Levels of Heavy Metals in Water and Sediments of River Ngadda and the Concentration in *Clarias gariepinus*

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Abstract

Food is necessary for survival, and its variety determines its nutritional value. Fish are among the most important of all. However, their breeding may encounter challenges some of which are, the water used for their breeding. Some of this water may be contaminated with poisonous heavy metals. Their contaminations with heavy metals from water, soil and atmospheric particles pose threat to quality and safety of life and the environment. Heavy metals such as cadmium (Cd), Copper (Cu), lead (Pb) and Zinc (Zn), have toxic effects on human health which may accumulate in the body over time. The concentrations of Cd,Cu, Pb, and Zn was determined in fish (Clarias gariepinus) which were freshly harvested within three locations (location A, B, and C) in river Ngadda Maiduguri, Borno State, Nigeria. Samples were collected during dry season. Metal concentrations in the samples were determined using Atomic Absorption Spectroscopy (AAS), one way ANOVA and correlations was used to determine significant difference in the levels of heavy metals. The result of Clarias gariepinus reveal that statistically there is no any significant difference because the $P \geq 0.01$ there were strong positive correlations between Cu, Cd, and Zn, but Pb did not show significant correlations with these metals. All the valves recorded were within the permissible limit. Statistically it was reveals that water and sediment analysis, has no significant difference ($P \geq 0.01$). However, only Cd in water (0.030±0.01, 0.030±0.01, 0.180±0.11) exceeded the threshold limit (0.01) in all locations. Strong positive correlations were found between the metals.

Keywords: *Clarias gariepinus, fish, river Ngadda, heavy metals, human health, concentration*

Introduction

Food is necessary for survival, and its variety determines its nutritional value. Fish is among the most important of all. However, their breeding may encounter challenges, some of which are, the water used for their breeding. Some of this water may be contaminated with poisonous heavy metals. Heavy metals are any metallic chemical element that has a relatively high density and is poisonous at low concentrations (Abduljaleel, *et al.* 2012; Mohsen and Salisu, 2008; Mcdowell *et al.* 2006). Heavy metals are classified into essential and non-essential (bioelements) some of these elements such as bioelements are importance for survival and growth. However, Heavy metals such as lead (Pb), cadmium (Cd), arsenic (As), Copper (Cu), Zinc (Zn), (essential) have toxic effects on human health which may accumulate in the body

