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Bioaccumulation of some trace element (Zn, Fe, Pb and Cu) in the gills and tissues of *Clarias gariepinus* and *Oreochromis niloticus* in River Ogbese, Ondo State, Nigeria

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River Ogbese support many human activities (domestic, agricultural, fishing, industrial activities) leading to its extensive contamination and accumulation of heavy metals which can cause both environmental and public health hazard. In order to ascertain the quality of the river, a study was carried out to determine some trace element concentration (Zn, Fe, Pb and Cu) in gills and tissues of *Clarias gariepinus* and *Oreochromis niloticus*, being the most dominant fish species in the water body. Thus, ten samples each of *C. gariepinus* (21.0 – 37.4TL, 171.7 – 305.8 g) and *O. niloticus* (15.2 – 20.6 TL, 70.8 – 150.5 g) were collected from River Ogbese and the concentration of Zinc, Iron, Lead and Copper were analyzed both in the gills and the flesh using atomic absorption spectrophotometry (AAS). The study revealed that the highest concentration of iron was obtained in the gills and tissues of both fishes; *C. gariepinus* (gill - 6.70-4.23±0.72, tissue - 6.84 - 5.27±0.44) and *O. niloticus* (gill - 6.79 - 1.89±1.42, tissue - 5.83-4.27±0.58). The metal concentration occurred in the order Fe>Zn>Cu>Pb. In general, accumulation of the essential elements; Zn, Fe, Cu were higher than the non-essential elements; Pb. This could be due to the fact that these essential elements are naturally abundant in Nigeria soil. The bioaccumulation of zinc and lead are significant (P>0.05) in the tissues of both species while iron varies significantly (P>0.05) in their gills. There is no significant variation (P<0.05) observed among zinc, lead and copper accumulated in the gills of both species.

Key words: River Ogbese, heavy metals, *Clarias gariepinus* and *Oreochromis niloticus*.

INTRODUCTION

Metals such as Fe, Cu and Zn are generally regarded as essential trace metals in view of their valuable role for metabolic activities in organisms, other metals like Cd, Pb, Ni and Hg exhibit extreme toxicity even at trace levels (Merian, 1991; DWAF, 1996). However, it is of interest to note that most essential metals are toxic when supplied in concentrations in excess of the optimum levels. Tam and Wong (1995) stated that heavy metal contamination

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in aquatic environments is of critical concern due to the toxicity of metals and their accumulation in aquatic habitats. River Ogbese is one of the prominent water body in Ondo State, Nigeria, the main uses of the river in the catchments include domestic, recreational (e.g. swimming) and fishing. Also, domestic, industrial and agricultural wastes are dumped into the river, as such causing contamination and accumulation of metals which could bio-accumulate in the aquatic biota. Among the aquatic fauna, fish is the most susceptible to heavy metal toxicants (Nwaedozie, 1998) and are more vulnerable to metal contamination than any other aquatic fauna. As a result, fishes are considered as better specimens for use in the investigation of pollutant loads than water samples because of the significant levels of metals they bioaccumulate.

Significant heavy metal levels were recorded in fishes of Warri River (Atuma and Egborge, 1986); Kolo creek, fish and shellfish of the Niger Delta (Kakulu et al., 1987); water, sediment and Tilapia zilli from Kolo creek, Ogbia, Bayelsa, (Ebenezer and Eremasi, 2012). Data provided by Agada (1994) show evidence of selected heavy metal contamination of *Chrysicthys nigrodigitatus* (catfish) and *Pseudotolithus elongatus* (Croaker) respectively. Also, Sani (2011) examined the concentration of heavy metal in tissues of Tilapia and Catfishes. Similarly, this study is undertaken to determine the concentration of heavy metal in gills and tissue of *Clarias gariepinus* and *Oreochromis niloticus* in River Ogbese. *C. gariepinus* and *O. niloticus* are of great commercial importance because they are widely consumed freshwater fish in Nigeria (Olaifa et al., 2004) and the most dominant species in the River. It is therefore a good choice to study their susceptibility to environmental contaminants, particularly the heavy metals so that the result can provide baseline data on the current pollution status of this river and to predict the safety of their consumption in the environment.

