



## **Determination of Some Heavy Metals in Cultured Nile Tilapia (*Oreochromis niloticus*) in Western Kordofan State, Sudan**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

The current study was conducted in two different localities have been selected in Western Kordofan State (Elsonout and Abu-zabad Localities) to evaluate some heavy metals concentrations (Copper, Cadmium, Zinc, and Lead) in three parts (liver, gills and muscles) of Nile Tilapia (*Oreochromis niloticus*) cultured in Dams, also to evaluate the same heavy metals concentrations in Dams water where Nile Tilapia is cultured. The evaluation was included the correlation of heavy metals accumulation between fish organs and water samples were compared. Finally, the results were compared with recommended levels by FAO, WHO and other international organizations. A total of 54 samples has been taken from marketable size Nile Tilapia parts (gills; livers and muscles) and subjected to analysis of heavy metals accumulations. Also, a total of 18 water samples were taken from Dams (shallow, middle and deep water). The data was subjected

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to SPSS using ANOVA. The findings of this work were revealed that, there were a highly significant differences ( $P \leq 0.01$ ) in all heavy metals among gills, liver and muscles of Nile Tilapia cultured in Dams. And there was a highly significant difference ( $P \leq 0.01$ ) in all heavy metals among gills, liver and muscles of Nile Tilapia according to localities. Anyway, when compared fish organs; we found that, gills were recorded the maximum figures in all heavy metals followed by livers and the minimum figures were recorded by muscles. The results of this study were in the permissible levels recommended by international organizations.

**Keywords:** Abu-zabad; elsonout; heavy metals; Nile tilapia.

## 1. INTRODUCTION

Fish is an important source of food and represents a major part of many natural food chains and it is highly nutritious due to its high protein content and the presence of omega-3 fatty acids, fats, amino acids and vitamins; it also contains several minerals, including Ca, Fe, Cd, Pb, Cu, and Zn [1,2]. The content of heavy metals in fish can enhance or counteract the positive benefits of the omega-3 and protein in fish [3]. At the same time, the levels of contaminants in fish are of particular interest because of the potential effects of such substances on the fish itself and on the organisms that consume them, including humans [4]. Some heavy metals are essential elements for human beings, which means that they must be a part of our diet [5].

The contamination of fish from such rivers and lakes will surely affect humans as consumers of those fish. Fish that occupy high levels in the aquatic food we are known for their tendency to concentrate heavy metals in their body parts, thus, it is important to study the capacities of different fish body parts to accumulate metals because fish plays an essential role in the human diet; such information will help ensure that high levels of heavy metals are not being transferred to humans via fish consumption [6]. This type of assessment is based largely on measuring the accumulated levels of heavy metals in different parts of tilapia fish, such as the liver, gills, and muscle. The gills and liver were chosen as target organs to evaluate the heavy metal accumulation in the fish, the levels of metals in the gills can represent the immediate levels of heavy metals in the water where the fish lives; meanwhile, the levels in the liver reflect the longer-term accumulation of heavy metals in the fish [7]. In recent decades, food safety has become a widespread public concern worldwide due to the increasing demand for food safety; this has stimulated research work regarding certain threats associated with the consumption of food stuffs contaminated with heavy metals,

pesticides or toxins [8]. The consumption of fish has been revealed to have benefits as well as risks, low levels of fish intake appear to reduce chronic heart diseases and mortality, at the same time, eating contaminated fish may pose a risk of heavy metal poisoning (as noted by these authors) [9].

### 1.1 Justifications

- 1) West Korfofan Tordas (Dams) are fresh closed Tordas playing an important role in the lives of many people in the region. They are the aquacultural areas. They serve for recreation purpose and also they are used for drinking water supply by the communities surrounding it.
- 2) The importance of Nile tilapia (*Oreochromis niloticus*) as source of protein and polyunsaturated fatty acids which decrease the risk of cardiovascular diseases for humans.
- 3) The Nile Tilapia (*Oreochromis niloticus*) the aquatic organisms affected by heavy metals, so in many cases was used as metal biological marker in toxicological studies, these fish are cultured into the still water bodies (dams).

