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ASSESSMENT OF SELECTED METALS IN THE MUSCLE AND LIVER OF THE AFRICAN CATFISH (*CLARIAS GARIEPINUS*) COLLECTED FROM ILUSHI RIVER, ILUSHI, EDO STATE, NIGERIA.

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ABSTRACT

This study determined the level of manganese, zinc, copper, and nickel in the liver and muscle of the African Catfish, *Clarias gariepinus* from Ilushi River, Edo State, Nigeria with a view to determining the level of heavy metal contamination. The results showed that the muscles and the livers contained varying levels of the assayed selected heavy metals and non-metallic elements. The heavy metal load assayed revealed that zinc had the highest mean concentration (0.217±0.008 μg/g) in liver and (0.130±0.006 μg/g) in muscle, Copper had the least concentration (0.063±0.004 μg/g) in liver and (0.027±0.003 μg/g) in muscle. The distribution of the heavy metals in the muscles and livers of *Clarias gariepinus* showed significant variations with the concentration of the heavy metals being higher in the liver than in the muscle of fish. Comparison with WHO/FAO/FEPA/USFDA permissible limit revealed that the concentrations of the assayed heavy metals in the fish were safe for human consumption.

Keywords: *Clarias gariepinus*, Heavy Metals, Liver, Muscle.

INTRODUCTION

Heavy metals which are metallic elements of high densities could be regarded as potentially toxic, semi-essential or non-essential (Szentmihalyi and Then, 2007). Ecotoxicological studies place significant concern on the category of heavy metals known as essential and non-essential due to their persistency and relative toxicity to flora and fauna (Storelli *et al*., 2005). The ubiquitous nature of heavy metals allows them to be rapidly dissolved in water and be readily conveyed into tissues of aquatic biota (Alam *et al*., 2002).

Aquatic environments are the repository of contaminants notably heavy metals, which are ploughed back into the food chains through bioaccumulation in plankton, invertebrates, fishes and finally biomagnified in man (Edward *et al.,* 2013). The buildup and elevation of heavy metals can potentially become toxic to aquatic biota like fish at very low exposure contact (Ekeanyawu *et al.,* 2010). Several anthropogenic activities and geologic processes such as disposal of waste effluents and utility waste from industries and agrochemicals influence the introduction of heavy metal contaminants into aquatic systems (Adefemi *et al*., 2004). Fish biota have been recognized as suitable bio-indicator in the assessment of heavy metal contamination in aquatic systems (Papagiannis *et al*., 2004), largely due to the ease of accumulation through uptake of metals in water and diet.

Several studies on heavy metal contamination in fish have been widely reported (Fernandes *et al*., 2008, Praveena *et al*., 2008, Öksüz *et al*., 2009, Yıldırım *et al*., 2009). Also, studies have reported on the effects of these contaminants on some aquatic organisms. Studies have also related increased levels of heavy metals accumulated within human bodies to the consumption of heavy metals tainted organisms. In this study, heavy metals pollution was assessed from the muscles and liver of the African Catfish caught from Ilushi River in Edo State, southern Nigeria. The study will provide baseline data on the metal concentrations in organs of widely consumed African Catfish collected from an area known for crude oil prospecting.

MATERIALS AND METHODS

Study Area

This study was conducted in Ilushi River, in the Ilushi community, Esan South East Local Government Area of Edo State, Nigeria. Ilushi is a predominantly fishing community whose river is a source of water used for both domestic and industrial purposes. This particular river is known to serve as a major distribution point for the sales of freshwater fish species due to the proximity to the Ilushi market. However, the Ilushi river, which is rural based receives effluent from a local cassava industry as well as from associated human related activities which potentially impacted the pristine ecosystem.

Samples Collection

A total of 28 live and apparently healthy *C. gariepinus* specimens were collected from different points along the course of the river. An average of 6-8 fishes was collected from each point using cast nets deployed by local fishermen. The fishes were conveyed to the laboratory in plastic container with water from the river early in the morning to avoid undue stress due to temperature rise. The samples were packaged in sterile plastic containers and frozen in deep freezers at -10^{0}C prior to preparation and processing.

Sample Preparation and Analysis:

Fish samples were carefully cut open using a plastic knife and the muscles and liver of the fish were dissected out. Approximately 5 g of wet tissue was weighed into an Erlenmeyer flask and 50 ml of $HN0_3$ was added together with 20 ml of H_2SO_4 and mixture shaken together and boiled until all organic matters were destroyed. The digest was allowed to cool and 75 ml of water was added to the mixture which turned pale yellow on observation. Twenty five (25) ml of a saturated solution of ammonium oxalate was added to the mixture and was evaporated to remove excess sulphuric acid (H_2SO_4). The mixture was allowed to cool and was then diluted with water and was further transferred to a 500 ml volumetric flask and made up to mark with de-ionized water. The digests were kept in a plastic bottle and were analyzed for selected heavy metals (manganese, copper, zinc and nickel). The biogenic ions (Na, K, Ca, Mg, P) were determined using air acetylene flame atomic absorption spectrophotometer (Perkin Elmer A.A310).

Statistical Analysis:

The data obtained which were presented as means ± standard error of means were subjected to Analysis of Variance using an instant statistical package (Origin pro 8.1)

RESULTS AND DISCUSSION

The heavy metal concentrations in muscle and liver of *C. gariepinus* (Figure 1) revealed that liver accumulated high amount (almost twice) of Cu and Zn than the muscle. The result obtained was consistent with other studies which revealed that heavy metal accumulated more in liver than any other part of fish (Aladesanmi and Awotoye, 2014). The distribution pattern of heavy metals reported was liver>gills>muscle>fins (Aladesami and Awotoye, 2014) which indicated that liver of *Clarias gariepinus* was more receptive to heavy metal accumulation than the muscles (Ekpo *et al.,* 2008; Yilmaz, 2009). The findings was also consistent with the report of Edem *et al* (2009) which showed that heavy metals were concentrated more in the liver than in other parts of fish organs.

