Alexandria, Egypt. Chem. Ecol 23:201–216.

[41] Uluturhan, E. and Kucuksezgin, F. (2007): Heavy metal contaminations in Red Pandora (Pagellus erythrinus) tissues from the Eastern Aegean Sea, Turkey. Water Res 41:1185–1192.

[42] Tayel, S., A.M. Yacoub and S. Mahmoud, (2008): Histopathological and haematological responses to freshwater pollution in the Nile Catfish *Clarias gariepinus*. Journal of Egypt. Acad. Soci. and Environ. Develop., 9: 43-60.

[43] Pelgrom, S., Lamers, L., Lock, R., Balm, P. and Wendelaar Bonga, S. (1995): Interactions between copper and cadmium modify metal organ distribution in mature tilapia; *Orechromis mossambicus*, to sublethal copper exposure. Environ. Pollut. 90: 415-423.

[44] Zaghloul, K. H.; Said, A. A.; El-Sayad, S. M. and Ali, G. S. (2016 b): Role of heavy metals bioaccumulation on some physiological and histopathological changes in the cultured *Oreochromis niloticus* and *Mugil cephalus* at El-Fayoum Governorate, Egypt. Egypt. J. Zool. 66: 167 – 188.

[45] Haggag, A. M., Marie, M. A. S., and Zaghloul, K. H. (1999): Seasonal effects of the industrial effluents on the Nile catfish. *Clarias gariepinus,* J. Egypt. Ger. Soc. Zool 28 (A) :365 – 391

[46] Zaghloul, K.H.; Omar, W.A. and Abo-Hegab, S. (2005): Environmental hazard risk assessment on *Oreochromis niloticus* and *Tilapia zillii* fish. J. Egypt. Ger. Soc. Zool., 46(A): 105-139.

[47] Mazon, A. F., Monteiro, E. A. S., Pinheiro, G. H. D., and Fernandes, M. N., (2002): Gill cellular changes induced by copper exposure in the South American tropical freshwater fish Prochilodus scrofa. Environm. Res. A., 88: 52- 63.

[48] Svobodova, Z.; Vykusova, B.; Modra, H.; Jarkovsky, J. and Smutna, M. (2006): Haematological and biochemical profile of harvest-size carp

Biochemistry letters, 14(1) 2019, Pages: 1-15

during harvest and post-harvest storage. Aquacult. Res., **37:** 959-965.

[49] Coles, E.H. (1986): Veterinary clinical pathology. W.B. Saunders, Philadelphia.pp.10-42.

[50] WHO (World Health Organization) (1998): WHO Guidelines for drinking-water quality. Geneva, World Health Organization. 3rd ed. Vol.1.

Table (1): Quality of water collected from branch of the river Nile and the main drains at El-Fayoum governorate, Egypt.

Studied Sites of Collection	pH	Dissolved oxygen mg/l	Total Hardness as $CaCO_3$ mg/l	Total alkalinity as $CaCO_3$ mg/I	Salinity g/l	NH_3 mg/l	NO_2 mg/l	Zn^{+2} P.l. = 5.0 mg/l	Cu^{+2} P.l. = 1.0 mg/l	Pb^{+2} P.l. = 0.05 mg/l	Cd^{+2} P.l. = 0.01 mg/l
El-Lahon canal (Branch of the river Nile)	7.57 ± 0.03 **C**	7.89 ± 0.02 **A**	141 ± 1.69 **C**	113 ± 4.74 **C**	0.084 ± 0.003 **C**	0.28 ± 0.02 **C**	0.03 ± 0.004 **C**	0.65 ± 0.04 **C**	0.04 ± 0.003 **C**	0.025 ± 0.005 **C**	0.002 ± 0.0003 **C**
El-Bats drainage canal	8.30 ± 0.04 A	5.36 ± 0.07 C	427 ± 10.9 A	290 ± 1.32 A	10.5 ± 0.42 A	3.15 ± 0.11 B	0.41 ± 0.01 B	**3.35 ± 0.14 A**	0.47 ± 0.02 A	**0.31** ± 0.015 B	0.053 ± 0.003 A
El-Wadi drainage canal	8.05 ± 0.04 B	5.75 ± 0.09 B	385 ± 7.3 B	256 ± 1.54 B	3.87 ± 0.27 B	4.19 ± 0.11 A	0.65 ± 0.03 A	2.9 ± 0.13 B	0.38 ± 0.02 B	**0.41** ± 0.01 A	0.032 ± 0.001 B
F-values	**79.9****	**386****	**401****	**102****	**331****	**516****	**291****	**163****	**289****	**259****	**162****

Data are represented as means of eight samples ± Sterr.
N.D. = Not detectable.
P.l. = Permissible level in water according to WHO (1998) [50]
Means with the same letter for each parameter are not significantly different, otherwise they do (SAS, 2000) [24] .
** Highly Significant difference ($P < 0.01$).

Biochemistry letters, 14(1) 2019, Pages: 1-15

Table (2): Residual zinc concentrations in some selected vital organs (mg/kg dry weight) of *Clarias gariepinus* collected from branch of the river Nile and the main drains at El-Fayoum governorate, Egypt.

Studied Sites of Collection	Gills	Liver	Kidney	Muscles P.l. = 40 ppm
El-Lahon canal (Branch of the river Nile)	10.18 ± 0.34 C	11.68 ± 0.42 B	7.13 ± 0.21 C	1.25 ± 0.08 C
El-Bats drainage canal	37.05 ± 1.41 A	31.77 ± 1.32 A	28.25 ± 2.47 A	3.10 ± 0.25 A
El-Wadi drainage canal	33.95 ± 0.90 B	33.32 ± 0.61 A	21.48 ± 1.81 B	2.85 ± 0.10 A
F-values	**220****	**189****	**37****	**72****

Data are represented as means of eight samples ± Sterr.
P.l. = Permissible level in fish tissues for human consumption according to WHO (1998) [50].
Means with the same letter for each parameter are not significantly different, otherwise they do (SAS, 2000) [24].
** Highly Significant difference (P<0.01).

