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Toxicity Potential of African Cat Fish (*Clarias gariepinus*) Tissues: A Comparative Study of River Galma, River Kubanni and Fish Farms in Zaria, Nigeria

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ABSTRACT

Concentration of some heavy metals; Lead (Pb), Copper (Cu) and Zinc (Zn), in the head, gills, liver and muscle tissues of Clarias gariepinus from River Galma, River Kubanni and some fish farms in Zaria, Nigeria, were determined using atomic absorption spectrophotometer (AAS), after wet digestion. The concentration of the metals differed significantly (ANOVA; $p < 0.05$) among the four fish tissues. Fish liver and gills appeared to have significantly higher tendency for the accumulation of these metals, while muscles had minimum concentrations. The difference in metal concentrations between the three locations were not statistically significant (ANOVA; $p > 0.05$), the difference of lead concentration between River Galma and fish farms being the only exception. The trend of metals concentration could be represented as: Cu > Zn > Pb. The mean of total concentrations was; lead 1.55 mg/kg, zinc 3.57 mg/kg, copper 5.75 mg/kg for River Galma, lead 0.5 mg/kg, zinc 3.86 mg/kg, copper 5.75 mg/kg for River Kubanni and lead 0.28 mg/kg, zinc 1.0 mg/kg , copper 5.21 mg/kg for fish farms. Comparison of these values with Food and Agricultural Organization (FAO) limits in fish tissue, Codex Committee on Food Additives and Contaminants maximum levels (CCFAC) and Health criteria established by the United States Environmental Protection Agency (US EPA) for human health risk for carcinogens shows that it is unsafe to consume Clarias griepinus tissues from River Galma and River Kubanni with respect to lead toxicity. Copper and zinc were however not implicated in the study.

Key Words: Heavy metals, *Clarias gariepinus*, River Galma, River Kubanni, Fish Farms, FAO limit

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INTRODUCTION

With increasing industrialization, urbanization, population growth and agricultural activities, the global environment has become fragile and has been a cause for concern [1]. Recently, there is a growing awareness of impact on environment of effluents and solid wastes of anthropogenic origin and serious concern on the use of water as a receptacle for such waste [2]. The discharge of industrial effluents and domestic wastes containing toxic substances including heavy metals into water bodies have significant impact on the receiving water quality and the aquatic organisms. As the concentration of metals in the environment increases, the metals inevitably enter the biogeochemical cycle. [3]. The pollution of aquatic environment with heavy metals has become a worldwide problem, because of their toxicity, relative indestructibility and most importantly the fact that water pollution transcend national and international boundaries [4].

Metals are natural component of the earth crust and are commonly found in natural waters. Natural processes may lead to anomalies exceeding average values by an order of magnitude without any anthropogenic contamination.

However, most often than not, sources of heavy metal pollution are actually anthropogenic in nature. Some metals are essential to living organisms, yet they may become highly toxic when present in high concentrations [5]. Aquatic organisms in heavy metals polluted environment may accumulate these metals to concentrations many times higher than present in water. Aquatic foods have essential amino acids, fatty acids, protein, carbohydrates, vitamins and minerals. Among sea foods, fish are commonly consumed and, hence, are a connecting link for the transfer of toxic heavy metals to other consumers. Fish has been recognized as a good accumulator of organic and inorganic pollutants. Age of fish, lipid content of the tissue and mode of feeding are significant factors that affect the accumulation of heavy metals in fishes. *Clarias gariepinus* is a bottom feeder, and ingestion of sediment will be reflected in the metal contents of their tissues. The contamination of fish by trace metals is a potential problem as they are ultimately transferred to other animals including humans along the food chain thus posing serious health challenges [4, 5, 6, 7.].

Elevated levels of certain metals in animals interfere with the absorption of other metals. High concentrations of lead for instance blocks the absorption of potassium, Calcium, Magnesium, Manganese, Zinc, Copper, and iron ion [8]. Zinc, copper and manganese, which are essential elements, compete for the same site in animals. This, no doubt, would affect tissue metal concentrations as well as certain physiological processes [5, 9]. A combination of zinc or cadmium with copper increases the toxic effect of copper several times, representing a synergistic action [10]. The World Health Organization as well as the Food and Agriculture Organization state that monitoring eight elements in fish – Hg, Cd, Pb, As, Cu, Zn, Fe, Sn – is obligatory and monitoring of others is suggested [3].