### 1.2 Statement of Problems

The hazards of heavy metal contamination and if it in acceptable levels and how to avoid the levels above the acceptable levels which are recommended by FAO, WHO and other international organizations.

### 1.3 The Objectives

- 1) To determine the distribution of selected heavy metal concentrations (copper (Cu), cadmium (Cd), Zinc (Zn), and lead (Pb)) in fish liver, gills and muscles for Nile Tilapia (*Oreochromis niloticus*) cultured in Dams, Western Kordofan State.
- 2) To estimate the distribution of selected heavy metal concentrations (copper (Cu), cadmium (Cd), Zinc (Zn), and lead (Pb)) in

water of Dams were Nile Tilapia (*Oreochromis niloticus*) is cultured, Western Kordofan State.

- 3) To check the level of these heavy metals levels so as to be compared with recommended levels by FAO, WHO and other international organizations.

## 2. MATERIALS AND METHODS

### 2.1 Area of Study

In the current investigation, two different localities have been selected in Western Kordofan State (Elsonout and Abu-zabad). For easy interpretation of results, samples were analyzed depending on general experimental strategy as follows:

- ✓ The similarities and differences in heavy metals concentrations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)) in three parts (Liver, Gills and Muscles) of Nile Tilapia (*Oreochromis niloticus*) cultured in Dams, Western Kordofan State, were investigated via laboratory analysis through this study.
- ✓ The similarities and differences in heavy metals concentrations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)) in Dams water where *O. niloticus* is cultured, Western Kordofan State, were investigated via laboratory analysis through this study.
- ✓ The correlation of heavy metals accumulation between fish organs and water samples were compared.
- ✓ Comparison of these heavy metals levels with recommended levels by FAO, WHO and other international organizations.

### 2.2 Fish Sampling

A total of 54 samples has been taken from marketable size (each three fish = one kg) *O. niloticus* cultured in Dams, 27 representative samples *O. niloticus* were randomly collected, 3 samples per organ (gills, liver and muscles) were taken.

### 2.3 Sample Preparation

Collected fish were gutted, scaled, fins removed and washed with clean, cold potable water, after that, Gills, Liver and Muscles were taken. Then, 5 grams per part were taken and transferred into

special sags and all sags were transferred to sterilized container (100 ml size).

### 2.4 Preservation of Samples

All collected samples were put into sterilized containers and preserved immediately in minced ice preservative container by means of layers (first minced ice layer then samples layer and ice layer and so on).

### 2.5 Water Sampling

A total of 18 water samples were taken from Dams where fish samples has been taken, 9 representative water samples per dam were randomly collected, 3 water samples per deep (shallow, middle and deep water). The samples were collected into sterilized water containers (100 ml size) and transferred immediately to the laboratory.

### 2.6 Heavy Metals Analysis

The fish samples were thawed to room temperature. All water and Fish samples were taken for the Heavy Metal analysis by both; furnace atomic absorption spectrometry and flame atomic absorption spectrometry according to [10].

$$2.1: \text{Heavy metal concentration } (\mu\text{g/g}) \\ = (\text{reading of atomic absorption} \times \text{volume of diluted solution} / \text{Weight of sample (g.)})$$

### 2.7 Statistical Analysis

The data were analysed using statistical package for Social Studies (SPSS version 17.0). One way analysis of variance (ANOVA) was used for means separation between localities and fish species. A P-value of  $\leq 0.05$  will be considered indicative of a statistically significant difference.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

The current study was conducted in two different localities have been selected in Western Kordofan State (Elsonout and Abu-zabad) to evaluate the similarities and differences in heavy metals concentrations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)) in three parts (liver, gills and muscles) of Tilapia fish (*Oreochromis niloticus*) cultured in Dams,

Western Kordofan State. Moreover, the study was intended to evaluate the similarities and differences in heavy metals concentrations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)) in Dams water where tilapia fish was cultured, Western Kordofan State. Furthermore, the evaluation was included the correlation of heavy metals accumulation between fish organs and water samples were compared. Finally, the evaluation was done for the comparison of these heavy metals levels with recommended levels by FAO, WHO and other international organizations. A total of 54 samples has been taken from two marketable size fish (gills; livers and muscles) of Tilapia fish (*Oreochromis niloticus*) cultured in Dams (Elsonout and Abu-zabad localities) were subjected to analysis Heavy Metals accumulations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)). Moreover, A total of 18 water samples were taken from Dams (shallow, middle and deep water) where fish samples has been taken. The data was subjected to SPSS using one way ANOVA.

