HEAVY METAL LEVELS IN *HEMICHROMIS FASCIATUS* FROM UBEJI CREEK, WARRI, DELTA STATE NIGERIA: IMPLICATIONS ON HUMAN HEALTH THROUGH CONSUMPTION

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ABSTRACT

The levels of heavy metals were determined in fish (Hemichromis fasciatus) from Ubeji Creek in Warri, Delta State, Southern Nigeria. Samples of H. fasciatus were obtained from March to May 2015. Heavy metal levels were determined using Atomic Absorption Spectrophotometer, SOLAAR 969 UNICAM SERIES. In the muscle, Fe had the highest mean level (119.00±38.31mg/kg) while Cr was the least (0.49±0.22mg/kg). In the liver, Fe also had the highest mean level (163.82±24.46mg/kg) while V was the least (0.87±0.47mg/kg). The total Total Hazard Quotient, TTHQ (0.2523) was less than 1 indicating that the consumption of H. fasciatus is unlikely to cause any adverse health effects to consumers. However Pb and Cd levels in H. fasciatus exceeded the Joint FAO/WHO standards and Cd levels also exceeded the EU/EC acceptable standards. Industrial effluents should be treated within regulatory standards before discharge into the Ubeji Creek due to fauna and human health risk.

Keywords: Fish, liver, muscle, health risk, consumption, metal.

INTRODUCTION

Contamination of rivers, water bodies and aquatic animals by heavy metals have been a global problem especially in developing countries such as Nigeria. Heavy metals have been reported in various concentrations in many Rivers and Creeks in Southern Nigeria (Vaikosen *et al*. 2014, Nwabueze 2011, Olowo *et al*. 2010). Aquatic ecosystems may be contaminated with heavy metals released from agricultural and industrial activities (Ezemonye and Enuneku, 2012). Once these metals get into the aquatic environment, they may be precipitated, absorbed on solid surfaces, remain soluble, suspended in water or

may be taken up and accumulated in the body parts or organs of aquatic organisms resulting in sublethal effects or death (Ipinmoroti *et al*., 1997; Yi and Zhang, 2012).
The accumulation of toxic metals to hazardous levels in biota has become a problem of increasing concern (Dean *et al*., 1972). The best known example of deaths attributed to metals ingested in seafood is the so called Minamata disease, which was first reported in Japan in the year 1953. Since that occurrence which was attributed to mercury pollution of the Minamata bay by an insecticide industry, other incidents of heavy metal poisoning due to various causes have been observed in certain parts of the world (Kurland *et al.,* 1960).
Report has shown that heavy metals are major pollutants that pose serious health risk and environmental concerns (Onyia *et al*., 2007). High levels of heavy metals in human body often result in severe damage to vital organs and systems. Reported damages include enhanced lipid peroxidation, DNA damage, enzyme inactivity and the oxidation of protein sulfydryl groups (Taiz and Zeiger, 1998). Excessive levels of heavy metals in food is associated with the etiology of a number of diseases, especially cardiovascular, renal, neurological and bone diseases (Chailapakul *et al*., 2008).
Toxic heavy metals in the aquatic environments get to man either directly from drinking water or indirectly through food chain and have been implicated in many human health conditions such as cancer, brain damage, kidney damage and behavioural problems (Obasohan and Eguavoen, 2008). WHO (1995) reported that heavy metals must be controlled in food sources in order to assure public safety. The use of fish as bio-indicators of metal pollution of aquatic environments and suitability for human use from toxicological view point has been documented (Deb and Santra 1997).

