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ASSESSMENT OF HEAVY METALS IN DIFFERENT BODY PARTS OF *Sarotherodon galillaeus* FROM ILO-IDIMU RIVER, OTA OGUN STATE, NIGERIA

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Abstract:

Ilo-Idimu River is a tropical zone lying between 60.47ºN of the equator and 20.33ºE, and 30.18ºE of the Greenwich meridian. The aim of this research is to determine the concentration of heavy metals in *Sarotherodon galilaeus*; a predominant fish species in Ilo-Idimu River, and its public health significance. Water samples were collected from the River at different locations and depth. Samples were also taken with the use of dissecting instruments from the scale, skin, flesh, gill, and gut of *S. galilaeus*. Atomic Absorption Spectrophotometer was used to determine the concentration of heavy metals in the water samples and various body parts of the fish. From the result obtained, the levels of heavy metals concentrations ranged between 0.00-3.14, 0.00-2.18, 0.52-3.08, 0.00-0.68 and 0.00-1.48 mg/kg in the gill, flesh, gut, skin and scale respectively. The highest level of heavy metals was recorded in the gill while the lowest was recorded in the skin. The concentration of each of the heavy metals was significantly different across body parts ($P<0.05$) except lead. Concentration of most of these heavy metals exceeded the maximum permissible limit. Our results indicated that there is inherent danger in consuming fishes from Ilo-Idimu river.

Keywords: *Sarotherodon galilaeus, assessment,* heavy metals, Ilo-Idimu River, Atomic Absorption Spectrophotometer

Introduction

Pollution of the aquatic environment is a serious and growing problem throughout the world. Increasing number and amount of industrial, agricultural and commercial chemicals discharged into the aquatic environment have led to various deleterious effects on the aquatic organisms, including fish. Heavy metals contamination of aquatic ecosystem has attracted the attention of several investigators in both the developed and developing countries of the world. The fact that heavy metals cannot be destroyed through biological degradation; their ability to accumulate in the environment make them deleterious to the aquatic environment and consequently, to man. Rivers represent the most complex aquatic systems in terms of transport and interactions of heavy metals with geochemical and biological processes. It was also observed that freshwater fish represent an important source of protein to human. Nevertheless, indiscriminate discharge of domestic, agricultural and industrial effluent into the water body limits its effective natural production and availability (Ogbuagu *et al,* 2005).

In a polluted environment, especially industrial area where effluent is being discharged regularly into the streams, from where it flows down to the river, there is a high possibility of heavy metal accumulation. Most of these metals are very poisonous and can have lethal effects on fish, other aquatic living resources and man when they find their way into the food chain. Some of these metals get into the river through metal scrapes, dissolved metals and their salts, loose enamel, glasses etc (Okonkwo and Eboatu, 1999). Examples of these heavy metals include mercury, cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), zinc (Zn) etc. These metals can cause specific health problems. For instance, Cd causes kidney malfunctioning leading to hypertension (Okonkwo and Eboatu, 1999). Furthermore, exposure to Pb may result in human breast lesion (Siqddiqui *et al.,* 2006). Accumulation of higher concentration of heavy metals could predispose animals to illness (Harper *et al*., 1999). Therefore, there is a global call for research to determine the pollutant level, especially heavy metals in aquatic and terrestrial animals since people depend mainly on these animals as source of protein.

There have been previous works on investigation of heavy metals concentration in adjourning water bodies such as Badagry and Epe lagoons in Lagos, where Olowu *et al* (2010) had carried out several researches on determination of heavy metals in fish tissues, water, and sediments. But to the best of our knowledge, there has been no reported work in literature on investigation of heavy metal in Ilo-Idimu River.

This river is located in a low land, and by gravity effluent from the neighbouring industries and domestic sewage run down into it. The health hazard which the people in this community are exposed to, especially those who depend on the living aquatic resources from this river prompted this investigation on assessment of heavy metal concentration in *S. galilaeus*; a predominant fish species in Ilo-Idimu River, and its public health significance.

Materials and Methods

Study area

The study area is Ilo-Idimu river, Sango-Ota, Ogun State. The river is located in Ado-Odo/Ota Local Government Area. The area is a tropical zone lying between 60.47°N of the equator and 20.33°E, and 30.18°E of the Greenwich meridian. The river is also at the boundary between Lagos and Ogun State, Nigeria.