over time (Adepoju-Bello *et al.* 2009). These metals can adversely have effect on the liver, kidney, lung, heart and can lead to cancer in humans (Ekong; Jaar & Weaver 2007; Navas-Acien *et al.,* 2007; Chiou, *et al.,* 1995; Hartley & Lepp. 2008; Klaassen; Liu; & Choudhuri. 1999; Patrick, 2003; Rahman *et al.,*2014 and Harmanescu *et al.,*2011). Metal contaminants in water bodies can come from either natural or anthropogenic origin. Most times heavy metals introduced into the aquatic environment are by anthropogenic sources and can cause serious health effects with varied symptoms depending on the nature and quantity of the metal Examples of anthropogenic activities particular are waste disposal, institutional, commercial, industrial and domestic wastewater (Marcovecchio *et al.,* 2007). Fish are readily available and affordable and serve as a source of carbohydrates, proteins, vitamins, minerals, and fibers as such many people consumed lager quantity of fish in their diet. Heavy metals is one of the challenge of improper wastewater disposal for aquaculture production, this is because they are non-degradable and often accumulate through trophic level causing a deleterious biological effects (Aktar *et al.,* 2010). The accumulation of heavy metals in fish tissues is highly dependent upon the concentration of heavy metals in the water and exposure period (Nyirenda *et al* 2013). Under certain environmental conditions heavy metals can accumulate up to toxic concentrations and cause ecological damage. In most cases fish is used as indicative factors in estimation of metal pollution in aquatic, the aquatic system because they lie at the top of the aquatic food chain and may accumulate large amount of some metals from the water (Abdel-Baki *et al.,* 2013). *Clarias gariepinus* mostly selected organism in various study for heavy metal contamination due to its feeding behaviour and bottom feeding habits (Obasohan *et al.,* 2008), in addition they are able to tolerate adverse aquatic conditions where other cultivable fish species cannot survive. Contamination of heavy metal in fish flesh and its health hazard effects to the human gain more concern to food scientists. Almost all heavy metals are potentially harmful to most living organisms after exposure and adsorb certain level of it (Aktar *et al.,* 2011). The most reported toxic heavy metals to human health from contaminated aquatic organisms are cadmium (Cd), Mercury (Hg) and Lead (Pb) (Omar, 2013) and some persistent organic pollutants (POPs) as a result of pollution from agriculture, industries, mining, household effluents and vector control (Polder *et al.,*2014). Among other effects, heavy metals may interfere with the major functions of the endocrine system of human and were termed endocrine disrupters. The study by Georgescu *et al.* (2011) demonstrated that heavy metals such as cadmium (Cd), arsenic (As), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn) may exhibit endocrine-disrupting activity in animal experiments. It was said that in most of developing countries, human is highly exposed to chronic heavy metals pollution and the effects are not clearly understood due to low knowledge on symptoms and medication (Nziku and Namkinga, 2013). Therefore, investigation of contamination of fish with heavy metals that are highly toxic to human being is of great importance for taking appropriate measures to protect public health and the environment at large (Singh *et al.,* 2012). It was reported that the outbreaks of food-related illness are due to pathogenic microorganism rather than to chemical or physical contaminants (Amagliani *et al.,* 2012). Presence of faecal coliform in fish intended for human consumption may constitute a potential danger of causing disease (Ampofo and Clerk, 2010). Escherichia coli and Staphylococcus aureusand Salmonella are within group of pathogenic bacteria which cause food poisoning that lead to public health problem associated with fish and fishery products (Henson & Humphrey, 2009). Fish are suitable bioindicator animals because they respond with great sensitivity to changes in the aquatic environment (Colborn and Thayer 2000; Siroka and Drastichova 2004; Van der Oost, Beyer, and Vermeulen 2003; Van Vuren, Van der Merwe and Du Preez 1994). Catfish (*Clarias gariepinus*) is one of the most important individual species in traditional freshwater fisheries in Africa (Skelton, 2001). Furthermore, it is widely distributed in Africa, where it occurs in almost any freshwater habitat, but favours floodplains, large sluggish rivers, lakes and dams. Cat fish can be able to

crawl on dry ground to escape drying pools. It can survive in shallow mud for long period of time, between rainy seasons. The fish is omnivorous, feeding on fish, birds, frogs, small mammals, reptiles, snails, crabs and other invertebrates. It is also capable of feeding on seeds and fruit (Jansen *et al.*2013). *Clarias gariepinus* is usually dark gray or black colaration on the back, fading to a white belly. It has an average adult length of 1- 1.5; it reaches a maximum length of 1.7m and can weight up to 60kg(Jansen *et al.* 2013) it belong to phylum Chordata, Class: Actinopterygii, Order: Siluriformes, Family: Clariidae, Genus: *Clarias gariepinus* (Anoop *et al.* 2009).

River Ngadda which traverses Maiduguri urban, and serves as a source of surface water use for domestic and agricultural activities especially to many of the urban inhabitants that dwell along its length of flow, has over the years suffer consistent quality compromise. This is as a result of channelization of urban wastewater generated through varied activities such institutional domestic, industrial and agricultural activities as was reveal from the study survey. The continuous discharge of the wastewater into the river may have negative effects on the flora and fauna that depend on it. In Nigerian urban centers for instance, many people consumed lager quantity of fish in their diet, and Maiduguri inhabitants therefore are not exceptions. Therefore, the study is motivated

Materials and methods

Data was collected from water, Sediment and catfish (*clarias gariepinus)* from river Ngadda. *Clarias gariepinus* being the most common fish consumed by the people and is abundant in River Ngadda. Samples of water, Sediment and catfish (*clarias gariepinus)* were collected from three different sites along the River Ngadda corresponding to the points where notable discharge of wastewater occurs (figure1). *Clarias gariepinus* being the most common fish consumed by the people and is abundant in River Ngadda. The sampled *Clarias gariepinus* were caught by fishermen and sediment was collected from River Ngadda, were placed in clean polythene bags labelled with an identified number and taken to the laboratory on the same day pending extraction. Water samples were collected at the surface in 40mL acid-washed polyethylene sample bottles, at each of the designated point taking care not to incorporate sediment into the samples. The samples were acidified with 10 mL of 1:1 nitric acid: deionized water.