River Galma and River Kubanni serves as a major source of portable water and fish in Zaria. The Zaria dam is on River Galma and supply water to Zaria metropolis while the Ahmadu Bello University (ABU) dam is on River Kubanni and supply water to the Ahmadu Bello University community and its environs. Fishing is carried out daily on the two Rivers which also serve as a source of water for irrigation. The basins of the two rivers are booming crop farming areas. Most of the industries located in Zaria discharge their waste directly or indirectly into these rivers. Municipal and domestic wastes are also discharged directly or indirectly into the rivers [11]. Since there is no formal control of effluent discharge from industries and homes into the Rivers, it is important to monitor the levels of metals in fish from these rivers in comparison with what obtains at privately owned fish farms. In this study, *Clarias gariepinus* was chosen. The concentration of lead, copper and zinc were measured in the head, gill, liver and muscle of fish in order to assess the potential risk associated with the consumption of fish from the two major rivers in Zaria.

MATERIALS AND METHODS

Study Location

Zaria is located at latitude 1103'N and longitude 7040'E, 128km South- East of Kano and 64km North-East of Kaduna City. River Galma is located at the southeastern part of Zaria and its source is the Jos Plateau. The Zaria dam is located on River Galma [11]. Kubanni River originates in the precincts of the Ahmad Bello University (ABU) Main Campus, Zaria (Northern Nigeria), as a trench in an undulating agricultural land and is fed by a number of tributaries [12]. Kubanni River drains the northwest zone of the city of Zaria and receives effluents mainly from domestic activity and runoff from intense cropping located in the adjoining land. The ABU dam is on the river [12].

Sample preparation

Ten *Clarias gariepinus* (mean weight 130±3g, Mean length 26.8±2.6cm) each were obtained on site from fishermen at the rivers (River Galma, River Kubanni) and five each from two Fish Farms in Sabon Gari area of Zaria, Nigeria. The fishes were stored in a cooler packed with ice block in order to maintain the freshness and latter transported to the Environmental laboratory of the National Research Institute for chemical technology (NARICT), Zaria, Nigeria for dissection of the organs after being washed thoroughly. The dissection was done using plastic knife. 5g of fish tissue was weighed and placed in a beaker, 10ml of freshly prepared concentrated nitric acid / hydrogen per oxide (1:1) was added and covered with a wash glass for initial reaction to subside. The beaker was placed on a water bath at a temperature not exceeding 100^{o}C for two hours to reduce the volume to 3-4ml. The digest was cold filtered into 50mls volumetric flask and made up to the mark.

Metal analysis

Metal analysis was carried out using flame atomic absorption spectrophotometer AA-6800 (Shimadzu, Japan) at National Research Institute for Chemical Technology (NARICT), Zaria-Nigeria. The calibration curves were prepared separately for each of the metals by running different concentrations of standard solutions. The instrument was set to zero by running the respective reagent blanks. Average values of three replicates were taken for each determination and were subjected to statistical analysis. The metals determined includes: Lead, Copper, and Zinc.

Analytical Quality Assurance

In order to check the reliability of the analytical methods employed for heavy metals determination, Lichens coded IAEA-336 was also digested and then analyzed following the same procedure. Double distilled and deionized water was used throughout the experimentation. All the reagents used in this work were AnalaR grades from BDH Chemicals (UK).

RESULTS AND DISCUSSION

To evaluate the accuracy and precision of our analytical procedure, a standard reference material of lichen coded IAEA-336 was analyzed in like manner to our samples. The values determined and the certified values of the five (5) elements determined were very close suggesting the reliability of the method employed (table 1).

Table: 1, Shows the results of analysis of reference material (Lichen IAEA -336) compare to the reference value

Element (Mg/l)	Pb	Cd	Cu	Mn	Zn
A Value	5.25	0.140	4.00	55.78	29.18
R value	4.2-5.5	0.1-2.34	3.1- 4.1	56-70	37-33.80

A Value = Analyzed value and R Value = Reference value.

The mean concentration and standard deviation of lead, copper and zinc in tissue of *Clarias gariepinus* from River Galma, River Kubanni and Fish Farms in Zaria are presented in Table 2. A comparison of mean of total metal concentrations of fish with maximum limits is presented in table 3. The distribution of lead, copper and zinc in the head, gills, liver and muscle of *Clarias gariepinus* across River Galma, River Kubanni and Fish Farms in Zaria are presented in Figures 1, 2, 3 and 4 respectively. Percentage concentrations of metals in organs are presented in figures 5 – 13.