At present, non-cancer risk assessment methods are typically based on the use of target hazard quotient (THQ). THQ is a ratio between the estimated dose of a contaminant and the reference dose below which there will not be any appreciable risk (US EPA 2000). If the ratio is greater than 1, there may be concern for potential health. This method of risk estimation has been used by Wang *et al*., (2005) and Amirah *et al*., (2013) and has been shown to be valid and useful.
Ubeji creek, in Udo community Warri, Delta state serves as a major source of income and feeding for most people living in that community. Attention has been drawn to the creek because of the anthropogenic activities of the industries around and in the community.
The aim of this study is to determine heavy metal levels in fish, *H. fasciatus* from Ubeji Creek, Warri and estimate health risk of heavy metal concentrations on man through consumption of contaminated fish.

MATERIALS AND METHODS

Description of Study Area

Ubeji Creek is located in Warri, Delta State, Nigeria, (Latitudes $05^0$20'31.56"N and longitude $05^0$25'53.5"E). The Ubeji Community is situated beside the Warri refinery and Petrochemical Company (WRPC). The landforms consist essentially of sedimentary basins and basement complex rocks (Ija and Antai, 2003). The implication of these rock formations allow permeability of fluids (Achudume, 2009). All industrial wastes, untreated or minimally treated are discharged into Ubeji Creek which runs immediately downstream and eventually ends up in Ubeji River which through Crawford Creek flows into Warri River. The occupation of the human population is mainly fishing and they depend on the creek as an outlet to larger water. The Ubeji Creek, receives effluent directly from the refinery and petrochemical company.
Fish Sample Collection and Preservation
Samples were collected from three sampling points of the sampling station around Latitudes $05^0$34'07.45"N and longitude $005^0$42'4.25"E in Ubeji Creek, the sampling points serving as three replicates. The fish was

collected by the use of wooden traps by local fishermen. The sampling station was visited each month from March, 2015 to May, 2015. Fish was kept in an ice chest for preservation and was taken to the laboratory for processing and Identification.

Pretreatment, Digestion and Heavy Metal Determination.

Digestion was according to Miroslav and Vladimir, (1999). Fish samples collected was dried in an oven (Gallenkamp oven) at 105^0C for 1 hour. The dried sample was grinded to a fine powder with a mortar. From the grounded sample, a known weight of 1g was placed into a 50 ml Pyrex beaker and then hatched in a muffle furnace at 500^0C for 3 hours. This was to allowed to cool and thereafter the ash was dissolved in 10ml of 10% Nitric acid and heated gently on a hot plate for 20 minutes. The solution was allowed to cool, filtered into a 250ml volumetric flask and made up to a final volume of 250ml with distilled water. Different heavy metals were then determined using the Atomic Absorption Spectrophotometer (AAS), model SOLAAR 969 UNICAM SERIES.

Statistical Analysis

Basic statistical measurement of central tendency and dispersion were used to characterize the levels of selected heavy metals in the muscle and liver of *H. fasciatus*. Paired sample statistics was adopted in comparing the levelss of individual heavy metals in the muscle and liver of *H. fasciatus* at 95% confidence level. Computer SPSS 20.0 windows application and Microsoft excel were used in the various analyses. Correlation statistics was used to test the level of relationship that existed between the levels of the individual heavy metals in the muscle and liver of *H. fasciatus*. Also regression statistics was adopted in testing the dependence of the various heavy metals in the muscle and liver on weight of the fish.

RESULTS

Table 1 shows the summary of heavy metals levels in the different tissues (Muscle and Liver) of *H. fasciatus* sampled from Ubeji creek. The mean levels of Fe, Mn, Zn, Cu, Cr, Cd, Ni, Pb and V in the muscle were 119.00±38.31, 5.01±1.46, 28.47±8.39, 1.87±0.43, 0.49±0.22, 0.80±0.13, 0.58±0.29, 0.97±0.32, 0.53±0.43 mg/kg respectively. The levels in the liver were 163.82±24.46, 8.10±1.451.45, 35.47±10.37, 3.32±1.15, 1.91±0.42, 1.70±0.66, 1.10±0.48, 2.11±0.82, 0.87±0.47 mg/kg respectively. The levels of Fe, Mn, Zn, Cu, Cr, Cd, Ni and Pb when compared between the muscle and liver, showed a highly significant difference ($p<0.01$).