Samples were collected from Lagos bridge (point1), Gwange bridge (point 2), and Custom bridge (point 3) see figure 1. In each point 20 samples of *Claries gariepinus* were randomly collected from each of the three sampling points. The total experimental unit were three locations, 20 fish in each location to give a total of 60 specimens (20 x 3 = 60). The fish were transported to the Department of Fisheries laboratory of University of Maiduguri, Borno State, Nigeria for identification.
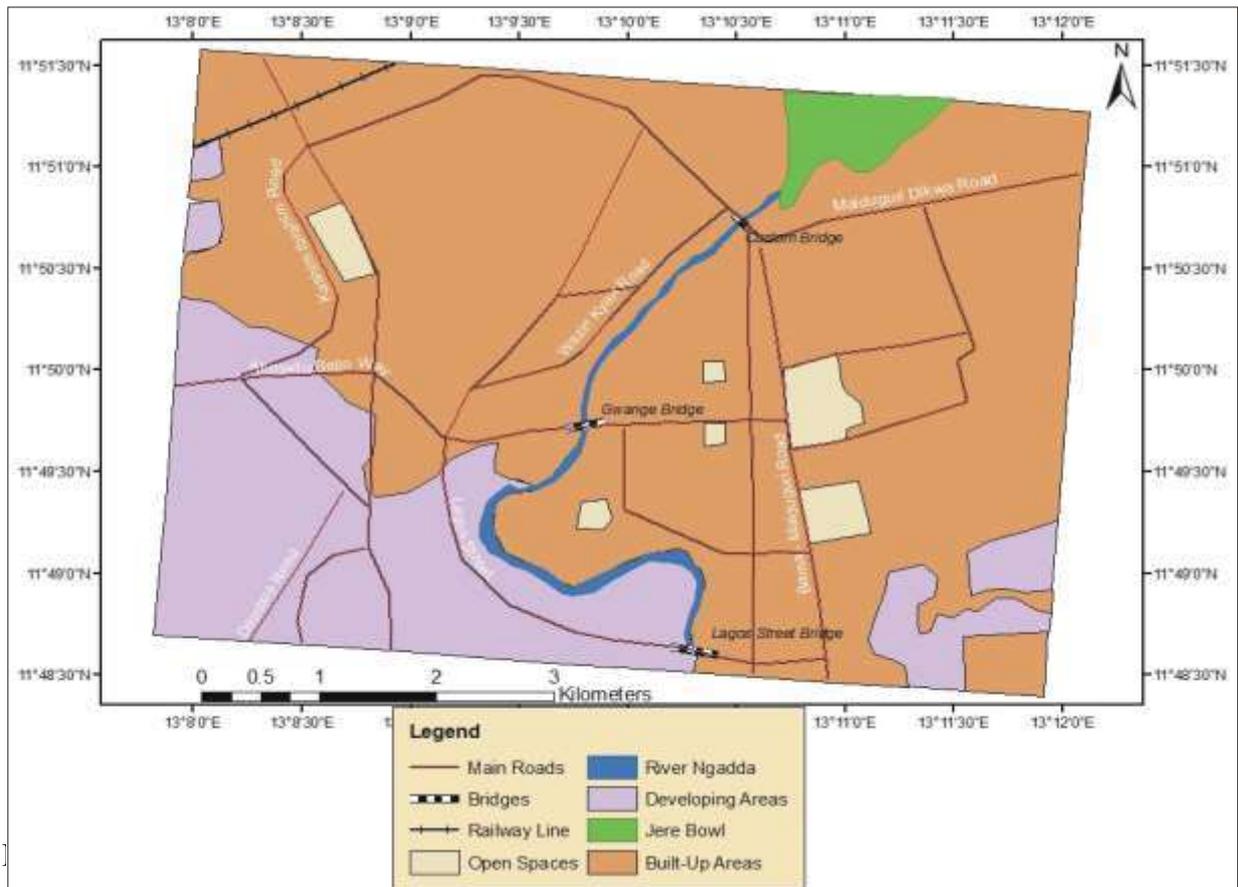
Sample preservation and Pretreatment