#### Note

Shallow water is the surface of water column, where pelagic fish live it seen to more effected by air oxygen.

Medium water is the meddle of water column, where middle fish live, it is subjected to less air oxygen than surface.

Deep water is the end of water column where benthic fish live.

### 3.2 Discussion

#### 3.2.1 Heavy metals profile ( $\mu\text{g/g}$ ) of *Oreochromis niloticus* organs at Elsonout and Abu-Zabad localities

##### Zinc (Zn)

The results showed in Table 1 that, the level of Zn ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Elsonout locality was: (0.120, 0.099 and 0.106) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among gills, liver and muscles of *Oreochromis niloticus*. Gills were recorded a highest value of Zn whereas livers recorded the lowest value. However, it is clear that, the gills are the preference part for Zinc accumulation, muscles is become as second part preferred for Zinc accumulation, and liver is unlike for Zinc accumulation.

Also, Table 1 shows that, the level of Zn ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Abu-zabad locality was: (0.119, 0.097 and 0.074) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among gills, liver and muscles of *O. niloticus*. Concerning localities, Table 1 shows the levels of Zn ( $\mu\text{g/g}$ ) of *O. niloticus* at Elsonout and Abu-zabad localities were: (0.120, 0.098 and 0.090) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among gills, liver and muscles of *O. niloticus* according to localities.

However, the findings were lower than [11] were stated out that, the Zn concentrations in fish muscle ( $\mu\text{g/g}$ ) were range from 4.14 to 4.84 and 3.03 to 4.71 for *O. niloticus* and *B. bayad*, respectively. Also, the findings were agreed with [12] who studied heavy metals in *Oreochromis Niloticus* and *Bagrus Bayad*, from River Nile and Swamp Water, at Khartoum and Western Kordofan States, Sudan, and there were found that, Zinc was 0.11( $\mu\text{g/g}$ ).

##### Copper (Cu)

The results showed in Table 1 that, the level of Cu ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Elsonout locality was: (0.149, 0.137 and 0.122) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among Gills, Liver and Muscles of *O. niloticus*.

Also, shows Table 1 that, the level of Cu ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Abu-zabad locality was: (0.148, 0.136 and 0.121) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Cu among gills, liver and muscles of *O. niloticus*. Concerning localities Table 1 shows that, the level of Cu ( $\mu\text{g/g}$ ) of *Oreochromis niloticus* at Elsonout and Abu-zabad localities were: (0.150, 0.139 and 0.124) for Gills, Liver and Muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among gills, liver and muscles of *O. niloticus* according to localities.

Gills were recorded a highest value of Cu whereas Muscles recorded the lowest value. However, it is clear that, the gills are the preference part for Cu accumulation, muscles is become as second part preferred for Cu accumulation, and liver is unlike for Cu accumulation.

Table 1. Heavy Metals Profile ( $\mu\text{g/g}$ ) of Nile Tilapia according to Fish Organ and Locality

