BIO-ACCUMULATION OF SOME HEAVY METALS IN THREE COMMERCIALLY IMPORTANT FISH SPECIES TISSUES RELATIVE TO THEIR CONCENTRATIONS IN AGAIE-LAPAI DAM, MINNA, NIGER STATE, NIGERIA

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ABSTRACT
This research assessed bioaccumulation of heavy metal concentration in water and fish tissues of three species of fish of commercial importance from Agaie/Lapai dam. Water samples were taken from five locations on the Dam and Clarias gariepinus, Tilapia gallilaeus and Auchenoglanis occidentalis were obtained from the dam landing site for four months. One gram of the target organs (gill, muscle and intestine) of each species were collected and weighed after dissection. The weighed organs were digested and heavy metal concentrations were determined in them and water using Atomic Absorption Spectrophotometer. Results showed that the heavy metal concentration in the water descended as follows Zn>Cu>Fe>Mn> Pb> Cr. The concentrations of Zinc in February, March and June were 0.692, 0.632, and 0.28mg/l respectively were the highest concentrations in water while Cr concentration was the lowest throughout the sampling period. There were significant differences (P<0.05) among the concentrations of the heavy metal recorded during the period. It was revealed that Clarias gariepinus intestine accumulated the highest concentration of Zinc (7.65mg/l). The mean concentration of heavy metals in all the species revealed that; Auchenoglanis occidentalis and Clarias gariepinus intestines and gills showed no significant difference (p>0.05) except in the muscle that had significant difference (p<0.05) in Cu. However, the mean concentration of heavy metals in Tilapia muscle and intestine had no significant difference (p>0.05), there was significant difference (p<0.05) in Cu (1.575mg/l) concentration in the gills. It is therefore concluded that there is presence of heavy metal in the dam and the fish tissue in Agaie/Lapai dam.

Key words:, *Clarias gariepinus*, *Tilapia gallilaeus Auchenoglanis occidentalis*, Gills, Intestine, Musle.

INTRODUCTION
Aquatic environments are being polluted due to increasing natural and human anthropogenic activities. Currently, pollution of aquatic environments with heavy metals have become a worldwide problem because they are indestructible, potentially toxic to aquatic organisms and are able to bio-accumulate in aquatic ecosystems. (Abraha et. al., 2012). More et al., (2003) described metals as non-biodegradable elements that are major aquatic environmental pollutants. These metals are grouped into essential macro and micro elements (Dimari et al., 2008). Micro elements are those vital trace elements that are required in small quantity by living organisms like copper (Cu), zinc (Zn), iron (Fe) (Nduka et al., 2010) and they play roles in the metabolic activities of organism while cadmium (Cd), lead (P), nickel (Ni), mercury (Hg) and arsenic (As) tends to be toxic even at trace level and are known as the non-essential elements.

Fish serves as one of the major sources of protein that is low in saturated fat and contains sufficient omega 3 fatty acids which supports good physical condition. The rate of bioaccumulation of this heavy metals in fishes depends on the route of metal uptake, type of heavy metal, fish species and the concentration of such metals in the water body (Begum et al., 2009). Fishes are also known as good bio-accumulators of organic and inorganic pollutants (Abatha, 2010). Heavy metal accumulation in fish differs from one part of the body to another due to the varying affinity of those parts to metal (Benzer et. al., 2013). Therefore, fish can be used to assess the health status of aquatic ecosystems (Yousuf and El-Shahawi, 1999; Farkas et al., 2002). Heavy metals concentration in aquatic environments is dependent upon its temperature, hardness and pH (Yang and Chen, 1996, Abdel Baki et. al., 2011). This study therefore examined the bioaccumulation of heavy metals in water and fish from Agai/Lapai Dam, Niger State, Nigeria.

MATERIALS AND METHODS
Study Area: Agaie- lapia dam is located adjacent to Bakajiba village at latitude $9^0$39N and longitude $6^0$33E southwest of Minna, Niger State having about 38 million cubic meters holding capacity and a crest length of 1,600 meters. Rivers from different communities make up the dam such as water from Bakajiba river, Tunga mallam river, Tunga Gana river, Tunga Alhaji Usman river. Each of the rivers being named after the originating village.