Test of Relationship for Individual heavy metals levels between the Muscle and Liver for *H. fasciatus.*

Correlation statistics was adopted in testing the level of the relationship between the levels of individual heavy metals in the liver and muscle of *H. fasciatus* from Ubeji creek.

A significant correlation between levels of heavy metals in the muscle and liver was recorded for Cr, Cd, and Ni. For the other heavy metals analysed, no significant correlation was observed in their accumulation in the tissues compared.

Table 1: Summary of heavy metals levels in tissues of *Hemichromis fasciatus* from Ubeji creek.

	Units	Muscle $\bar{x}$±SD (Min-Max)	Liver $\bar{x}$±SD (Min-Max)	P-Value	FAO/WHO (2011) Standard	EU/EC (2006) Standard
Fe	Mg/kg	119.00±38.31 (55.50-158.90)	163.82±24.46 (140.70-198.10)	p>0.05	N/A	N/A
Mn	Mg/kg	5.01±1.46 (2.55-7.23)	8.10±1.451.45 (6.46-10.10)	p<0.01	N/A	N/A
Zn	Mg/kg	28.47±8.39 (15.10-37.20)	35.47±10.37 (22.00-46.50)	p>0.01	N/A	N/A
Cu	Mg/kg	1.87±0.43 (1.11-2.42)	3.32±1.15 (1.72-4.94)	p<0.05	N/A	N/A
Cr	Mg/kg	0.49±0.22 (0.12-0.77)	1.91±0.42 (1.38-2.38)	p<0.01	N/A	N/A
Cd	Mg/kg	0.80±0.13 (0.61-0.95)	1.70±0.66 (1.20-3.28)	p<0.01	2	0.05
Ni	Mg/kg	0.58±0.29 (0.35-1.15)	1.10±0.48 (0.62-1.92)	p<0.05	N/A	N/A
Pb	Mg/kg	0.97±0.32 (0.57-1.48)	2.11±0.82 (1.11-3.63)	p<0.01	0.3	0.3
V	Mg/kg	0.53±0.43 (0.24-1.51)	0.87±0.47 (0.47-1.75)	p<0.05	N/A	N/A

p>0.05 – No Significant Difference; p<0.05 – No Significant Difference; p<0.01 – Highly Significant Difference

Regression Statistics

Regression statistics was adopted to test the level of dependence of the heavy metals obtained in the tissues (muscle and liver) to the weight of *H. fasciatus*. The levels of Fe, Zn and Cd in the muscle showed significant regression (p<0.05) with the weight of the fish. For other metals irrespective of the tissue, there was no significant regression (p>0.05) with the weight of the fish.

DISCUSSION

This study has shown that *H. fasciatus* had heavy metal levels in the muscle and liver. Iron had the highest mean level of 119.00±38.31mg/kg in the muscle. The high levels in fish could be due to bioaccumulatiuon from contaminated water and food. The source of Fe is likely from oil and gas industries located close to the Creek. Similarly, Eddy and Ukpong (2002) reported that Iron had the highest concentration in *T. zilli* from upper Calabar River. They attributed the source of Fe to improper waste disposal within the community.