Table 2: Mean ± S.D of lead, copper and zinc in *Clarias garipenus* from River Galma, River Kubanni and fish farms in Zaria, Nigeria

Elements/Sampling Station	River Galma				River Kubanni				Fish Farm			
	Head	Gills	Liver	Muscle	Head	Gills	Liver	Muscle	Head	Gills	Liver	Muscle
Lead	0.13±0.01	0.55±0.04	5.31±2.21	0.19±0.04	0.18±0.01	0.78±0.65	0.78±0.44	0.26±0.08	0.11±0.02	0.52±0.2	0.30±0.28	0.20±0.09
Copper	1.13±0.49	2.18±0.63	19.62±3.90	0.60±0.08	0.53±0.02	2.01±0.58	28.90±11.75	0.51±0.04	0.64±0.39	1.47±0.84	18.07±	0.67±0.01
Zinc	2.56±0.67	5.83±4.12	3.98±3.24	1.91±0.98	2.33±0.86	3.49±2.7	8.76±4.14	0.87±0.46	1.65±0.12	2.23±0.14	1.88±0.23	0.63±0.04

Table 2: A comparison o f Mean o f total metal concentrations with maximum limits

Stations	Heavy Metal	Mean of total concentration in fish (mg/kg)	Maximum limits	Reference
Galma	Lead	1.55±0.58	0.5	FAO (1983)
	Copper	5.75±1.30	30	FAO (1983)
	Zinc	3.57±2.25	30	FAO (1983)
Kubanni	Lead	0.50±0.30	0.5	FAO (1983)
	Copper	7.75±3.04	30	FAO (1983)
	Zinc	3.86±2.04	30	FAO (1983)
Fish farms	Lead	0.28±0.15	0.5	FAO (1983)
	Copper	5.21±0.97	30	FAO (1983)
	Zinc	1.00±0.13	30	FAO (1983)

The lowest mean of total concentration (0.28 mg/kg) of lead was measured in *Clarias gariepinus* from fish farms while the highest mean of total Concentration (1.55 mg/kg) of lead was measured in *Clarias gariepinus* from River Galma (table 3). The trend of lead in *Clarias gariepinus* from the three sampling locations was River Galma > River Kubanni > Fish Farms. Statistical analysis shows that the difference in lead levels across the locations was not statistically significant (ANOVA, $p > 0.05$), the difference between River Galma and Fish Farms being the only exception (ANOVA, $p < 0.05$). Statistical analysis also shows statistically significant difference between lead concentration in liver and head, liver and gills and between liver and muscle with lead concentration of the liver being significantly higher than the concentration in head, gills and muscles at 95% confidence level. The trend of lead in tissues of *Clarias gariepinus* from River Galma, Kubanni and Fish Farms were as follows liver > gills > muscle > head, liver = gills > muscle > head and gills > liver > muscle > head, respectively (table 2). The highest concentration of lead was recorded in the liver in each of the sampling stations, except in the Fish Farm where the highest concentration was recorded in the gills. The lowest concentration was recorded in head in each station. A similar finding was recorded by [13]. High accumulating ability of the liver is said to be the result of the activity of metallothioneins, the proteins that can bind to some metals, thus reducing their toxicity and allowing the liver to accumulate high concentrations [13, 14]. Due to the above reason, Liver has been recommended as the best environmental indicator of both the water pollution and chronic exposure to heavy metals [13]. There was a statistically significant difference of lead concentration in *Clarias gariepinus* liver across the three sampling locations (ANOVA < 0.05), with River Galma being significantly higher than River Kubanni and fish farms (figure1). The order was River Galma > River Kubanni > Fish Farms. The tissue with the second highest concentration of lead in this study was the gills. Lead concentration of gills followed the order River Kubanni > River Galma > Fish Farms (figure 2). The difference in lead concentration of fish gills was not statistically significant at 95% confidence level. Gills could be important as a site of direct metal uptake from water [13, 15].

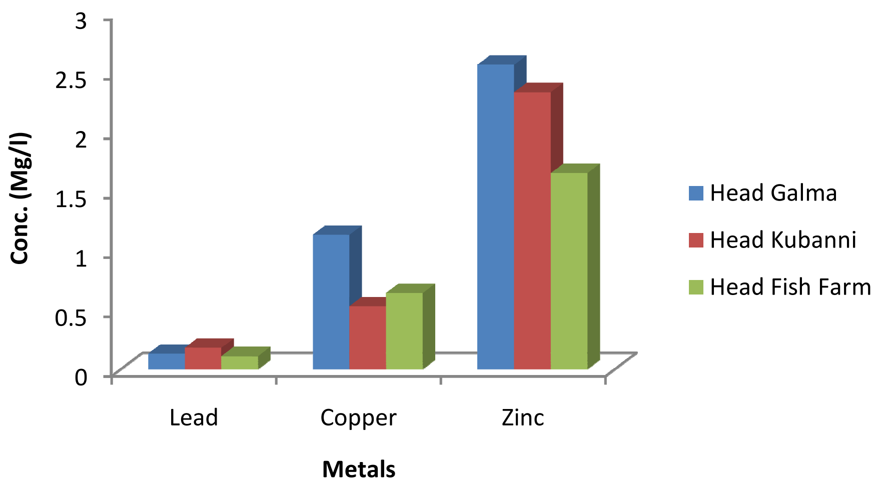

Figure 1: The dispersion of lead, copper and zinc in the head of *Clarias gariepinus* across River Galma, River Kubanni and Fish Farms in Zaria