Sample Collection: Water samples were collected from five stations, from Rivers Bakaja, Tunga Mallam, Tunga Gana, Tunga Alhaji Usman and also from the dam spillway. Three fish species (Clarias gariepinus, Tilapia gallilaeus and Auchoeglanis occidentalis) were selected and bought from the fishermen at the bank of the dam because of their economic importance. The samples were collected and stored in a cooler with iced blocks and transported to Water Resources, Aquaculture and Fisheries, Federal University of Technology, Minna, Niger State laboratory.

Laboratory analysis: Digestion of water sample: wet method of digestion was used to carry out this Analysis (APHA, 2005). 100 ml of water was taken from the water sample collected from the dam. Ten milliltres of nitric acid was added and to 100 ml of water collected from the dam and then digested on a hot plate at a temperature of 150oC till the water reached a boiling point. The resulting solutions were allowed to cool and the volume was then made up to 100 ml with distilled water.

Digestion of fish samples: wet method of digestion was used to carry out these analyses (APHA, 2005). 1g of the gills, tissue and intestine was each weighed from various fish species. 20ml of nitric acid was added to individual sample and digested on hot plate at 150oC till the samples were fully dissolved. 100ml of distilled water was added to the digested sample and then poured in a sample bottle with labels for further analysis.

Metal Extraction: Bulk Scientific Atomic Absorption Spectrophotometer (AAS) (model Accusy 211; manufacturer USA) was used for determining the bio-accumulation factors of the metals.

Statistical Analysis: One-way statistical analysis of variance (ANOVA) was used to determine the significant differences ($P < 0.05$) in the concentration of these metals both in the fish and the water at ($P \leq 0.05$) probability using SPSS package.

RESULTS

The concentration of Iron (Fe), copper (Cu), Zinc (Zn), Lead (Ld), Manganese (Mn) and Chromium (Cr) in fish (gills, muscles, intestine) and water from Agaie-Lapai dam were as presented in tables 1 - 6.

Water Sample: Heavy metals were found to decrease in the sequence Zn> Fe >Cu >Mn>Pb>Cr. There was no significant difference ($P>0.05$) in Mn and Cr among the months. There was significant difference ($P< 0.05$) in the copper concentration with the highest value in March. In June, mean concentration of metals recorded were Cr (0mg/L), Mn (0.042mg/L).Cu (0.178mg/L), Zn (0.28mg/L) and Fe (0.088mg/L). Results obtained in July showed significant difference ($p\leq 0.05$) between the metals.

Season: Results obtained during the dry season (February and March) and wet season (June and July) shows significant difference ($P< 0.05$) in Cu, Zn, Fe and Pb while no significant difference was observed in Mn and Cr as shown in table 2. The average concentrations of heavy metals in the dry season were higher than in the wet season and were found to be in the following decreasing order Zn>Cu>Fe>Mn>Pb>Cr. This could be as a result of concentration effect in the dry season. Seasonal variation of metals in fish organs shows that there is no significant different ($p> 0.05$) between all the metals during the dry season while during the wet season only Cr (0.022) shows significant different ($p\leq 0.05$). Within the seasons all the metals show significant different except for Cr which shows no different within the season as shown in Table .3.

Fish Organs: Heavy metal concentrations in gills of these species were in the following decreasing order Fe>Zn>Cu>Mn>Pb>Cr. They were in the same order in muscles but a little difference was observed in the intestine in the following order Fe>Zn>Mn>Cu>Pb>Cr. Intestine accumulated the highest concentration of Zinc while the highest concentration of zinc was found in the muscle of Clarias gariepinus. There was no significant difference ($p> 0.05$) among all the metals studied in Auchenoglanis occidentalis gills (AUGG) and Auchenoglanis occidentalis muscles (AUGM) except for Cu (2.375,1.325mg/l) respectively which show significant different ($p\leq 0.05$). However, in Auchenoglanis occidentalis intestine (AUGI), there was no significant difference ($p> 0.05$) for all the metals studied. Results obtained for Clarias gariepinus gills (CLRG) and Clarias gariepinus muscles (CLRM) shows that there was no significant difference ($p> 0.05$) among all the metals present apart from Cu (2.95, 1.125mg/l) respectively shows significant different in both. Also, Clarias gariepinus intestine (CLRI) shows that there was no significant difference ($p> 0.05$) in all the metals. In Tilapia gallilaeus gills (TPLG), Tilapia gallilaeus muscles (TPLM) and Tilapia gallilaeus intestine (TPLI)..