Localities	Heavy Metals												LS
	Zn P $\pm$ (SE = 0.01)			Cu $\pm$ (SE = 0.01)			Cd $\pm$ (SE = 0.001)			Pb $\pm$ (SE = 0.002)			
	Gills	Liver	Muscles	Gills	Liver	Muscles	Gills	Liver	Muscles	Gills	Liver	Muscles	
Elsonout	0.120 <sup>a</sup>	0.099 <sup>b</sup>	0.106 <sup>c</sup>	0.149 <sup>a</sup>	0.137 <sup>b</sup>	0.122 <sup>c</sup>	0.014 <sup>a</sup>	0.012 <sup>b</sup>	0.010 <sup>c</sup>	0.274 <sup>a</sup>	0.261 <sup>b</sup>	0.236 <sup>c</sup>	**
Abu-zabad	0.119 <sup>a</sup>	0.097 <sup>b</sup>	0.074 <sup>c</sup>	0.148 <sup>a</sup>	0.136 <sup>b</sup>	0.121 <sup>c</sup>	0.015 <sup>a</sup>	0.013 <sup>b</sup>	0.012 <sup>c</sup>	0.266 <sup>a</sup>	0.256 <sup>b</sup>	0.234 <sup>c</sup>	
Overall	0.120 <sup>a</sup>	0.098 <sup>b</sup>	0.090 <sup>c</sup>	0.150 <sup>a</sup>	0.139 <sup>b</sup>	0.124 <sup>c</sup>	0.015 <sup>a</sup>	0.013 <sup>b</sup>	0.011 <sup>c</sup>	0.275 <sup>a</sup>	0.262 <sup>b</sup>	0.245 <sup>c</sup>	
LS	**			**			**			**			
FAO/WHO (1989)	30			40			1.67			0.5			

*abc*  $\equiv$  means for each independent having different manuscript are significantly different.

*NS*  $\equiv$  no significant difference at ( $p > 0.05$ ).

\*\*  $\equiv$  highly significant difference at ( $p \leq 0.01$ ).

*LS*  $\equiv$  level of significant.

Table 2. Heavy Metals Profile ( $\mu\text{g/ml}$ ) of Water according to Locality and Water Depth, (SE = 0.0005)

Localities	Heavy Metals												LS
	Zn			Cu			Cd			Pb			
	Shallow	Medium	Deep	Shallow	Medium	Deep	Shallow	Medium	Deep	Shallow	Medium	Deep	
Elsonout	0.059 <sup>c</sup>	0.063 <sup>b</sup>	0.069 <sup>a</sup>	0.116	0.104	0.118	0.008 <sup>b</sup>	0.009 <sup>a</sup>	0.010 <sup>a</sup>	0.151 <sup>c</sup>	0.159 <sup>b</sup>	0.166 <sup>a</sup>	**
Abu-zabad	0.051 <sup>c</sup>	0.061 <sup>b</sup>	0.065 <sup>a</sup>	0.114	0.117	0.120	0.006 <sup>b</sup>	0.008 <sup>a</sup>	0.009 <sup>a</sup>	0.149 <sup>c</sup>	0.155 <sup>b</sup>	0.160 <sup>a</sup>	
Overall	0.055 <sup>c</sup>	0.062 <sup>b</sup>	0.067 <sup>a</sup>	0.110	0.110	0.119	0.007 <sup>b</sup>	0.008 <sup>a</sup>	0.009 <sup>a</sup>	0.150 <sup>c</sup>	0.157 <sup>b</sup>	0.163 <sup>a</sup>	
LS	**			NS			**			**			
FAO/WHO (2011)	3.00			0.100			0.003			0.200			
EC (2005)	--			--			0.003			0.010			

*abc*  $\equiv$  means for each independent having different manuscript are significantly different.

*NS*  $\equiv$  no significant difference at ( $p > 0.05$ ).

\*\*  $\equiv$  highly significant difference at ( $p \leq 0.01$ ).

*LS*  $\equiv$  level of significant.

The findings were agreed with [12] who studied heavy metals in *Oreochromis niloticus* and *Bagrus Bayad*, from River Nile and Swamp Water, at Khartoum and Western Kordofan States, Sudan, and there were found that, Cu was 0.09 ( $\mu\text{g/g}$ ). Furthermore, the findings in agreement with [13] who made evaluation of heavy metals level for *O. niloticus* liver and muscle in Nubian lake, Sudan, and he was pointed-out that, Cu level was 0.128 ( $\mu\text{g/g}$ ).

### Cadmium (Cd)

The results showed in Table 1 that, the level of Cd ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Elsonout locality was: (0.014, 0.012 and 0.010) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Cd among gills, liver and muscles of *Oreochromis niloticus*. Gills were recorded a highest value of Cd whereas muscles recorded the lowest value. Also, shows Table 1 that, the level of Cd ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Abu-zabad locality was: (0.015, 0.013 and 0.012) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Cd among gills, liver and muscles of *O. niloticus*. Concerning localities shows in Table 1 that, the level of Cd ( $\mu\text{g/g}$ ) of *O. niloticus* at Elsonout and Abu-zabad localities were: (0.015, 0.013 and 0.011) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among gills, liver and muscles of *O. niloticus* according to localities.