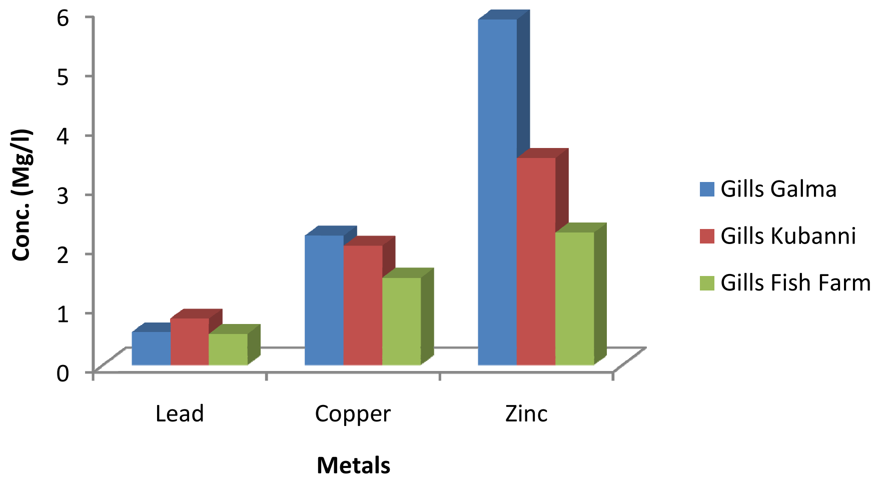

Figure 2: The dispersion of lead, copper and zinc in the gills of *Clarias gariepinus* across River Galma, River Kubanni and Fish Farms in Zaria

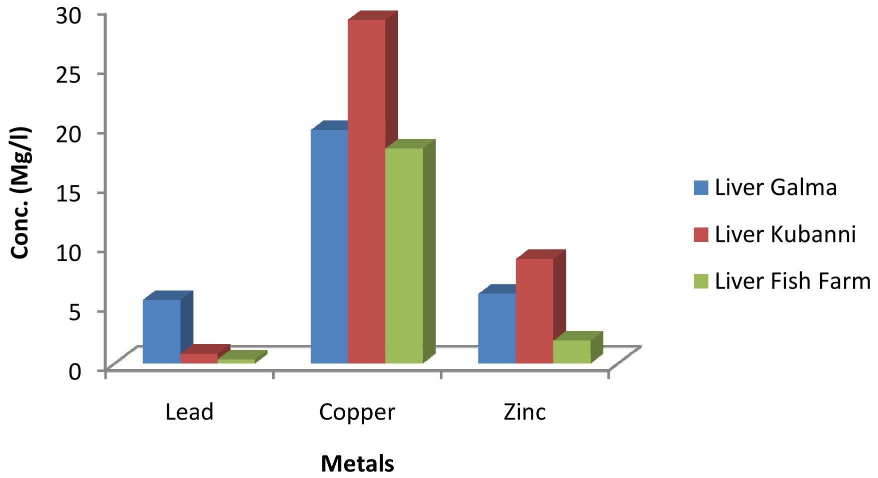

Figure 3: The dispersion of lead copper and zinc in the liver of *Clarias gariepinus* across River Galma, River Kubanni and Fish Farms in Zaria

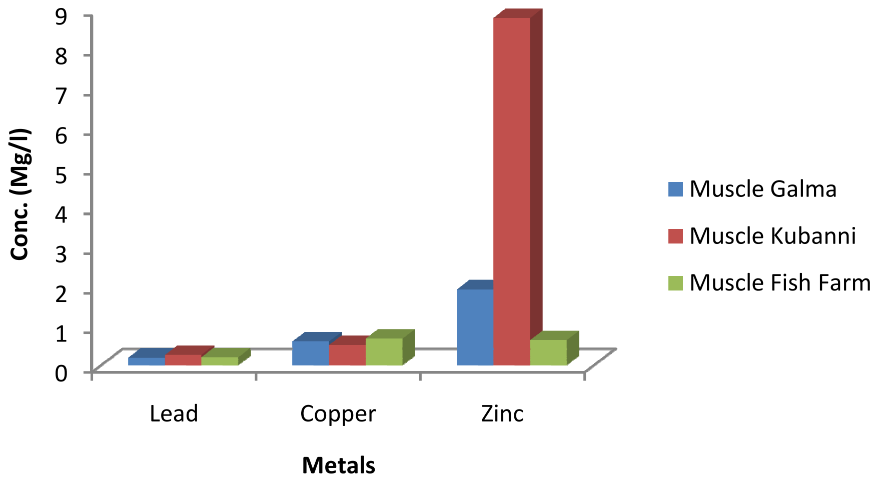

Figure 4: The dispersion of lead, copper and zinc in the muscle of *Clarias gariepinus* across River Galma, River Kubanni and Fish Farms in Zaria