Sampling

Samples of *S. galilaeus* were obtained from various locations at Ilo-Idimu river, Ota which covers different environmental conditions. The sampling locations include the upper region of the river, the middle and the lower region. However, this sampling was not intended to differentiate or compare fishes in each of these locations as regard heavy metals, rather this regional sampling was only done for the purpose of sampling only, because fish is a migratory animal. The weight of the fish samples ranged from 30.98-56.23 g, the standard length from 9.78-15.00 cm and the head length from 2.86-3.55 cm.

Determination of heavy metals

Fe, Zn, Cu and Pb were determined using AOAC (1990) method. Two grams (2 g) of each of the samples were heated in a muffle furnace at 600^0C until it changed to ash. Thirty millilitres (30ml) of 0.1M H_2SO_4 was used to digests the ash, and the solution was made up to 100ml with de-ionized water and then filtered. The concentrations of these heavy metals in the scale, skin, flesh, gill and gut of *S. galilaeus* were measured by AAS; model 210 VGP at the Central Teaching and Research Laboratory of Bells University of Technology, Ota. The instrument setting and operational conditions were done in accordance with the manufacturers' specifications. Results were expressed in mg/kg dry weight for the body parts and mg/litre for the water samples.

Statistical analysis

The values of heavy metal concentration in water and fish samples were subject to a one-way analysis of variance (ANOVA) using SPSS 18.0 statistics for significance evaluation.

Results and Discussion

Table 1. shows the levels of heavy metals in the water and body parts (scale, skin, flesh, gill and gut) of *S. galilaeus* from Ilo-Idimu River. Heavy metals were found at various level of accumulation in the studied fish. The concentrations of heavy metal in water were measured in milligrams per litre while their concentrations in the fish samples were measured in milligram per kilogram.

Table 1. Mean concentration of heavy metals in the water and in different body parts of *S. galileaus* from Ilo-Idimu river, Ota

Heavy metals	Water (mg/L)	Gill (mg/kg)	Flesh (mg/kg)	Gut (mg/kg)	Skin (mg/kg)	Scale (mg/kg)
Zinc	0.24 ± 0.01^a	0.35 ± 0.02^b	0.53 ± 0.02^b	0.52 ± 0.01^b	0.57 ± 0.01^b	0.94 ± 0.02^b
Iron	1.05 ± 0.57^a	3.14 ± 0.01^b	0.64 ± 0.01^a	3.07 ± 0.02^b	0.64 ± 0.03^a	0.94 ± 0.02^a
Lead	1.08 ± 0.32^a	0.00 ± 0.00^b	0.00 ± 0.00^b	0.68 ± 0.01^a	0.00 ± 0.00^b	0.00 ± 0.00^b
Copper	0.25 ± 0.04^a	1.71 ± 0.03^b	2.28 ± 0.01^b	1.22 ± 0.01^b	0.64 ± 0.02^b	1.69 ± 0.01^b

Foot note:

- for water and each body part separately, mean ± S.D with superscript of the same alphabet shows no significant difference ($P>0.05$)
- for water and each body part separately, mean ± S.D. with superscript of different alphabet shows that there was significant difference ($P<0.05$)

Table 2. Recommended limit by National and International organisations on safety standard

	Water (mg/L)		Fish (mg/g)	
Metals	FDA	WHO	EPA	WHO
Pb	0.005	0.01	0.05	1.5
Zn	-	3.0	5.0	150
Cu	1.0	1-2	1.0	-
Fe	-	0.3	0.1	-

Source: WHO (1986); EPA and FDA (1976) as reported by Opanuwa *et al* (2012)