Gills were recorded a highest value of Cd whereas muscles recorded the lowest value.

The findings were agreed with [12] who studied heavy metals in *O. Niloticus* and *Bagrus Bayad*, from River Nile and Swamp Water, at Khartoum and Western Kordofan States, Sudan, and there were found that, Cd was 0.01 and 0.03 ( $\mu\text{g/g}$ ) for *O. niloticus* and *Bagrus bayad*, respectively.

However, the findings were lower than [14] and [15] were reported that, the Maximum permissible limit of Cd in fish muscle ( $\mu\text{g/g}$  dry wt.) is 1.67, 0.17 and 0.67, respectively.

### Lead (Pb)

The results showed in Table 1 that, the level of Pb ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Elsonout locality was: (0.274, 0.261 and 0.236) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Pb among Gills, Liver and Muscles of *O. niloticus*. Gills were

recorded a highest value of Pb whereas muscles recorded the lowest value. Also, shows Table 1 that, the level of Pb ( $\mu\text{g/g}$ ) of *O. niloticus* fish at Abu-zabad locality was: (0.266, 0.256 and 0.234) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Pb among gills, liver and muscles of *O. niloticus*. Concerning localities show in Table 1 that, the level of Pb ( $\mu\text{g/g}$ ) of *O. niloticus* at Elsonout and Abu-zabad localities were: (0.275, 0.262 and 0.245) for gills, liver and muscles, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among gills, liver and muscles of *O. niloticus* according to localities.

Gills were recorded a highest value of Pb whereas muscles recorded the lowest value.

Compared with other studies, we found that, the findings were lower than [11] were mentioned that, the Pd concentrations in fish muscle ( $\mu\text{g/g}$ ) were range from 4.20 to 5.69 and 3.11 to 5.02 for *O. niloticus* and *B. bayad*, respectively. However, the findings were greater than [12] who studied heavy metals in *O. Niloticus* and *Bagrus Bayad*, from River Nile and Swamp Water, at Khartoum and Western Kordofan States, Sudan, and there were found that, Pb was 0.15 and 0.17 ( $\mu\text{g/g}$ ) for *O. niloticus* and *Bagrus bayad*, respectively.

The findings shown in Table 1 that, there was a highly significant difference ( $P \leq 0.01$ ) in all heavy metals according to organs.

However, when we were compared the overall findings were figured-out that, gill were accumulated heavy metals more than liver and muscles in *O. niloticus* cultured in Elsonout and Abu-zabad localities Dams.

In this research, we observed the trend that different metals are accumulated at different concentration in various organs in each fish species (Table 1). The difference in the levels of accumulation in different organs of a fish can primarily be attributed to the differences in the physiological role of each organ. Other factors such as regulatory ability, behaviour and feeding habits may play a significant role in the accumulation differences in the different organs. Also the chemical nature of the metals ionic strength and pH tends to be a master variable in the accumulation process. In acidic conditions, there are enough hydrogen ions to occupy many of the negatively charged surfaces and little space is left to bind heavy metals, hence more heavy metals remain in the soluble phase. The

soluble form of heavy metals is thought to be more harmful because it is more easily transported and more readily available to aquatic organism. Gills contained the highest concentration of all the tested heavy metals, followed by liver, while the muscle tissues appeared to be the least preferred organ for the bioaccumulation of metals as the lowest metal concentration (Table 1) were detected in this tissue. The general order of heavy metals concentrations in various organs of the Nile tilapia used in this research can be represented (Table 1) as follows: Gills > Livers > muscle tissues. Higher metal concentrations in the gills could be due to the element complexation with the mucus that is virtually impossible to completely remove from the gill lamellae before prepared for analysis. Furthermore, the adsorption of metals onto the gills surface as the first target for pollutants in water could be a significant influence in the total metal levels of the gill. Target organs such as gills and livers are metabolically active parts that can accumulate heavy metals in higher levels, as shown in various fish species.