After the identification by Department of Fisheries, the *Clarias gariepinus* were dissected to remove the intestine, liver, flesh and gills of each sampled fish. The intestines, livers, flesh and gills tissues of each fish samples were dried at 105°C until they reached a constant weight. The dried samples were grinded into powder form using porcelain mortar and pestle. The fine powder was then dispensed into plastic bottles and ready for analysis.

Water samples were filtered using Whatman No. 1 filter paper and stored at 4^0C. Sediment samples were freeze-dried and passed through a 1 mm clean plastic sieve to remove shell fragments. Sieved sediments were ground in an agate mortar. The powdered sediments were then transferred to a clean nylon membrane sieve (0.071 mm) and shaken to obtain a fine homogeneous powder. A sample of 0.5g of dried sediment material was weighed for digestion.

Determination of heavy metals in Fish

Concentrations of the heavy metal; (Cu,Cd,Zn,& Pb) in the sampled Fish were determined using the wet digestion method involving three acids as described by Gallaher *et al.* (1975) and Damenna and Nacleau (1993). A quantity of 0.5g each of each oven dried ground, sieved was weighed into a 125ml Erlenmeyer flask and digested with mixture of conc. HNO_3, 60% $HCLO_4$ and conc. H_2SO_4 (32.5:4:1 v/v) under a fume hood. The mixture was cooled and filtered into a 100ml volumetric flask and the volume made up to the mark with distilled water. The concentrations of Cu, Cd, Cn and Pb were then determined using Atomic Absorption Spectrophotometer (AAS).

Quality Control/Assurance in experimental samples

Samples were kept in clean polythene bags during transportation to the laboratory to avoid contamination from external environment. Reagent blanks were used in all analysis to check reagent impurities and other environmental contamination during analysis (Anake *et al*, 2009, *cited in* Sabo 2013). Analytical reagent (AnalaR) grade chemicals and distilled water were used throughout the study. Detergent and 20% (v/v) concentrated Trioxonitrate (IV) acid were used in washing the glassware and plastic containers then rinse with water and finally with distilled water (Audu & Lawal, 2005; Sabo 2013). Furthermore, the instruments were calibrated prior to use, equally the tools and work surface were carefully cleaned for each sample to avoid cross contaminations.

Analysis of variance (ANOVA)

All the data were analyzed using statistical software "R" 2013 version. One-way ANOVA was used to determine whether there is significant difference in the levels of heavy metals concentration in fruits vegetable and between locations.

Results

Mean concentration of heavy metals in Flesh, Gills, Liver, and Intestine of Clarias gariepinus

As reveal from Table 1 the mean concentration of all the studied metals in Flesh, Gills, Liver, and Intestine of *Clarias gariepinus* samples, the concentrations of the metals are detected in all the organs of the sample Clarias gariepinus. as presented, the highest mean concentration of both Cu and Zn with values 1.061 ± 0.62 and 1.484 ± 1.30 are in the liver, followed by the Gills 0.098 ± 0.08 and 0.127 ± 0.11, than intestine 0.089 ± 0.09 and 0.543 ± 0.39 respectively. The least mean concentration was found in the flesh with 0.032 ± 0.03 and 0.049 ± 0.04 respectively. Statistically there is no any significant difference because the P-valves are greater than 0.01 ($P \geq 0.01$). Moreover, the mean concentration of Cd in Table 1 shows that intestine had the highest mean concentration of 0.022 ± 0.02 than 0.014 ± 0.01 in gills. The least mean concentration was found in the both flesh and liver with 0.008 ± 0.01. While the result for Pb in Table 10 indicates that the gills of the *Clarias gariepinus* samples had the highest mean concentration of 0.190 ± 0.04 followed by intestine (0.152 ± 0.08) and flesh (0.144 ± 0.12). The liver of the *Clarias gariepinus* had the least mean concentration of 0.094 ± 0.08. The differences were not significant because the $P \geq 0.01$. The findings of this study reveals statistically there is no any significant difference because the P-values are greater than 0.01 ($P \geq 0.01$). Moreover, there were strong positive correlations between Cu, Cd, and Zn, but Pb did not show significant correlations with these metals.