High metal concentrations in gills can point out the water as the main source of contamination [13]. Lead concentration in head in the study followed the order River Kubanni > River Galma > Fish Farms. Statistical analysis revealed a significant difference in lead levels in head between River Galma and River Kubanni and between River Kubanni and Fish Farms (ANOVA, $p < 0.05$). The difference between River Galma and Fish Farms was not statistically significant (ANOVA, $p > 0.5$). Lead concentration in muscle was observed to follow the order; River Kubanni > Fish Farms > River Galma. There was no statistically significant difference in lead levels in fish muscles across the three sampling locations (ANOVA, $p > 0.05$). Findings of this study shows that the percentage concentration of lead in *Clarias gariepinus* tissue was Head 2%, Gills 9%, Liver 86% and Muscle 3% for River Galma, Head 9%, Gills 39%, Liver 39% and Muscle 13% for River Kubanni and Head 10%, Gills 45%, Liver 27% and Muscle 18% for Fish Farms (figures 5 - 7). Recorded data from this study indicates that the mean of total concentrations of lead (1.55mg/kg) measured in *Clarias gariepinus* from Rivier Galma was over three times the Food and Agricultural Organization (FAO) guideline of 0.5mg/kg [16]. Though the mean total concentration of lead (0.5mg/kg) measured in *Clarias gariepinus* from River Kubanni equals the FAO guideline, the liver and gills had lead concentration higher than the FAO guideline. Consuming *Clarias gariepinus* from River Galma and River Kubanni could pose serious health risk. The mean total concentration of lead (0.2mg/kg) measured in *Clarias gariepinus* from fish farms was below FAO guideline thus pose no significant toxicological risk. The mean total concentration of lead measured across River Galma, River Kubanni and Fish Farms were above (or equal to in the case of fish farms) the Codex Committee on Food Additives and Contaminants maximum levels (CCFAC) of 0.2mg/kg, but below the health criteria (4mg/kg) established by the United States Environmental Protection Agency (US EPA), for human health risk for carcinogens [17]. Lead levels in liver of *Clarias gariepinus* from River Galma found to be above the US EPA health criteria being the only exception. Lead is classified as one of the most toxic heavy metals. There is no exposure limit below which lead appear to be safe. WHO has recently withdrawn the Provisional Tolerable Weekly Intake (PTWI) value for lead on the grounds that it is not possible to set an intake value that is protective for health [18]. Lead is number 2 on the Agency for Toxic Substances and Disease Registry (ATSDR) Top 20 List, and accounts for most of the cases of pediatric heavy metal poisoning [19]. It interferes with the normal development of a child's brain and nervous system; therefore children are at greater risk of Lead toxicity. The effect on peripheral nervous system on the other hand, is more pronounced in adults. Lead absorption constitutes serious risk to public health. It induces reduced cognitive development and intellectual performance in children, increased blood pressure, and cardiovascular diseases in adult as well as liver and kidney dysfunction [20, 21].

The highest mean of total copper concentration (7.75 mg/kg) was measured in *Clarias gariepinus* from River Kubanni while the lowest mean total copper concentration (5.21mg/kg) was measured in *Clarias gariepinus* from