### 3.2.2 Heavy metals profile ( $\mu\text{g/ml}$ ) of water according to locality and water depth

#### Zinc (Zn)

The results showed in Table 2 that, the levels of Zn ( $\mu\text{g/ml}$ ) of Water Depth at Elsonout locality were: (0.059, 0.063 and 0.069) for shallow, medium and deep, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among water depth (shallow, medium and deep). Deep was recorded a highest value of Zn, whereas shallow recorded the lowest value.

Also, Table 2 shows that, the levels of Zn ( $\mu\text{g/ml}$ ) of water depth at Abu-zabad locality were: (0.051, 0.062 and 0.065) for shallow, medium and deep, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Zn among water depth (shallow, medium and deep). Deep was recorded a highest value of Zn, whereas Shallow recorded the lowest value. However, it is clear that, the Zinc accumulation is increase from shallow to the depth. The overall mean of Zn in two localities are 0.055, 0.062 and 0.067 ( $\mu\text{g/ml}$ ) for shallow, medium and deep, respectively.

The results of this work is in the range of [16] and [17] who were found the concentrations of Zn in water of Lake Victoria were range from 0.01-5.62 mg/L.

However, these findings is in the range of [18], who was presented the levels of heavy metals in water and mentioned that, Zn was 0.50 mg/L. and less than [19] who was figured-out that, the heavy metals in water and stated that, Zn were 2.00, 0.05 and 5.00 mg/L. Furthermore, the current results is less than [20] assessed the trace metals in lakes water and pointed-out that, Zn was 2.00 mg/L.

#### Copper (Cu)

The results showed in Table 2 that, the levels of Cu ( $\mu\text{g/ml}$ ) of water depth at Elsonout locality were: (0.116, 0.104 and 0.118) for shallow, medium and deep, respectively. There was no significant difference ( $P > 0.05$ ) in Zn among water depth (shallow, medium and deep). However, Deep was recorded a highest value of Cu, whereas Medium recorded the lowest value.

Also, Table 2 shows that, the levels of Cu ( $\mu\text{g/ml}$ ) of water depth at Abu-zabad locality were: (0.114, 0.117 and 0.120) for shallow, medium and deep, respectively. There was no significant difference ( $P > 0.05$ ) in Cu among water depth (shallow, medium and deep). Anyway, Deep was recorded a highest value of Cu, whereas Shallow recorded the lowest value. The overall mean of Cu in two localities are 0.110, 0.110 and 0.119 ( $\mu\text{g/ml}$ ) for shallow, medium and deep, respectively.

The findings of the work are greater than [16] and [17] who were found the concentrations of Cu in water of Lake Victoria were 0.01 mg/L. however, the findings are in range of USEPA [18], who were stated-out that, the permissible level of Cu in Water was 1.50 mg/L. [19] Figured-out that, the permissible level of Cu in water was 2.00 mg/L. Furthermore, these results are greater than [20] who was assessed the trace metals in lakes water and pointed-out that, means of Cu was 0.20 mg/l.

#### Cadmium (Cd)

The results showed in Table 2 that, the levels of Cd ( $\mu\text{g/ml}$ ) of water depth at Elsonout locality were: (0.008, 0.009 and 0.010) for shallow, medium and deep, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Cu among water depth (shallow, medium and deep). However, deep water was recorded a highest value of Cd, whereas Medium water recorded the lowest value.

Also, Table 2 shows that, the levels of Cd ( $\mu\text{g/ml}$ ) of water depth at Abu-zabad locality were: (0.006, 0.008 and 0.009) for shallow, medium and deep, respectively. There was a highly significant difference ( $P \leq 0.01$ ) in Cd among water depth (shallow, medium and deep). The overall mean of Cd in two localities are 0.007, 0.008 and 0.009 ( $\mu\text{g/ml}$ ) for shallow, medium and deep, respectively.

The findings were agreed with [21] who were studied some heavy metals concentration in Water, Muscles and gills of *Tilapia niloticus* as biological indicator of Manzala Lake pollution in Egypt; he was figured out that; Cd in water 0.070 to 0.140 mg/L. however, the results of the current research were in the permissible limits which were figured-out by [22] who were represented the permissible limits of heavy metals for water was Cd 0.003 mg/L. Also, represented the permissible limits of heavy metals in soil was Cd 0.3 mg/kg.