The level of heavy metal pollution in the water and their uptake by *S. galilaeus*; a predominant fish species in Ilo-Idimu river was determined in this study. According to the result obtained, the levels of heavy metals ranged between 0.00-3.14, 0.00-2.18, 0.52-3.08, 0.00-0.68 and 0.00-1.48 mg/kg in the gill, flesh, gut, skin and scale respectively. This result shows that the highest level of heavy metals was recorded in the gill (0.00-3.14 mg/kg) while the lowest was recorded in the skin (0.00-0.68 mg/kg) (Table 1.). All the body parts revealed varied levels of significance difference for each of the heavy metals concentration at $P<0.05$ except lead. There is a marked ($P<0.05$) difference in the concentration of all heavy metals between water and gut samples except lead ($P>0.05$). Similar result was observed in the scale and flesh ($P<0.05$) except for iron which does not reveal any significant difference in each case. The concentration of heavy metal in the gill also revealed a high significance ($P<0.05$) difference when compared with water. In the skin sample of the studied fish, the difference is highly significant ($P<0.05$) when compared with water sample except iron ($P>0.05$).

The concentration of most of the heavy metals that were analysed in the fish body parts were beyond the maximum permissible limit recommended by international organization on safety standard (Table 2.) except in the skin where Cu was within the recommended dose by Environmental Protection Agency (EPA). Also, the concentration of Zn in the fish body parts was below the maximum limit by EPA and World Health Organization (WHO). Lead was present only in the gut and is beyond the maximum permissible limit by EPA whereas it is within the recommended limit by WHO. The water sample also depicts a high concentration beyond the permissible limit for Fe and Pb as recommended by WHO. The corresponding concentrations of Cu and that of Zn in the water were within the acceptable limit by Food and Drug Administration (FDA) and WHO.

However, the high accumulation of Cu and Fe in the gill and gut may be due to the fact that gills serve as the respiratory organ in fishes through which metal ions were absorbed. This result corroborates the previous report by Bebianno *et al* (2004). Gill is in direct contact with the contaminated medium (water) and due to its very thin epithelium, it can easily receive heavy metals during filtration of water (Etuk and Mbonu, 1999). The high concentrations of Fe, Cu, and Pb in the gut may also be due to the fact that gut is the primary channel through which food substances get into the body of the fish. This result is similar to what Khaled (2004) observed in different fish species from El Max Bay Alexandria. Furthermore, high concentrations of some of the metals were found in the intestine because intestine is part of the viscera muscles which concentrates toxic metals (Kemdrin, 1979). The high accumulation of Fe in the gill of the studied fish is similar to what Mohammad (2008), Robinson and Avenant-Oldewage (2006) and Uysal *et al* (2008) obtained in *Oreochromis niloticus*, *Oreochromis mossambicus* and *Liza aurata* respectively. In a study reported by Christopher *et al* (2009) on the distribution of Pb, Zn, Cd, As and Hg in bones, gills, livers and muscles (flesh) of Tilapia (*O. niloticus*) from Henshaw town beach market in Calabar, his results showed that the muscle and gill of Tilapia harbour the least concentrations of heavy metals, Zn and Pb inclusive.

Olowu *et al* (2010) also recorded a low concentration of Zn in Tilapia and Catfish from two fish stations in Lagos and concluded that both fish species may be considered safe for consumption, but the need for continuous monitoring to prevent bioaccumulation is necessary.

Conclusion

This study shows that fish takes up and bio-accumulates heavy metals in various quantities depending on their concentrations in the water and the route they pass in to the body such as the gill and gastro intestinal tract. This agrees with the results of Oluyemi *et al* (2008) and Kemdrin (1979) who reported on the level of heavy metals in aquatic organism from different water bodies. Their results showed that aquatic animals (fish inclusive) bio-accumulate heavy metals in a considerable amount, and because these metals are not bio-degradable, they tend to stay in the fish tissues for a very long time which upon consumption of these fishes, the heavy metals get transferred to man, leading to heavy metal poisoning especially if present in higher concentrations.

Finally, since the concentration of most of these heavy metals in the studied fish and water are more than the recommended limit most especially Cu, Fe and Pb, the people in this area should be discouraged from consuming this fish species until its safety is ascertained.

Based on the findings during this study, the following recommendations are suggested.

- The Government, through Ministry of Environment, should enforce a regulation that will ensure that effluent or sewage were properly treated before being discharge into the river, and this must be strictly adhered to by all industries and establishment concerned.
- The government should undertake effective and regular monitoring of this aquatic environment. This will helps to improve the quality of water and fishes in this river.
- Further research should be carried out on Heavy metal concentration in the body parts of other fish species in this river.

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