Table 1: Month Mean Variation of Heavy Metal Concentration in Water Samples.

Month	Mn(mg/L)	Cu(mg/L)	Zn(mg/L)	Fe(mg/L)	Pb(mg/L)	Cr(mg/L)
February	0.044a	0.224b	0.692a	0.19ba	0.006b	0a
March	0.046a	0.276a	0.632a	0.098b	0.01a	0.004a
June	0.042a	0.178b	0.28b	0.088b	0c	0a
July	0.026a	0.058c	0.076c	0.279a	0c	0.002a
± SE	0.009	0.016	0.045	0.039	0.01	0.002
USEPA (2008)	0.05	1.3	5.0	0.3	0.015	0.1
WHO (2008)	0.4	2.0	-	-	0.01	0.05

Mean in the same column carrying same superscript are not significantly different (P>0.05). Mn =Manganese, Cu= Copper, Fe= Iron, Cr= Chromium, Pb= Lead, Zn= Zinc.

Table: 2: Mean Season Variation of Heavy Metal Concentration in Water Sample

Season	Mn(mg/l)	Cu(mg/l)	Zn(mg/l)	Fe(mg/l)	Pb(mg/l)	Cr(mg/l)
Dry	0.045a	0.25a	0.662a	0.144a	0.008a	0.002a
Wet	0.034a	0.118b	0.178b	0.179a	0b	0.001a
±SE	0.006	0.023	0.042	0.038	0.009	0.001

Mean in the same row having same superscript are not significantly different from each other (p>0.05). Mn =Manganese, Cu= Copper, Fe= Iron, Cr= Chromium, Pb= Lead, Zn= Zinc.

Table 3: Mean concentration of heavy metals in the gills of the experimental fish species

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGG	0.85a	2.375abcd	6.3ab	5.3ba	0.05a	0b
CLRG	2.075a	2.95abc	4.75ab	2.275b	0.0375a	0.175a
TPLG	1.425a	1.575cd	5.6ab	3.775ba	0.0375a	0.05ab
Permissible limits (FAO/WHO, 2008)	2-9	3	10	10	0.05	0.15

Table 4: Mean concentration of heavy metals in the musscles of the experimental fish species

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGM	0.5a	1.325cd	4.25ab	4.075ab	0.05a	0b
CLRM	0.55a	1.125d	4.025ab	14.8a	0.025a	0.1ab
TPLM	0.425a	1.85abcd	1.8b	1.4b	0.0375a	0.025ab
Permissible limits (FAO/WHO, 2008)	2-9	3	10	10	0.05	0.15

Table 5: Mean concentration of heavy metals in the intestines of the experimental fish species

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGI	0.95a	3.4ab	5.875ab	12.6ab	0.0375a	0.025ab
CLRI	3.925a	3.625a	7.65a	1.975b	0.025a	0.05ab
TPLI	4.05a	1.675abcd	2.175ab	5.5ab	0.025a	0.025ab
Permissible limits (FAO/WHO, 2008)	2-9	3	10	10	0.05	0.15

Table 6: Mean Concentration of Heavy Metal in Auchenoglanis occidentalis (AU), Clarias gariepinus (CLR) and Tilapia gallilaeus(TG) the Fish Organs.

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGG	0.85a	2.375abcd	6.3ab	5.3ba	0.05a	0b
AUGM	0.5a	1.325cd	4.25ab	4.075ab	0.05a	0b
AUGI	0.95a	3.4ab	5.875ab	12.6ab	0.0375a	0.025ab
CLRG	2.075a	2.95abc	4.75ab	2.275b	0.0375a	0.175a
CLRM	0.55a	1.125d	4.025ab	14.8a	0.025a	0.1ab
CLRI	3.925a	3.625a	7.65a	1.975b	0.025a	0.05ab
TPLG	1.425a	1.575cd	5.6ab	3.775ba	0.0375a	0.05ab
TPLM	0.425a	1.85abcd	1.8b	1.4b	0.0375a	0.025ab
TPLI	4.05a	1.675abcd	2.175ab	5.5ab	0.025a	0.025ab
±SE	1.394a	0.619	1.908	4.3	0.0245	0.585
Permissible limits (FAO /WHO, 2008)	2-9	3	10	10	0.05	0.15

