

Assessment of heavy metals concentration in the intestine, kidney and muscle of *Oreochromis niloticus* in Federal University of Agriculture Abeokuta reservoir

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Abstract

Different sizes of Oreochromis niloticus (Tilapia) were caught using cast net in FUNAAB reservoir. Water samples were also collected and analyzed for five metals: Lead, Chromium, Cadmium, Zinc, and Copper by Atomic Absorption Spectroscopy (AAS). During the experiment, three tissues were compared with the level of metal in water, Intestine, Kidney and Muscles.

*Generally, lower concentrations of metals were recorded in water than in fish tissues; lower concentration in the tissue of *O niloticus* except were found in the water which is less than the recommendation for human consumption by World Health Organisation. Lead was found to be the dominant in the intestine of *Oreochromis niloticus* while Chromium was recorded the least of all the metals. There is a significant difference ($P < 0.05$) in heavy metal concentration in the tissue of *O niloticus* except for Chromium. Though, the heavy metals of interest were present in a measurable quantities, they are still within safe limits for consumption.*

Keywords: Heavy metals, concentration, *Oreochromis niloticus*, reservoir, FUNAAB

Introduction

The contamination of fresh waters with a wide range of pollutants has become a matter of concern over the last few decades (Vutukuru, 2005). The natural aquatic systems may extensively be contaminated with heavy metals released from domestic, industrial and other man-made activities (Velez and Montoro, 1998;). Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organisms (Farombi, *et al* 2007). Among animal species, fishes are the inhabitants that cannot escape from the detrimental effects of these pollutants (Olaiifa *et al* 2004). Water is indeed life and thus the most important natural resource without which life would be non-existent. Availability of safe and unreliable source of water is an

essential prerequisite for sustainable development. Landfills and other solid wastes disposal sites are major targets of pollution because rainfall and ground water leach these highly contaminated substances into rivers, streams and waterways (surface water) which are inadvertently used by people residing in such areas. Water borne diseases kill 50,000 people daily (Nguyen *et al* 2005) and yearly, about 4 million children under the age of five die in developing countries due to water related problems (Pylea *et al.* 2005). There is an increase concern about the effects and fates of trace metals in Nigerian environment; much of this concern arises from the information available on the concentration of these metals within the environment. Heavy metals are easily absorbed by aquatic life forms and accumulation may occur in higher concentration than in parent

water bodies (Schmitt and Brumbaugh, 1990).

The metals that are of greatest concern in freshwaters are mercury (Hg), Lead (Pb), Cadmium (Cd), Copper (Cu) and Zinc (Zn) which have effects on liver. This accumulation and demagnification depends upon available heavy metal concentration in both water and sediments. Trace elements concentrations are generally higher in sediments and muscles than in water. There seems to be a high concentration of heavy metals levels in areas where pollution occur more and high. Fish is a valuable and cheap food item and source of protein to man. Federal University of Agriculture Abeokuta reservoir serves as a major source of water for various researches; it leads to many rivers where fishing activities are being carried out on a large scale and because there is no formal control of effluent discharge along its path, it is important to monitor the levels of metals in the reservoir. Heavy metals pose a great threat to immediate environment at concentrations beyond permissible level not only to aquatic organisms, but also to human, hence the need for evaluation of associated Water and the Tilapia species due to their predominance, acceptability and market value, (Roderick, 1999).

Bio-accumulation of heavy metals is dangerous to human health as Lead, Cadmium and Copper affect the formation of blood cells. Heavy metals toxicity from the consumption of metal polluted fishes can cause malfunction of livers, kidneys, Circulatory System and movement of nerve signals. Heavy metals in human body also play a role in the development of cancers (Nguyen *et al.*, 2005). This study was carried out to determine the effect of some heavy metals on the intestine, kidney and muscle of *Oreochromis niloticus* in

FUNAAB Reservoir.