MATERIALS AND METHODS

Study area

River Ogbese lies between longtitude 5°26' and 6°34' and latitude 6°43'E and 7°17' E. The River runs through Ogbese town, a town which is about five kilometres from Akure, in Akure North Local Government Area of Ondo State, Nigeria. River Ogbese is one of the major perennial rivers in South Western Nigeria; it took its source from Awo Ekiti in Ekiti State. It flows for approximately 22 km from its source to meet River Ose which is 265 km long and discharges into the Atlantic Ocean through an intricate series of creeks and lagoons (Figure 1).

Samples collection

Fish samples were collected from fishermen in River Ogbese using gillnets which were set over-night. The fishes were transported to the laboratory in a picnic box with some quantity of water (from the river). Each fish was properly cleaned by rinsing with distilled water to remove debris, planktons and other external adherent. The samples were then dried, wrapped in aluminium foil and then frozen at –10°C prior to analysis.

Sample preparation

The fish samples were defrosted for two hours and the scales were removed from the tilapia using a plastic knife. Catfish (*C. gariepinus*) and Tilapia (*O. niloticus*) were dissected to remove organs (tissue and gills) according to FAO methods cited by Dybem (1983). The fish parts were dried at 80°C for 2 h in Gallenkamp hot box oven and then blended in an electric moulienx blender. Approximately, 0.5 g each of sample was weighed and ashed at 550°C for 24 h in an electric muffle furnace. The ash was diluted in 5 ml of concentrated hydrochloric acid (HCl) and concentrated nitric acid (HNO_3) mixed at ratio 3:1. The diluents is left for some minutes for proper digestion in a beaker of 50 ml, distilled water was added to the diluents to make up to 100 ml in volumetric flask. This was then filtered into a conical flask with filter paper. The levels of heavy metals such as iron, copper, lead and zinc were determined using Shimadzu AA-680 Japan Atomic Absorption Spectrometer flame emission spectrometer fitted with GFA – 4B Graphite Furnace, according to AOAC (1995) and the results were given in milligram per litre (mg/L).

Data obtained from the experiments were analyzed and the results were expressed as mean ± S.D. The results were evaluated using Student's test and two way correlation. Values of $p < 0.005$ were considered statistically significant.

RESULTS AND DISCUSSION

The concentration of heavy metals; (Copper, Lead, Zinc and Iron) in the gills and tissues of *C. gariepinus* and *O. niloticus* from River Ogbese indicates a level of metal pollution. This may be attributed to the various human activities, such as discharge of untreated sewage and uses of industrial materials that contain metals or the ability of the sediment to act as sink (Olowu et al., 2010). The presence of these elements in both the gills and tissues of fish in the study area agrees with studies carried out in some water bodies in Nigeria as presented in Table 1. Hence, heavy metal contamination affect the aquatic life of fresh water fish, therefore, proper monitoring of the aquatic systems is of great importance since the continuous bioaccumulation of these metals will lead to health hazard of the consumer of these economically important fish species from the water body. The mean concentration of Zinc (Zn), Iron (Fe), Copper (Cu) and lead (Pb) obtained in the gills and tissues of the two fish species are presented in Tables 2 and 3. The result obtained from the determination of Zn, Fe, Cu and Pb in the gills of the two fish species are represented in Figure 1. For tissue, the results are represented in Figures 2 and 3

Concentration of trace element in the gills and tissue of *C. gariepinus*

Table 2 shows the concentration pattern of trace elements in *C. gariepinus*, following the order Fe<Zn<Cu<Pb. The