Mean in the same row having same superscript are not significant different from each other (p>0.05).AUGG=Auchenoglanis occidentalis gill, AUGI= Auchenoglanis occidentalisIntestine, AUGM= Auchenoglanis occidentalis Muscles, CLRG=Clarias gariepinus Gills, CLRI= Clarias gariepinus Intestine, CLRM=Clarias geriepinus Muscles, TPLG=Tilapia gallilaeus Gills, TPLI=Tilapia gallilaeus Intestine, TPLM= Tilapia gallilaeus Muscles.

Table 3-5 above showed the heavy metal concentrations in the various organs of the different species examined during the study. Table 3 showed that Auchenoglanis occidentalis gills accumulated the highest concentration of zinc (6.3mg/L) while the lowest concentration of lead was observed in all the gills of the experimental species. All the metals still fell within the permissible level except Chromium in Clarias gariepinus gills which was a little above the permissible level

Table 4 showed that Clarias gariepinus mussle accumulated more Mn, Fe and Cr compared to the muscles of other species examined while more concentration of Copper was found in Tilapia muscle. However, the highest concentration of metals examined was found in Clarias gariepinus muscle with the value of 14.8 which was far above the permissible limit recommended by WHO

Table 5 showed the mean concentration of heavy metal in the intestine of the experimental fish species. Clarias gariepinus intestine had the highest concentration of Zinc with mean value of 7.65 mg/l least concentration of lead was found in the intestine of Clarias gariepinus and Tilapia and chromium in Auchenoglanis occidentalis intestine. All the heavy metals fell below the acceptable limit, (WHO, 2008).

DISCUSSION

Concentration of heavy metals in the gills, muscles and intestine of three different species (Auchenoglanis occidentalis, Clarias gariepinus and Tilapia zilli) from the Dam do accumulate heavy metals. In line with other studies (Ekeanyanwu et. al., 2010;Abraha et. al., 2012) revealed that heavy metals accumulated in the gills, muscles and intestines of these species. The concentration of these metals in water and fish tissues suggested interrelation of metal accumulation in the various components of the fish as observed by Farag et. al., 2007. The concentration of zinc in the water sample constituted the major portion of the total metal ions determined while Chromium concentration was the lowest. Concentration of the metals fell below the permissible level as prescribed by USEPA and WHO, (2008).

The concentration of copper and Iron were slightly above the recommended level by FAO/WHO, (2008) while other metals fell below the permissible levels. The concentrations of these metals were generally lower in the water compared to their concentration in the fish tissues. This is in agreement with the findings of Chale, 2002; Ekeanyanwu et. al.,, 2010. The result obtained indicates the variation in the heavy metal present during dry and wet season. This variation and differences in concentration might also be attributed to temperature changes within the season, level of runoff during the dry and also level of water in the dam. This is in line with the report from (Akan.et al., 2012). It was observed in Auchenoglanis occidentalis and Clarias gariepinus that only the muscles have significantly different (P<0.05) metal concentration. However, Tilapia gallilaeus gills shows significant difference (P<0.05) in Cu which is not in agreement with result gotten by (Isaq et.al., 2011). They reported that the highest concentration of heavy metals was found in tilapia gills while the lowest was found in the muscles while Clarias gariepinus had the highest concentration in the gills and lowest in the tissues. This may be as a result of the feeding habit of the fish and seasonal changes in the taxonomic composition of the different trophic levels affecting the concentration and accumulation of heavy metals in the body of the fish (Chen and Folt, 2000).

CONCLUSION

It was evident from this study that heavy metals from the water and fish samples were below the permissible level, however, the metal still accumulate in the tissues of fish which may gradually increase above the permissible level if care is not taken. It is equally evident that Agaie-lapai dam is polluted with heavy metal and this call for effective management of this natural resource. It is therefore suggested that regular biomonitoring of heavy metal contaminants in fish is essential in order to prevent excessive buildup of the toxic metals in bio-resources of the Dams.

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