#### Lead (Pb)

The results showed in Table 2 that, the levels of Pb ( $\mu\text{g/ml}$ ) of water depth at Elsonout locality were: (0.151, 0.159 and 0.166) for shallow, medium and deep, respectively. There was no significant difference ( $P > 0.05$ ) in Zn among water depth. However, deep was recorded a highest value of Pb, whereas medium recorded the lowest value.

Also, Table 2 shows that, the levels of Pb ( $\mu\text{g/ml}$ ) of water depth at Abu-zabad locality were: (0.149, 0.155 and 0.160) for shallow, medium and deep, respectively. There was no significant difference ( $P > 0.05$ ) in Cu among water depth. Anyway, deep was recorded a highest value of Pb, whereas shallow recorded the lowest value. The overall mean of Pb in two localities are 0.150, 0.157 and 0.163 ( $\mu\text{g/ml}$ ) for shallow, medium and deep, respectively.

The findings were in agreement with [16] and [17] who were found the concentrations of Pb in water of Lake Victoria were in range of 0.35-0.36-0.63 mg/L. however, the results were so greater than [18] and [19], who were represented the levels of heavy metals in water and figured out that, Pb was 0.05 and 0.05 mg/L, respectively.

Furthermore, these findings were agreed with [21] who were studied some heavy metals concentration in water, muscles and gills of

*Tilapia niloticus* as Biological Indicator of Manzala Lake pollution in Egypt; he was figured out that Pb in water were ranged from: 0.050 to 0.310 mg/L. In addition that, the results were in the range of [22] who were represented the permissible limits of Pb for water was Pb 0.010 mg/L. Also, represented the permissible limits of Pb in Soil was Pb 0.2 mg/kg.

#### 4. RECOMMENDATIONS

- ✓ According to the findings, we recommend that, people of Western Kordofan State should eat *O. niloticus* and there was no heavy metal hazards found in these fish.
- ✓ Further researches are needed for other cultured fish in Western Kordofan Dams to check the heavy metals levels.
- ✓ Other heavy metals should be checked in cultured fish and water to be compared with their levels in fish.

#### 5. CONCLUSION

The current study was conducted in two different localities have been selected in Western Kordofan State (Elsonout and Abu-zabad) to evaluate the similarities and differences in heavy metals concentrations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)) in three parts (liver, gills and muscles) of *Tilapia* fish (*O. niloticus*) cultured in Dams, Western Kordofan State. Moreover, the study was intended to evaluate the similarities and differences in heavy metals concentrations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)) in Dams water where *Tilapia* fish was cultured, Western Kordofan State. Furthermore, the evaluation was included the correlation of heavy metals accumulation between fish organs and water samples were compared. Finally, the evaluation was done for the comparison of these heavy metals levels with recommended levels by FAO, WHO and other international organizations. A total of 54 samples has been taken from two marketable size fish (gills; livers and muscles) of *Tilapia* fish (*Oreochromis niloticus*) cultured in Dams (Elsonout and Abu-zabad localities) were subjected to analysis heavy metals accumulations (Copper (Cu), Cadmium (Cd), Zinc (Zn), and Lead (Pb)). Moreover, A total of 18 water samples were taken from Dams (shallow, middle and deep water) where fish samples has been taken. The data was subjected to SPSS using one way ANOVA. The findings of this work were revealed that, There were highly significant differences ( $P \leq 0.01$ ) in all heavy metals among



gills, liver and muscles of *O. niloticus* cultured in Dams (Elsonout and Abu-zabad localities). And there was a highly significant difference ( $P \leq 0.01$ ) in all heavy metals among gills, liver and muscles of *O. niloticus* according to localities. Anyway, when compared fish organs; we found that, Gills were recorded the maximum figures in all heavy metals followed by livers and the minimum figures were recorded by muscles. The results of this study were in the permissible levels recommended by international organizations. According to the findings, we recommend that, people of western Kordofan State should eat *O. niloticus* and there was no heavy metal hazards found in these fish.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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