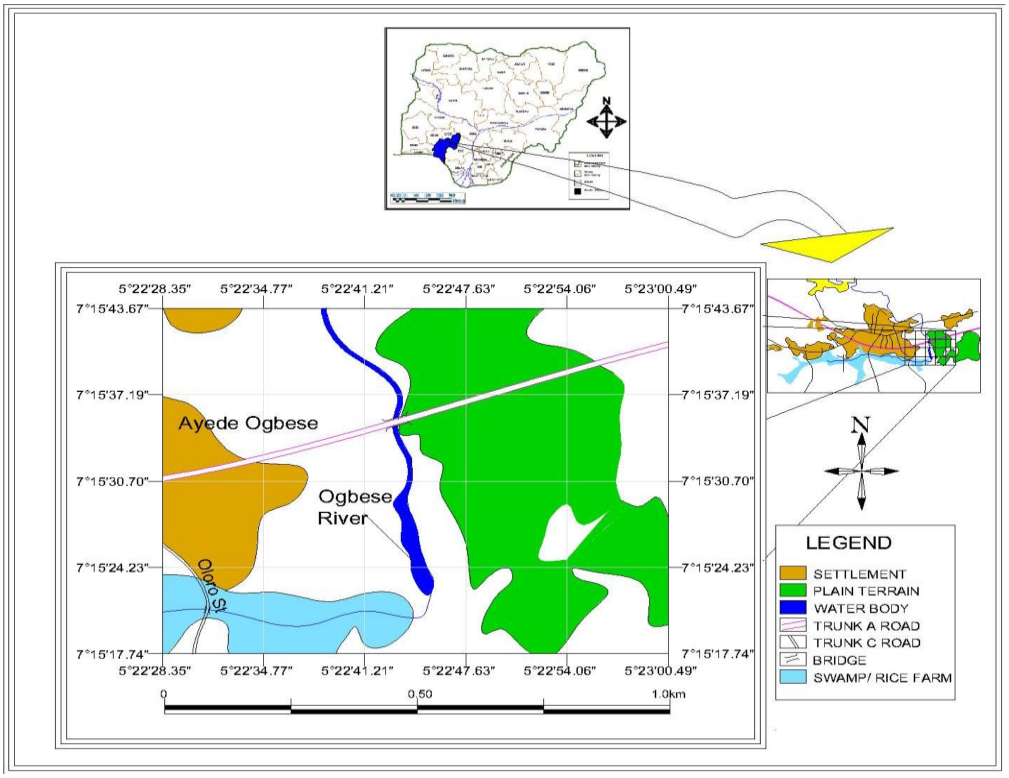


Figure 1. The map of River Ogbese.

result shows that Iron has the highest values in the tissue and gills of *C. gariepinus* (6.84±0.44 and 6.70±1.40). Although the concentration of iron was more in the tissue than the gills; an indication of bioaccumulation of Fe in the flesh of this species over time. Adeyeye and Ayoola (2012) revealed in their study of heavy metals concentration in some organs of *C. gariepinus* from Eko-Ende Dam, Ikirun, Nigeria, iron was the most abundant of all the metals considered. The result showed that the bioaccumulation of Zn in the tissue is more than that of the gills. The range of Zn was 2.84±0.28 and 1.44±0.37 in tissue and gills respectively. Thus, heavy metals when discharged into the river enter the food chain and accumulate into the fish body as observed during this study.

According to Allen-Gill and Martynov (1995), high levels of copper and zinc in fish muscles appear to be due to high levels of binding proteins in the muscles. Also, the high concentrations of iron and zinc in the fish parts could be associated to the fact that these metals are naturally abundant in Nigeria soils and since the source of metal depositories is the aquatic system (Olowu et al., 2010). The accumulation of iron is statistically significant in gills (>0.005) whereas zinc and lead vary significantly in the tissue. The concentration of copper in the tissue (1.68±0.23) is higher than the gills. This agrees with Sani (2011) who recorded highest copper concentration in the tissues of catfish than the gills and bones. On the contrarily, Yilmaz et al. (2007) reported that in *Leuciscus cephalus* and *Lepornis gibbosus*, copper, cadmium, and cobalt accumulations were higher in the liver and gills than in the fish muscle. It is generally accepted that heavy metal uptake occurs mainly from water, food and sediment. However, the efficiency may differ in relation to ecological needs, metabolism and the contamination gradients of water, food and sediment, as well as other factors such as salinity, temperature and interacting agents (Pagenkopf, 1983).