Table 1: Mean Concentration of heavy metals (mg/kg) in fish organs from the three sampling locations

Fish body part	Conc.Cu±SD	Conc.Zn±SD	Conc.Cd±SD	Conc.Pb±SD
Flesh	0.032 ± 0.03	0.049 ± 0.04	0.008 ± 0.01	0.144 ± 0.12
Gills	0.098 ± 0.08	0.127 ± 0.11	0.014 ± 0.01	0.190 ± 0.04
Kidney	0.650 ± 0.21	0.919 ± 0.45	0.033 ± 0.03	0.186 ± 0.09
Liver	1.061 ± 0.62	1.484 ± 1.30	0.008 ± 0.01	0.094 ± 0.08
Intestine	0.089 ± 0.09	0.543 ± 0.39	0.022 ± 0.02	0.152 ± 0.08
p-value	0.028	0.043	0.519	0.658
Standard	3.0	30	0.5	2.0

Mean Concentration (mg/kg) of heavy metals in *Clarias gariepinus*

The mean value of heavy metals in *Clarias gariepinus* by locations as presented in Table 2 the mean concentration of Cu (0.485 ± 0.75mg/kg) recorded in *Clarias gariepinus* samples collected at location A was the highest whereas the lowest (0.234 ± 0.19mg/kg) was recorded in sample obtained at location B. The mean values of Zn were 1.086 ± 1.11mg/kg (highest) at location C and 0.294 ± 0.22 mg/kg (lowest) at location B. The mean values of Cd at location C was recorded highest with 0.027 ± 0.02mg/kg and the least was recorded at location A (0.003 ± 0.00) moreover, the highest value recorded in Pb was recorded at location B with 0.204 ± 0.07 and the least was recorded at location A (0.094 ± 0.08mg/kg). Statistically there is no any significant difference between the location because the $P \geq 0.01$. Strong correlations were found between Cu and Cd (r =0.929), Cu and Zn (r = 0.969), Cd and Zn (r = 0.890) in location A, while Cd and Zn (r = 0.961) Cu and Zn (r =0.839) for location B and C respectively at the p < 0.01 level. There were relative strong positive correlations between Cu, Cd, and Zn, but Pb did not show significant correlations with these metals.

Table 2: Mean Concentration (mg/kg) of heavy metals in Clarias gariepinus by location

Location	Conc.Cu±SD	Conc.Zn±SD	Conc.Cd±SD	Conc.Pb±SD
A	0.485 ± 0.75	0.493 ± 0.61	0.003 ± 0.00	0.094 ± 0.08
B	0.234 ± 0.19	0.294 ± 0.22	0.021 ± 0.02	0.204 ± 0.07
C	0.440 ± 0.45	1.086 ± 1.11	0.027 ± 0.02	0.162 ± 0.06
p-value	0.565	0.533	0.046	0.208
Standard	3.0	30	0.5	2.0