The levels of Zinc in the Muscle and Liver of *H. fasciatus* was higher compared to the findings of Akintujoye *et al.,* (2013) who reported no concentration of zinc (Zn) in *T. zilli*. The high mean levels of Zinc in this study can be due to bioaccumulation of the metal from water by fish from the industrial activities carried out around Ubeji creek. Mn, Cu, Cd, Ni, Pb and V had heavy metal concentrations of 5.01±1.46, 1.87±0.43, 0.80±0.13, 0.58±0.29, 0.97±0.32 and 0.53±0.43. This is in line with the report of Cheng *et al.,* (2008) who worked on *Oreochromis mossambicus* from Pearl River, South China. Chromium had the lowest heavy metal level of 0.49±0.22mg/kg in the muscle. In the liver, Iron (Fe) also had the highest level of 163.82±24.46mg/kg. The dominance of Fe over other metals recorded herein is in line with the report of Ekpo *et al.,* (2013) who worked on *T. Zilli* from Alua Dam within the Lake Chad Basin of Borno State, Nigeria. The range of concentration of Zn and Cd recorded in the liver is higher than that recorded by El-moselhy *et al.,* (2014) in the liver of another specie *Epinephelus sp.* The difference might be as a result of greater metal load in Ubeji Creek because of the presence of the refinery close to the creek. The level of Pb recorded in this study was 2.11±0.82 mg/kg in the liver which is higher than the value recorded by Ambedhkar and Muriyan (2013) in the liver of *Clarias gariepinus* from Preumal Lake Cuddalore District, Tamilnaim India. Pb is a toxic element which has no biological functions and show their carcinogenic effect on aquatic biota and humans. Lead toxicity is known to cause muscular - skeletal renal, ocular, neurological, immunological reproductive and developmental effects (ATSDR, 1999). In Zamfara State, Nigeria, lead has been reported to cause mortality in hundreds of people and mostly affected infants due to their smaller bodies and behaviors. Levels of Cu, Cr and Ni reported in this study were 3.32±1.15, 1.91±0.42 and 1.10±0.48mg/kg respectively in the liver. This is lower than the values reported by Mehijbeen and Nazura (2013) from the liver of another species of fish (*Mastacembelus armatus)* in Kasimpur, Alighar rivulet water. The levels of Mn and V were 8.10±1.45 and 0.87±0.47 respectively in the liver and this range of concentration is in line with the study of Apori *et al.,* (2012) who worked on *T. zilli*. The source of vanadium in fish samples can be attributed to the petrochemical effluents from oil and gas companies close to the creek.

Heavy metal levels of *H.fasciatus* was in the order of Fe>Mn<Zn<Cu<Cr<Cd>Ni<Pb>V which differed from the findings of Vaikosen *et al.,* (2014) in *Hemichromis fasciatus* exposed to surface water in Burrow pits within onshore production area from the Niger Delta Region whose order was Fe<Pb<Cr<Ba<Cd<Zn<Cu<Ni. The levels of Fe, Zn and Cd in the muscle showed significant regression ($p<0.05$) with the weight of the fish. For other metals irrespective of the tissue, there was no significant regression ($p>0.05$) with the weight of the fish. The level of trace metals detected can be attributed to some chemicals that are used by the petrochemical and other allied industries which find their way into the creek; it is also attributed to high concentration of vehicles in this zone due to the numerous car parking lots that discharge (leak) fuel and contaminated engine oil into the environment. Liver of the examined fish contained the highest concentration of all the detected metals because the liver is an active site for the detoxification of xenobiotics and toxins.

The total THQ (TTHQ) which measures the aggregated health risk due to heavy metal uptake via the ingestion of *H. fasciatus* was 0.2523. The TTHQ value is less than 1 suggesting that the consumption of *H. fasciatus* is unlikely to cause any adverse health effects to consumers. However Pb concentration in *H. fasciatus* exceeded the Joint FAO/WHO, CODEX (2011) and EU/EC (2006) acceptable standards for food items to be consumed by man. Cd also exceeded the EU/EC (2006) acceptable standard. Lead is known to induce reduced cognitive development and intellectual performance in children and increased blood pressure and cardiovascular disease in adults. Cadmium may accumulate in the human body and may induce kidney dysfunction, skeletal damage and reproductive deficiencies (Alturiqi *et al*., 2012). Excessive concentrations of Pb and Cd in food is associated with a number of diseases especially cardiovascular, renal, nervous and skeletal systems (WHO, 1995). These metals have also been implicated in carcinogenesis and teratogenesis (Maleki and Zarasvand (2008). Industrial effluents effluents should be treated within regulatory standards before discharge into the Ubeji Creek as it may health risk resident fauna and to humans that consume contaminated fauna.