Fish Farms (table 3). Copper concentration in *Clarias gariepinus* from the three sampling locations followed the trend: River Kubanni > River Galma > Fish Farms. No statistical significant difference was observed in copper levels cross the locations (ANOVA, $p < 0.05$). A significantly higher level of copper was found in the liver than in other fish tissues (ANOVA, $P > 0.05$). Similar findings have also been recorded by other authors [13, 14]. Statistically significant difference was observed between copper concentration in liver and head, liver and gills and between liver and muscle with copper concentration in liver being significantly higher than the concentration in head, gills and muscles at 95% confidence level. Copper concentration in *Clarias gariepinus* tissues followed the trend; liver > gills > head > muscle for River Galma and River Kubanni, and liver > gills > muscle > Head for Fish Farms (figures 8, 9, 10). The highest concentration of copper was recorded in the liver in each of the sampling stations (table 2). The liver copper concentrations are usually regulated by a homeostatic control below 50 µg/g dry weight, and can exceed this threshold only if the control mechanisms are overloaded [13]. Higher copper levels in liver usually imply loss of regulatory control of liver copper. The lowest concentration was recorded in muscle in each station except in Fish Farms where the lowest copper concentration was recorded in head (Table 2). There was no statistically significant difference in copper concentration in *Clarias gariepinus* liver across the three sampling locations at 95% confidence level. Copper concentration in liver followed the order: River Galma > River Kubanni > Fish Farms (figure 3). The tissue with the second highest concentration of copper was the gills (figure 8, 9, 10). Copper concentration in gills followed the order; River Galma > River Kubanni > Fish Farms (and figure 2). Copper concentration in head followed the order; Fish Farms > River Galma >River Kubanni (figure 1). Statistical analysis revealed no significant difference in copper levels in head between River Galma and River Kubanni and between River kubanni and fish farms (ANOVA, $p > 0.5$). Copper concentration in fish muscle also followed the order; Fish Farms > River Galma > River Kubanni (figure 1). There was no statistically significant difference in copper levels in fish muscles across the three sampling locations (ANOVA, $p > 0.05$). The percentage concentration of copper in *Clarias gariepinus* organs was Head 5%, Gills 9%, Liver 83% and Muscle 3% for River Galma, Haed 2%, Gills 7%, Liver 90% and Muscle 2% for River Kubanni and Head 3%, Gills 7%, Liver 87% and Muscle 3% for Fish Farms (figures 8 - 10). Copper is an essential part of several enzymes and is necessary for the synthesis of haemoglobin, but very high intake of copper can cause adverse health problems [22]. The findings of this study indicates that the mean of total concentration of copper measured in *Clarias gariepinus* from Rivier Galma (5.75mg/kg), River Kubanni (7.75mg/kg) and Fish Farms (5.21mg/kg) were below the Food and Agricultural Organization (FAO) maximum limit of 30mg/kg [16] and the health criteria established by the United States Environmental Protection Agency (US EPA) for human health risk for carcinogens (480mg/kg). Consuming *Clarias gariepinus* from River Galma, River Kubanni and Fish Farms in Zaria therefore pose no significant toxicological risk with respect to copper intoxication. For an average adult (60 kg body weight), the provisional tolerable daily intake (PTDI) for copper is 3mg for fish muscle [23]. Abnormal accumulation of copper in the tissue and blood causes Wilson disease. Most of the absorbed copper is stored in the liver and bone marrow. Acute exposure to copper causes vomiting, diarrhea, hypertension and cardiovascular collapse [24].

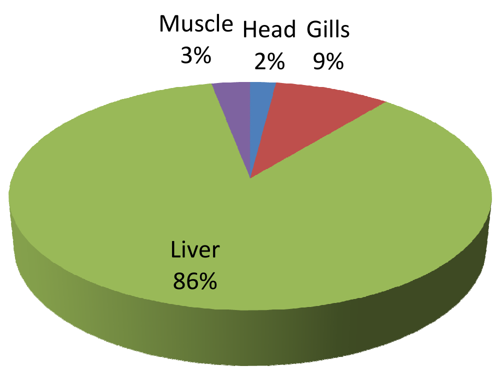

Figure 5: Percentage concentration of lead in organs of *Clarias gariepinus* from River Galma

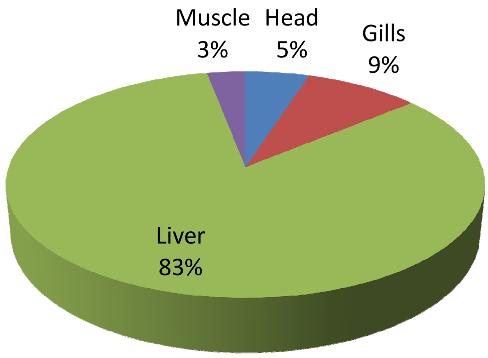

Figure 8: Percentage concentration of copper in organs of *Clarias gariepinus* from River Galma

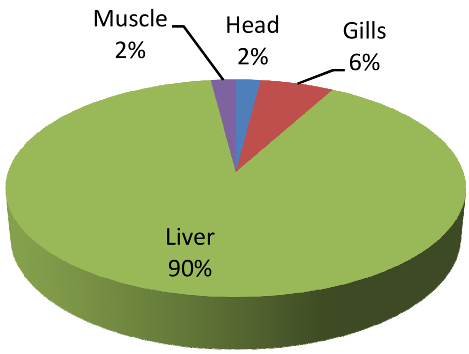

Figure 6: Percentage concentration of lead in of organs *Clarias gariepinus* from River Kubanni

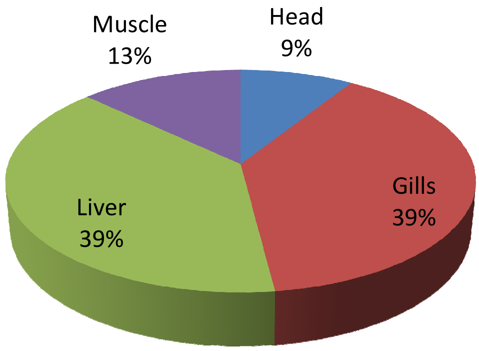

Figure 9: Percentage concentration of copper in organs of *Clarias gariepinus* from River Kubanni