Table (3): Residual copper concentrations in some selected vital organs (mg/kg dry weight) of *Clarias gariepinus* collected from branch of the river Nile and the main drains at El-Fayoum governorate, Egypt.

Studied sites of collection	Gills	Liver	Kidney	Muscles p.l. = 20 ppm
El-Lahon canal (Branch of the river Nile)	1.60 ± 0.46 B	3.28 ± 0.24 C	2.1 ± 0.07 B	0.63 ± 0.09 C
El-Bats drainage canal	2.91 ± 0.1 A	14.59 ± 0.41 A	10.55 ± 0.35 A	1.88 ± 0.15 A
El-Wadi drainage canal	2.38 ± 0.16 A	11.79 ± 0.42 B	10.64 ± 0.27 A	1.10 ± 0.10 B
F-values	**84****	**256****	**353****	**33****

Data are represented as means of eight samples ± Sterr.
P.l. = Permissible level in fish tissues for human consumption according to WHO (1998) [50].
Means with the same letter for each parameter are not significantly different, otherwise they do(SAS, 2000) [24] .
** Highly Significant difference (P<0.01).

Biochemistry letters, 14(1) 2019, Pages: 1-15

Table (4): Residual lead concentrations in some selected vital organs (mg/kg dry weight) of *Clarias gariepinus* collected from branch of the river Nile and the main drains at El-Fayoum governorate, Egypt.

Studied sites of collection	Gills	Liver	Kidney	Muscles P.l. = 0.6 ppm
El-Lahon canal (Branch of the river Nile)	0173 ± 0.008 C	0.178 ± 0.01 C	0.025 ± 0.012 C	0.067 ± 0.008 C
El-Bats drainage canal	1.21 ± 0.18 B	0.48 ± 0.03 B	0.31 ± 0.008 B	0.165 ± 0.019 B
El-Wadi drainage canal	1.94 ± 0.09 A	0.88 ± 0.10 A	0.42 ± 0.04 A	0.58 ± 0.10 A
F-values	**59****	**33****	**64****	**18.3****

Data are represented as means of eight samples ± Sterr.
P.l. = Permissible level in fish tissues for human consumption according to WHO (1998) [50].
Means with the same letter for each parameter are not significantly different, otherwise they do (SAS, 2000) [24] .
** Highly Significant difference (P<0.01).

Table (5): Residual cadmium concentrations in some selected vital organs (mg/kg dry weight) of *Clarias gariepinus* collected from branch of the river Nile and the main drains at El-Fayoum governorate, Egypt.

Studied aquatic habitats	Gills	Liver	Kidney	Muscles P.l. = 0.5 ppm
El-Lahon canal (Branch of the river Nile)	0.022 ± 0.004 C	0.038 ± 0.005 C	0.015 ± 0.003 C	N.D.
El-Bats drainage canal	0.39 ± 0.06 A	0.256 ± 0.02 A	0.68 ± 0.08 A	0.065 ± 0.01 A
El-Wadi drainage canal	0.25 ± 0.044 B	0.156 ± 0.02 B	0.30 ± 0.04 B	0.036 ± 0.01 B
F-values	**16****	**51****	**39****	**12****

Data are represented as means of eight samples ± Sterr.
P.l. = Permissible level in fish tissues for human consumption according to WHO (1998) [50].
N.D. = Not Detectable
Means with the same letter for each parameter are not significantly different, otherwise they do (SAS, 2000) [24].
** Highly Significant difference (P<0.01).

Biochemistry letters, 14(1) 2019, Pages: 1-15

Table (6): Blood parameters of *Clarias gariepinus* collected from branch of the river Nile and the main drains at El-Fayoum governorate, Egypt.

Studied Sites of Collection	RBCs (X 10^6/mm^3)	Hb (g/100 ml)	Ht (%)	MCV (µ m^3/cell)	MCH (pg/cell)	MCHC (g/100 ml)	WBCs (X 10^3/mm^3)
El-Lahon canal (Branch of the river Nile)	3.05 ± 0.13 A	10.85 ± 0.28 A	31.3 ± 1.36 A	102.6 ± 4.4 B	35.0 ± 1.03 B	34.7 ± 0.8 B	29.6 ± 1.25 C
El-Bats drainage canal	1.42 ± 0.10 B	7.78 ± 0.22 B	16.38 ± 0.78 B	115.0 ± 6.7 A	54.0 ± 0.99 A	47.57 ± 0.59 A	95.8 ± 6.03 A
El-Wadi drainage canal	1.61 ± 0.14 B	8.30 ± 0.79 B	19.0 ± 1.10 B	118.0 ± 9.8 A	51.0 ± 0.65 A	43.9 ± 1.45 A	78.5 ± 4.01 B
F-values	**44****	**11****	**52****	**15****	**27****	**19****	**65****

Data are represented as means of eight samples ± Sterr.
Means within the same column, with the same letter for each parameter are not significantly different, otherwise they do (SAS, 2000) [24].
** Highly significant difference at P ≤ 0.01

Scientific Research & Studies Center-Faculty of Science- Zagazig University- Egypt

Biochemistry Letters

Journal home page:

Corresponding author: Khalid H. Zaghloul, E-mail address: khz00@fayoum.edu.eg ,