CONCLUSION

The levels of heavy metals (Fe, Mn, Zn, Cu, Cr, Cd, Ni, Pb and V) in *Hemichromis fasciatus* of Ubeji creek, Warri, Delta State were determined. The liver had the highest heavy metal levels than the muscle. The TTHQ value was less than 1 suggesting that the consumption of *H. fasciatus* is unlikely to cause any adverse health effects to consumers. However Pb levels in *H. fasciatus* exceeded the Joint FAO/WHO, CODEX (2011) and EU/EC (2006) acceptable standards for food items to be consumed by man. Cd also exceeded the EU/EC (2006) acceptable standard. Industrial effluents should be treated within regulatory standards before discharge into the Ubeji Creek as it may health risk resident fauna and to humans that consume contaminated fauna.

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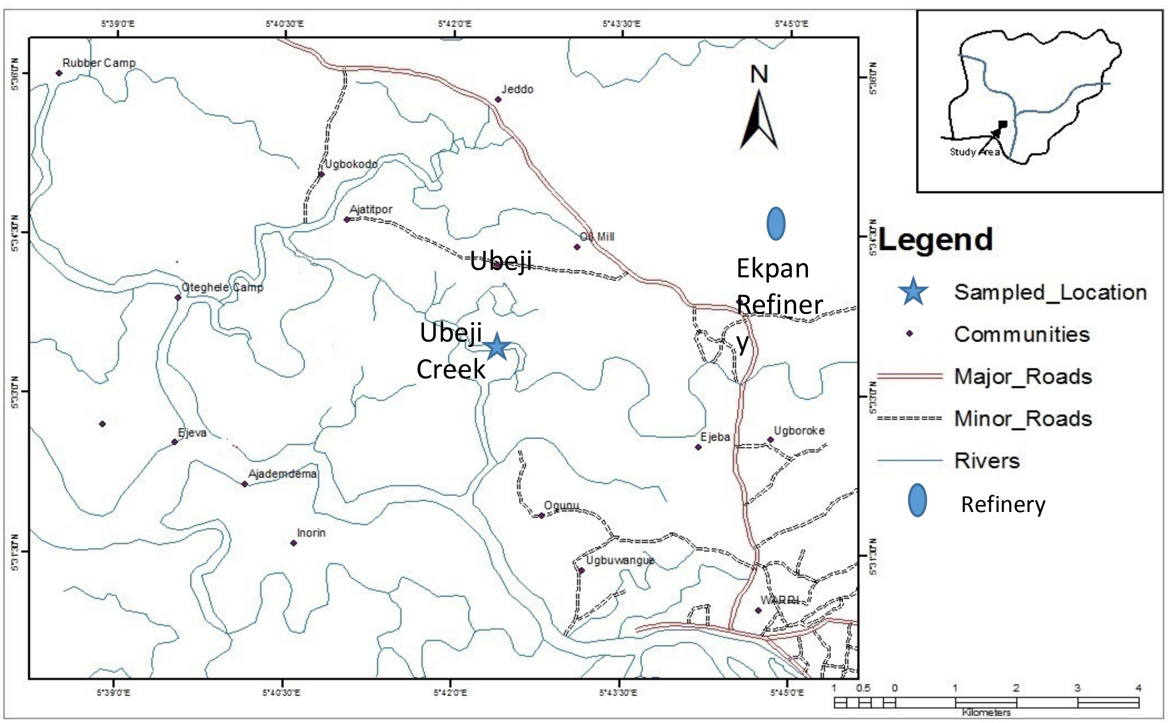

FIG. 1: MAP OF STUDY AREA SHOWING THE SAMPLED LOCATIONS