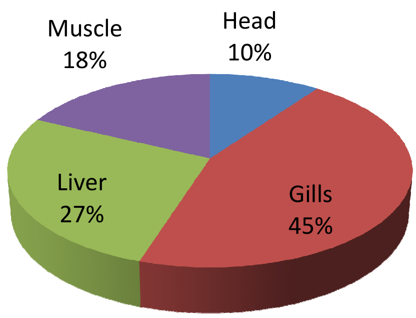

Figure 7: Percentage concentration of lead in organs of *Clarias gariepinus* from Fish farm

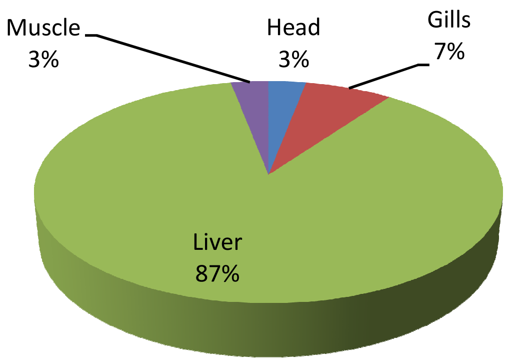

Figure 10: Percentage concentration of copper in organs of *Clarias gariepinus* from Fish Farms

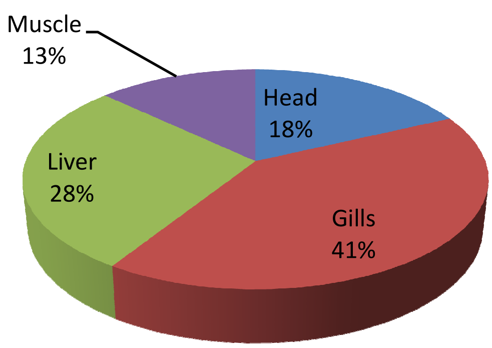

Figure 11: Percentage concentration of zinc in organs of *Clarias gariepinus* from River Galma

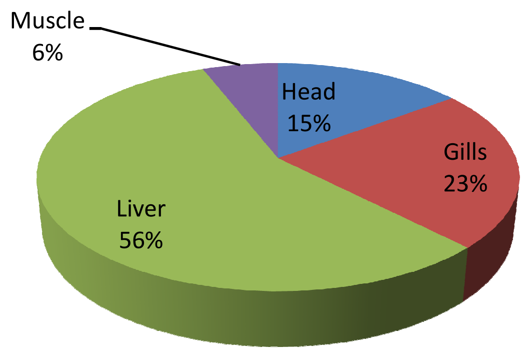

Figure 12: Percentage concentration of zinc in organs of *Clarias gariepinus* from River Kubanni

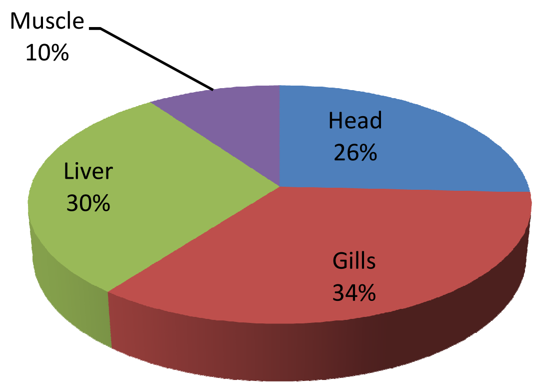

Figure 13: Percentage concentration of zinc in organs of *Clarias gariepinus* from Fish Farms

The lowest mean of total concentration of Zinc (1.0mg/kg) was measured in *Clarias gariepinus* from Fish Farms while the highest mean total concentration (3.86 mg/kg) was measured in *Clarias gariepinus* from River Kubanni (table 3). The trend of zinc in *Clarias gariepinus* from the three sampling locations was River Kubanni > River Galma > Fish Farms. Statistical analysis revealed that the difference in total zinc concentrations between River Galma and River Kubanni, and between River Galma and Fish Farm were not statistically significant (ANOVA, $p > 0.05$), but the difference between River Kubanni and Fish Farm was statistically significant (ANOVA, $p < 0.05$). There was no statistically significant difference in zinc levels between the tissues (head, gills, liver and muscle) of *Clarias gariepinus* at 95% confidence level. The trend of zinc in organs of *Clarias gariepinus* from River Galma, Kubanni and Fish Farms were as follows gills > liver > head > muscle, liver > gills > head > muscle and gills > liver > head > muscle, respectively. The highest mean concentration of zinc in the tissues was recorded in the gills for fish from River Kubanni and Fish Farms (table 3). The highest mean concentration of zinc in the tissues of *Clarias gariepinus* from river Kubanni was recorded in the liver (table 2). The lowest concentrations were recorded in muscle in each station. Several studies have determined the highest zinc concentrations in gills [13, 25, 26] and their findings are in agreement with this study.