The concentration of lead is higher in the gills (1.40±0.44) than the tissues (0.9±0.19) as agrees with Uzairu et al. (2009) in their study of the concentration levels of trace metals in fish and sediments from Kubani River, Northern Nigeria. However, the concentration of metals in gills reflects their concentration in water where the fish lives. Nevertheless, the presence of higher amounts of heavy metals in any parts of the body will definitely induce changes in biochemical metabolisms and other induced stresses.

Concentration of trace element in the gills and tissue of *O. niloticus*

The concentration pattern of trace elements in the gills and tissues of *O. niloticus* follows the order Fe>Cu>Zn>Pb. Iron has the highest values in the tissue

Table 1. Heavy metals concentration in fish (mg/kg) in studies from other locations in Nigeria.

Location/ Fish	Organ		Zn	Cu	Fe	Pb	Reference
Ogun River, Nigeria	Liver		19.75	4.70	--	3.40	Farombi et al. (2007)
(*Clarias gariepinus)*	Gill		20.35	4.55	--	2.40	
Kidney	5.00	--	3.35				
Heart	2.19	--	1.69				
Alau Dam, Maiduguri, Nigeria	Liver		0.52	0.44	0.40	0.40	Dimari et al. (2008)
(*Tilapia gallier)*		Gill	0.36	0.63	0.33	0.53	
Intestine	0.36	0.34	0.12				
Okumeshi River, Delta, Nig.	Liver	--		--	--	0.01	Ekeanyanwu et al. (2010)
(Tilapia)	Gill		--	--	--	<0.01	
Muscle	--	--	<0.01				
Kubani River, Zaria, Nigeria	Liver	49.56		19.31	--	0.28	Uzairu et al. (2009)
a. (*Clarias gariepinus)*	Gill		20.05	1.87	--	0.12	
Muscle	0.24	--	0.04				
b. (*Oreochromis niloticus)*	Liver	65.72		40.11	--	0.76	
Gill	5.32	--	0.24				
Muscle	1.15	--	0.02				
Lake Chad, Nigeria	Liver		0.54	0.52	0.34	0.32	Akan et al. (2009)
a. (*Tilapia zilli)*		Gill	0.33	0.45	0.28	0.03	
Kidney	0.31	0.15	0.01				
b. (*Clarias anguillaris*)	Liver		0.31	0.32	0.26	0.15	
Gill	0.32	0.24	0.10				
Kidney	0.21	0.12	0.02				
Henshaw Beach, Calabar, Nigeria	Liver		0.257	--	--	0.173	Edem et al. (2009)
(*Oreochromis niloticus)*	Gills		0.198	--	--	0.133	
(Group A: 29 cm size)			0.079	--	--	0.053	
Tiga Dam, Kano, Nig	Gill		-	0.00		2.30	Sani (2011)
(a) Tilapia		Muscle	-	0.11		2.00	
Gill	0.45		5.20				
(b) Catfish		Muscle		0.51		7.20	
Eko-Ende Dam, Ikirun, Nigeria							
(*Clarias gariepinus)*	Gill		1.45	0.68	11.64	ND	Adeyeye and Ayoola (2012)
Muscle	0.15	6.99	ND				
FAO/WHO Limits			40	30		0.5	FAO/WHO (1989)
IAEA – 407				3.28	146	0.12	Wyse et al. (2005)

and gills of *O. niloticus* (5.83±0.58 and 6.79±1.42 respectively). Although higher concentration was recorded in gills than the tissue which could be attributed to the fact that water always passes through mouth and gill when filtered, which agrees with the findings of Olowu et al. (2010). Dural et al. (2007) and Ploetz et al. (2007) reported highest levels of cadmium, lead, copper, zinc and iron in the liver and gills of fish species viz. *Sparus aurata, Dicentrachus labrax*, *Mugil cephalus* and *Scomberomorus cavalla*. The concentration of copper in the tissue of *O. niloticus* (4.46±1.48) is higher than the gills (1.44±0.12 and 2.86±0.51). This agrees with Sani