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Materials and Methods

Description of site

The study was carried out at FUNAAB reservoir, Alabata stream located in Odeda Local Government Area of Ogun State. The reservoir is situated on Latitude 7.22°N and Longitude 3.45°E and it is largely inundated by noxious water weed especially water hyacinth which floats and is rooted in the water which considerably disturbs fishing navigation and other activities on the water. The area lies in tropical climate which has an average rainfall of 110mm and a mean ambient temperature of about 34°C and a yearly humidity of 82. The reservoir has its source from River Alabata with a surface area of 160m²

Collection of samples

The samples were collected in the morning once a week for three weeks; cast net of 20mm to 30mm mesh size was used at different locations of the reservoir and retrieved immediately from the cast net to get *Oreochromis niloticus* for the assessment. The collected samples were put into ice bags and taken to the laboratory immediately for further examinations. The samples were washed in water to remove particles and it was allowed to thaw and dissected to separate parts: intestine, kidney and Muscle.

Wet Oxidation Digestion

The fish samples were dried at 60°C and grinded into powdery form. 0.2g of grounded sample was weighed and placed

Table 1: Level of heavy metals concentration in Intestine, Kidney and Muscle of *Oreochromis niloticus* and water sample

Metal	Intestine	Kidney	Muscle	Water (ppm)
Pb (u/g)	0.024 ± 3.055 ^a	0.024 ± 2.59 ^a	0.0224 ± 4.18 ^b	9.84 ± 0.04 ^c
Cd	0.014 ± 1.26 ^a	0.012 ± 1.52 ^c	0.013 ± 3.52 ^b	26.43 ± 0.18
Cr	0.001 ± 0.31 ^a	0.001 ± 0.24 ^a	0.0015 ± 0.20 ^a	61.67 ± 0.88
Zn	0.009 ± 0.65 ^b	0.009 ± 0.63 ^c	0.010 ± 0.89 ^a	123.67 ± 1.86
Cu	0.010 ± 0.43 ^c	0.012 ± 0.73 ^a	0.011 ± 0.52 ^b	8.7 ± 0.634

Value in the same row with different superscript are significantly different ($p > 0.05$).

in a conical flask. 25ml of Trioxonitrate(V), 4ml of chloric(VII) acid and 2ml of tetraoxosulphate(VII) acid was measured and poured into the conical flask containing the grounded sample. The conical flask was placed on heating mantle and the mixture started burning with brown flames which later turned to thick white and the digested sample was allowed to cool down before it was diluted to 50ml of perchloric acid and poured into the sample bottle. The metals (Zinc, Copper, Chromium, Cadmium and lead) were analyzed using bulk AA-200 Atomic Absorption Spectrophotometer with graphical and recordable screen. All data obtained were subjected to Analysis of variance to test for significant difference between the means of the heavy metal levels and water. The alpha (α) risk or level of significant use was 5%, or $p < 0.05$.

Results

Five metals: Chromium (Cr), Copper (Cu), Zinc (Zn), Lead (Pb) and Cadmium (Cd) were analyzed. The level of heavy metals concentration were measured in intestine, kidney and muscle compared with the level in water. (Table 1). Data showed with different letters are statistically significant in rows ($P < 0.05$). Table 1 showed the heavy metals concentration in each tissue of the fish species samples (*Oreochromis niloticus*) and water of the reservoir.

Discussion

It was observed that the concentration of

Lead in the intestine, kidney and muscle of *Oreochromis niloticus* is significantly higher ($P < 0.05$) than its concentration in any tissue and water. The concentration of lead in the muscle (*O. niloticus*) is significantly lower ($P > 0.05$) concentration in other tissue of same species.

However, this study agrees with Mansour and Sidky (2002) who found enrichment of Lead in the liver of fresh water fin fish. Moreover, Gupta *et al* (2009) concluded that liver and other organs are important target for Lead. The concentration of Cadmium (0.014 mg/l) is significantly higher ($P < 0.05$) in the intestine of *Oreochromis niloticus* than all other examined tissues of same species, however, Cadmium concentration in muscles is significantly lower ($P > 0.05$) than concentration with other tissues of same species. The result obtained also agreed with the report by Philip and Segar (1986) who found lower concentrations of Cd in muscle tissue of fish from the Southern Baltic, which ranged from 0.001 to 0.057ppm.