A statistically significant difference in the concentration of zinc in liver of *Clarias gariepinus* between River Kubanni and Fish Farm was observed (ANOVA < 0.05). The difference in the concentration of zinc in liver of

Clarias gariepinus between River Galma and River Kubanni, and between River Galma and Fish Farms were not statistically significant at 95 % confidence level. Zinc concentration in liver followed the order: River Galma > River Kubanni > fish farms (figure 3). In this study gills recorded a comparable high concentration as the liver. Zinc concentration in gills followed the order River Galma > River Kubanni > Fish Farms (figure 2). The difference was not statistically significant at 95% confidence level. Zinc concentration in fish head followed the order River Galma > River Kubanni > Fish Farms (figure 1). There was no statistically significant difference in zinc levels in head between River Galma, River Kubanni and fish farms (ANOVA, $p > 0.5$). It was observed that zinc concentration in muscle followed the order River Galma > River Kubanni > Fish Farms (figure 4). There was no statistically significant difference in zinc levels in muscles across the three sampling locations (ANOVA, $p > 0.05$). Findings of this study shows that the percentage concentration of zinc in *Clarias gariepinus* tissues was Head 18%, Gills 41%, Liver 28% and Muscle 13% for River Galma, Head 15%, Gills 23%, Liver 57% and Muscle 6% for River Kubanni and Head 26%, Gills 35%, Liver 29% and Muscle 10% for Fish Farms (figures 11 - 13). Zinc is an important element the body needs to function properly. A small amount of Zinc is necessary for a balanced human diet. It helps maintain immune function, cell division and repair, and helps in the metabolism of carbohydrate. Zinc is also needed for the sense of taste and smell [27]. The mean total concentration of zinc measured in *Clarias gariepinus* from Rivier Galma (3.57mg/kg), River Kubanni (3.86mg/kg) and Fish Farms (1.0mg/kg) were below the Food and Agricultural Organization (FAO) maximum limit of 30mg/kg [16] and the health criteria established by the United States Environmental Protection Agency (US EPA) for human health risk for carcinogens (120mg/kg). Consuming *Clarias gariepinus* from River Galma, River Kubanni and Fish Farms in Zaria thus pose no significant toxicological risk with respect to zinc intoxication. The recommended daily zinc intake for adults is between 9 and 11 mg per day. However, exposure to excess amount of zinc can result to zinc poisoning. According to the National Institutes of Health, zinc toxicity starts between 35 and 40 mg daily [27, 28]. Zinc poisoning can be deadly if not detected and treated quickly. Zinc is an intestinal irritant, and the first sign of zinc poisoning is usually intestinal distress. This includes, vomiting, stomach cramps, diarrhea, and nausea. Further symptoms of zinc poisoning are low blood pressure, urine retention, jaundice, seizures, joint pain, fever, coughing, and a metallic taste in the mouth as well as induce copper deficiency [27, 28]

Statistical analysis revealed a strong positive Correlation between lead and copper concentration across the sampling point suggesting same source. The correlation was statistically significant at 99% confidence level. A weak positive correlation was observed between copper and zinc concentrations in fish organs. A weak negative correlation was observed between lead and zinc concentration in fish organs suggesting different sources.

CONCLUSION

Fish have been recognized as a good accumulator of organic and inorganic pollutants. The contamination of fish and other seafoods by trace metals is a potential problem as they are finally transferred to other animals including humans along the food chain. Assessment of the heavy metal levels in food fish is therefore of particular importance. In this study, lead, copper and zinc levels were investigated in *Clarias gariepinus* from River Galma, River Kubanni and Fish Farms in Zaria. Metal contents were generally higher in *Clarias gariepinus* from River Galma and River Kubanni than Fish Farms. Lead level was higher in fish from River Galma than River Kubanni whereas copper and zinc levels were higher in River Kubanni than River Galma. The study revealed that liver and gills accumulates higher concentrations of metals. Fish muscles, comparing to the other tissues contained the lowest levels of metals. Comparison of metal contents obtained in the study to FAO, US EPA and CCFAC permissible limits shows that lead poisoning can occur from the consumption of the *Clarias gariepinus* from River Galma and River Kubanni by humans. Copper and zinc were not implicated in the study. In view of the importance of fish to diet of man, it is necessary that biological monitoring of the water and fish meant for consumption should be done regularly to ensure continuous safety of the seafood.

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