Table 2. Concentration of trace element in the gills and tissue of catfish (*C. gariepinus*).

Fish species	Zn			Fe			Pb			Cu		
	Max	**Min**	**Std ±**	**Max**	**Min**	**Std±**	**Max**	**Min**	**Std±**	**Max**	**Min**	**Std±**
Clarias gariepinus (tissue)	2.84	2.00	0.28	6.84	5.27	0.44	0.90	0.30	0.19	1.68	1.00	0.23
Clarias gariepinus (gills)	1.44	0.27	0.37	6.70	4.23	0.72	1.40	0.1	0.44	1.44	1.10	0.12

Table 3. Concentration of trace element in the tissue and gills of tilapia (*O. niloticus*).

Fish species	Zn			Fe			Pb			Cu		
	Max	**Min**	**Std±**	**Max**	**Min**	**Std±**	**Max**	**Min**	**Std±**	**Max**	**Min**	**Std±**
Oreochromis niloticus (tissue)	2.45	0.54	0.53	5.83	4.27	0.58	1.00	0.10	0.33	4.46	0.51	1.48
Oreochromis niloticus (gills)	1.87	0.40	0.35	6.79	1.89	1.42	1.50	0.00	0.45	2.86	1.20	0.51

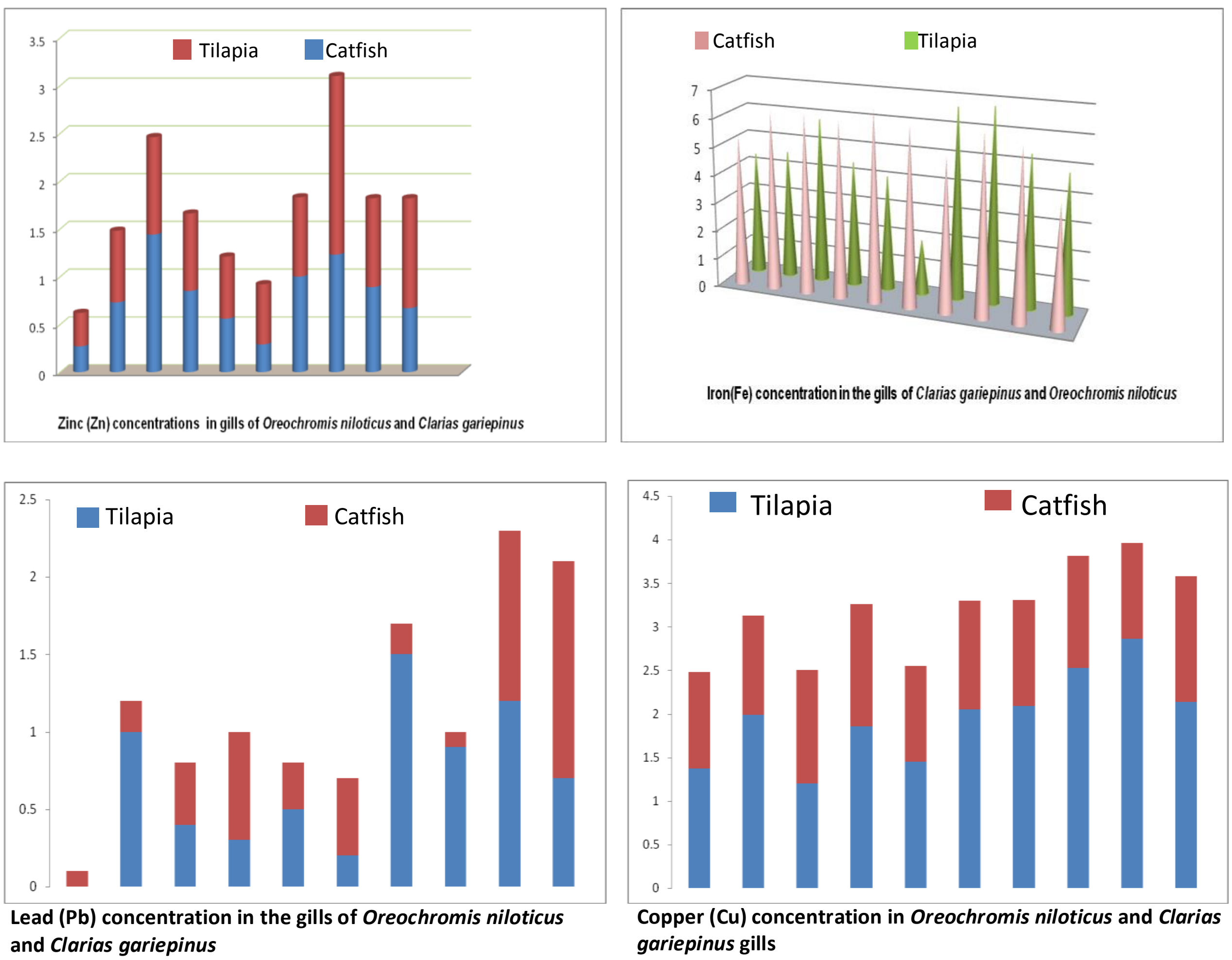
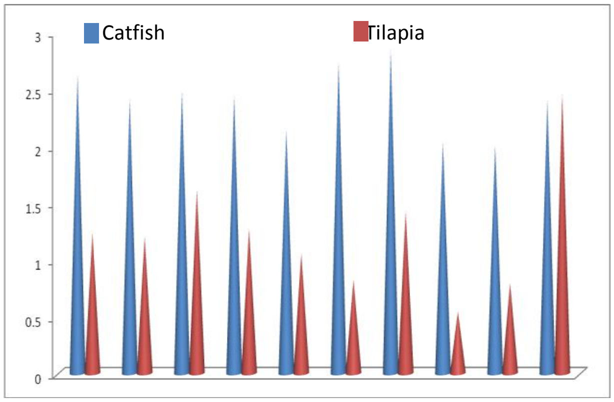
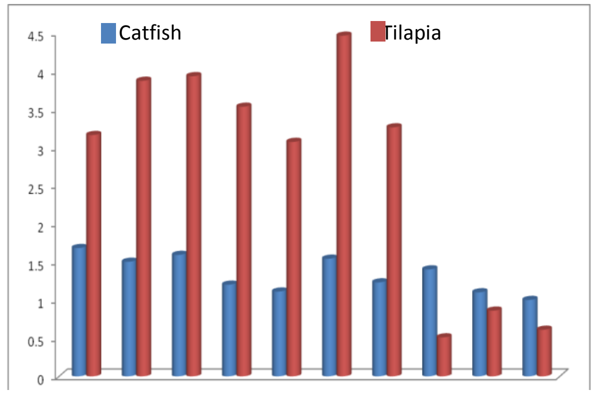


Figure 2. Concentration of trace element in gills of *O. niloticus* and *C. gariepinus*.