Chromium concentration in intestine (0.001 u/g), Kidney (0.001u/g) and muscle (0.0015u/g) of *Oreochromis niloticus* shows no significant difference among themselves. However, its concentration in water shows difference to all other tissues. The concentration of Zinc (0.010u/g) in the muscle of *O. niloticus* is significantly higher than its concentration in other

tissues, while kidney concentration of Zn (0.009u/g) in *O. niloticus* is lower than concentration with other tissues of same species. Accumulation of zinc in muscle indicate Zn levels in kidney and intestine to be the same (0.010u/g) followed by intestine as shown in the result.

The concentration of lead in the muscle (0.0224u/g) of *O. niloticus* is significantly lower ($P>0.05$) than its concentration in Other tissue, while there is no significant difference between the concentration of lead in the intestine and kidney (0.024u/g). The higher concentration of lead recorded in both intestine and kidney of the species could be as a result of its ability to substitute calcium in the body particularly in bone as lead (Pb) atom is similar in size and shape to calcium atom (Mansour and Sidky, 2002).

The accumulation of lead and copper metals are relatively lower than water concentration in both metals as shown in the result, this conforms with (Olaifa *et al*, 2004) which says aquatic organisms accumulate metals to concentration many times higher than present in water. Copper concentration in kidney (0.012u/g) only shows significantly lower than concentration with other tissues of same species.

The result shows that the highest tissue concentration of heavy metals among the tissue of *O. niloticus* was found in the intestine, while the kidney shows the highest concentration. Lead was found to have the higher concentration in the tissue of *O. niloticus*, while chromium was found

to be the lowest. Most previous reports have shown that accumulation patterns of metals in fish are dependent both on uptake and elimination rates. The uptake of metals in fish is influenced by many factors, including the species, the specific organs studied and with environmental factors, like temperatures and Ph. Hakanson (1984), reported that the factors affecting uptake and accumulation of pollutants were locality, species, sex, age, state of gonadal maturation, as well as environmental factors.

In elimination of metals is an active biochemical and physiological process, one problem which often remains unresolved is to know the pathways by which metals are incorporated into the fish. Several authors demonstrated that gills play an important, perhaps even dominant role in metal uptake (Thomas *et al*, 1983 and Adeosun *et al*, 2010). This may be true primarily for the water soluble fractions of metals.

Metal concentrations in fish are mostly measured in liver or muscle (flesh), the latter being of most concern to man because it is the main tissue consumed as food. On the other hand, liver is now widely recognized as a valuable indicator of pollution (Philips and Segar, 1986).

Conclusion

All tissues of *Oreochromis niloticus* examined in FUNAAB reservoir have heavy metal concentration that is lower than the specified WHO (1984) consumption limits. The concentration of

Table 2: Range and mean values of selected water quality parameters in FUNAAB reservoir

Parameters	Range	Mean and standard Error
Ph	9.79 – 9.91	9.85 ± 0.0371
Temperature (°C)	26.1 – 26.7	26.4 ± 0.1264
Total Dissolved Solids (mg/l)	60 – 63	61.5 ± 0.8819
Electrical Conductivity (mg/l)	120 -126	123 ± 1.8559
Dissolve Oxygen(mg/l)	7.6 -9.8	8.7 ± 0.6337

Source: Field data

heavy metals in these tissues shows that they are at safe level for human consumption. More importantly, the muscle, which is the part mostly consumed was found to accumulate lowest concentration of heavy metals among all targeted tissues examined.

The muscle, which is the part mostly of commercial importance studies like this should be extended to other fish species to ascertain safe limit for human consumption and the activities at the upstream of the reservoir which should be kept under strict surveillance which are capable of increasing the heavy metals discharge into the reservoir, especially as population increases.

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