A slightly different result was obtained during the study with Mn and Ni, which were accumulated in nearly the same quantity in the liver and muscle of the fish. However, Mn was slightly higher in liver when compared to muscular concentration. Habib and Dayyab (2014) also observed that manganese and nickel were not detected in muscle of *Clarias gariepinus* collected from Challawa river. All these observations recorded were consistent with the findings from the current study that muscles of *Clarias gariepinus* was probably not an active organ in the accumulation of heavy metals as the concentrations of assayed heavy metals in liver were significantly higher ($P<0.05$) for all the metals when compared to the fish muscles. Heavy metals accumulate in the liver probably due to the highly vascularised conditions which facilitates metal absorption unlike the muscles.

Analyses of the results showed that the concentrations of copper and zinc in the fish fell below permissible limits (FAO, 1983; FDA, 2001; FEPA, 2003) (Table 1) and thus do not necessarily pose any human health risk. However, the manganese concentrations both in liver and muscle recorded in the fish were slightly above permissible limit of USFDA and FEPA (FDA, 2001; FEPA, 2003) (Table 1).

The concentrations of the selected non-heavy metals (P, K, Na, and Mg) are shown in Figure 2.

The results revealed that unlike the heavy metals, non-heavy metals accumulated more in the muscles in all cases. The trend at which non-heavy metals accumulated were: K>Na>P>Mg. The level of potassium in muscle was about thrice the concentration in liver. The non-heavy metals were most probably preferably accumulated in muscle while heavy metals were probably preferentially absorbed in liver.

Table 1: Comparative permissible limits of assayed heavy metal concentrations (μg/g) in animal tissues

Heavy metal	FAO (1983)	WHO (1989)	USFDA (2001)	FEPA (2003)
Cu	30.0	2.0	1.3	0.5-1.5
Zn	30.0	3.0	5.0	5-10
Mn	1.0	0.5	0.05	0.05
Ni	10.0	0.02	0.07-0.08	0.5-0.6

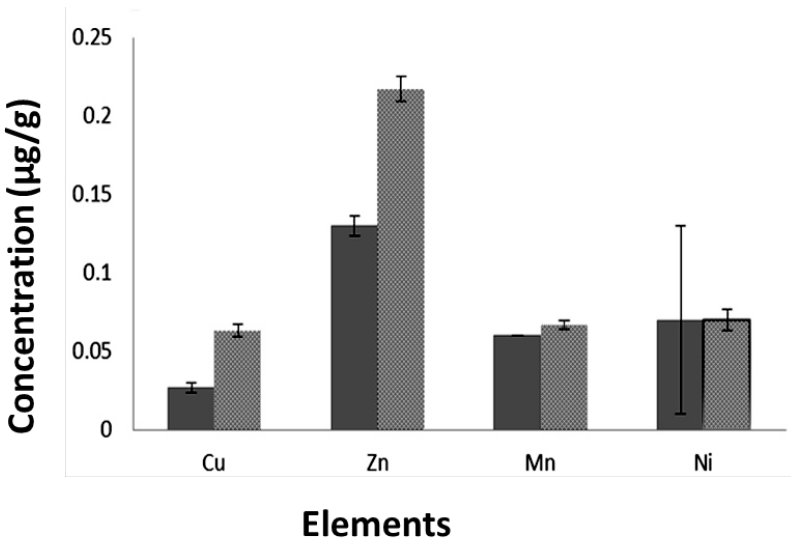

Figure 1: Heavy metal concentration in muscle (blue) and liver (red) of *Clarias gariepinus*

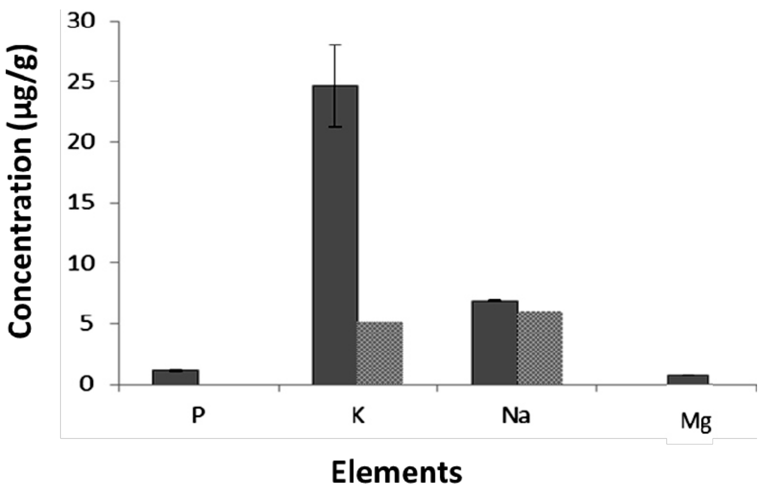

Figure 2: Non heavy metal concentration in muscle (blue) and liver (red) of *Clarias gariepinus*

CONCLUSION

In this study, heavy metals were preferentially accumulated in liver while the non-heavy metals were preferentially accumulated in the muscle. The heavy metals investigated in this study were found to be below permissible regulatory limits. However, before it can be conclusively stated that *C. gariepinus* in the area are safe for consumption, more samples should be analyzed and periodic check undertaken to ensure the heavy metal concentrations are below permissible limits. Also, there is need to ascertain the bioaccumulation potential of other organs such as kidney, gills, stomach for comprehensive status of heavy metals accumulation in the fish.

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