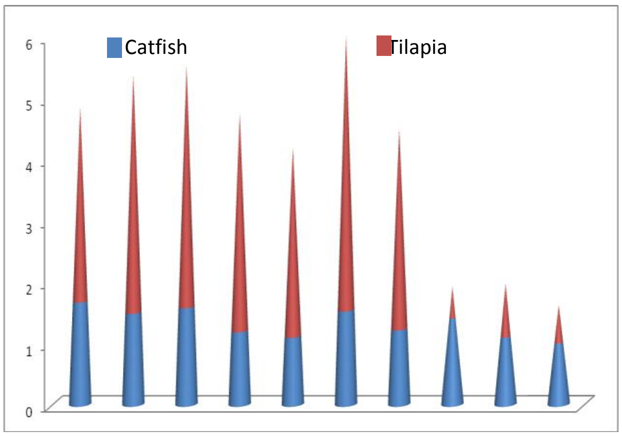
(2011) having the concentration of Cu in gills less than that of the tissue in tilapia. The high Cu concentration in the study exceeded the 1.5 uglg Cu/L allowable level in drinking water in Nigeria (FEPA, 1991). The Cu concentration in the gills and muscle tissues is comparable with the report of Ebenezer and Eremasi (2012). This is an indication that most Copper minerals are relatively insoluble. Naturally, Copper is often not a



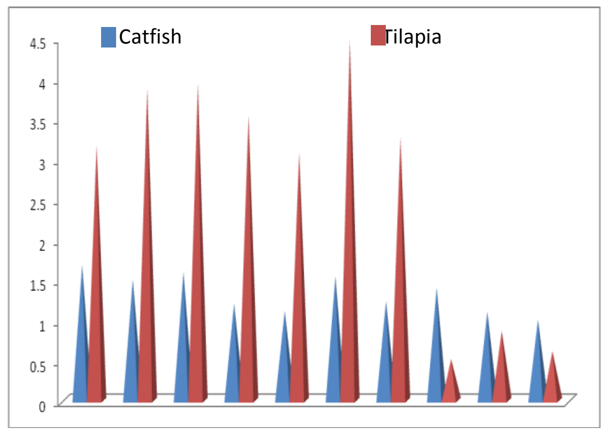
Zinc (Zn) concentration in *Clarias gariepinus* and *Oreochromis niloticus* tissues



Iron (Fe) concentration in *Clarias gariepinus* and *Oreochromis niloticus* tissues



Lead (Pb) concentration in *Clarias gariepinus* and *Oreochromis niloticus* tissues



Copper (Cu) concentration in *Clarias gariepinus* and *Oreochromis niloticus* tissues

Figure 3. Concentration of trace element in tissue of *O. niloticus* and *C. gariepinus*.

threat to humans except when present at abnormally high values, where it causes anaemia, disorder of bones and connective tissues and liver damage. The toxicity depends upon the hardness and pH of the water. It is more toxic in soft water with low alkalinity (Taha, 2004). The Zn values range between 2.45±0.53 and 1.87±0.37 in tissue and gills respectively.

The result showed that the concentration of Zn in the tissue is more than that of the gills as shown in Figures 1 and 2. Alabaster and Lloyd (1980) stated that zinc has low toxicity to man, but relatively high toxicity to fish. The appreciable levels recorded in the *O. niloticus* in this study would therefore be a serious cause for concern.The accumulation of lead is higher in the gills of *O. niloticus* (1.50±0.45) than the tissue (1.0 ±0.33). The level of Pb recorded in this study is within the allowable limits of 2.0 mg/Pb/g. The higher level of Pb in the gills than in the muscle tissues indicated that the gill is the primary site for Pb uptake in fish. This observation is consistent with Yousalfzai and Shakoori (2008). There had been a strong relationship between gill metal burden and toxicity (Playle et al., 1993; DiToro et al., 2001). The bioaccumulation of Pb by fish may create detrimental effects on fisheries resources and could constitute a considerably health hazard, to man. Lead reduces reproductive capacity (Wangboje and Oronsaye, 2001) while the consumption of the fish lead – polluted fishes by man interferes with heamoglobin synthesis. In severe cases; Pb poisoning may lead to encephalopathy anaemia, renal problems and death (Lawson, 1989).

Conflict of Interests

The author(s) have not declared any conflict of interests.

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