Mean concentration of heavy metals in water sample

Table 3 indicates the mean values of heavy metals in water samples by locations which Cu found to be highest in location B (0.150 ± 0.04mg/l) while the least concentration was recorded in water sample obtain from location C (0.076 ± 0.02mg/l).the mean Zn concentration (0.139 ± 0.06mg/l) obtained at location A was highest than those recorded at locations B and C of which location B was with the least value (0.098 ± 0.04mg/l). Mean concentration of Cd (0.180 ± 0.11mg/l) was highest at location C both location A and B were recorded with the least values 0.030 ± 0.01mg/l. However, statistically it was reveals that, there is no significant difference $(P \geq 0.01)$. However only Cd exceeded the threshold limit recommended by FAO. Strong correlations were found between Cu and cd(r =0.670), Cu and Zn (r = 0.683) Pb and Zn (r =0.713) in location A, while Cu and Pb(r = 0.899) Cd and Pb (r =0.516) Pb and Zn (r =0.962) for location B and whereas, Cu and Pb(r = 0.563) Cd and Zn (r = 0.784) Pb and Zn (r =0.784) respectively at the p < 0.01 level. There were relative strong positive correlations between Cu, Cd, Pb and Zn.

Table 3: The mean Concentration of heavy metals (mg/L) in water obtained from River Ngadda at the three sampling locations

Location	Conc. Cu±SD	Conc.Zn±SD	Conc. Cd±SD	Conc. Pb ± SD
A	0.135± 0.04	0.139 ± 0.06	0.030 ± 0.01	0.126 ±0.03
B	0.150 ± 0.04	0.098 ± 0.04	0.030 ± 0.01	0.132 ± 0.06
C	0.076 ± 0.02	0.116 ± 0.03	0.180 ± 0.11	0.431± 0.46
p-value	0.078	0.543	0.024	0.592
Standard	0.20	2.0	0.01	5.0

Mean concentration of heavy metals in sediment

The mean Concentration of heavy metals (mg/kg) in sediment are shown in Table 4 below As it was reveal in Table 4 the highest value of Cu was recorded at location A (0.440 ± 0.18mg/kg) while the least was recorded at location B with 0.098 ± 0.03mg/kg. Statistically there is no significant difference in the level of Cu metal between the location because the $P \geq 0.01$. Zn had the highest value (1.473 ± 0.44mg/kg) was recorded at location A and the lowest (0.055 ± 0.02mg/kg) at location B. Statistically it was reveal that there is a significant differences between the location because the $P \leq 0.01$.Whereas, the highest value of Cd was recorded at location A (1.473 ± 0.44mg/kg) and the least is recorded at location B. The mean concentration of Pb had the highest value at location A with 0.968 ± 0.62mg/kg and the lowest was found at location B (0.252 ± 0.07mg/kg). Strong correlations were found between Cu and Pb ($r =0.759$), Pb and Zn ($r = 0.914$) in location A, while Cu and Zn($r = 0.805$) Cd and Zn ($r = 0.696$) Cd and pb ($r =0.992$) Pb and Zn ($r =0.779$) for location B and whereas, Cu and Cd($r = 0.723$) Cd and Zn ($r = 0.892$) respectively at the $p < 0.01$ level. There were relative strong positive correlations between Cu, Cd, Pb and Zn.

Table 4: Mean Concentration of heavy metals (mg/kg) in sediment obtained from River Ngadda at the three sampling locations

Location	Conc.Cu±SD	Conc.Zn±SD	Conc.Cd±SD	Conc.Pb±SD
A	0.440 ± 0.18	1.473 ± 0.44	1.473 ± 0.44	0.968 ± 0.62
B	0.098 ± 0.03	0.055 ± 0.02	0.055 ± 0.02	0.252 ± 0.07
C	0.320 ± 0.11	0.447 ± 0.13	0.447 ± 0.13	0.314 ± 0.08
p-value	0.035	0.002	0.042	0.019
Standard				

Discussions

Heavy metals in organs of clarias gariepinus, water and sediments obtained in river Ngadda

Concentrations of Cu, Cd, Pb and Zn (heavy metals queried) in the organs of *Clarias gariepinus,* water and sediments obtained in river Ngadda are presented below:

Heavy metals in flesh, gills, liver, and intestine of clarias gariepinus

Studies have shown that fish organ contained different concentrations of heavy metals in polluted environment. For instance, Abdel-Raheam *et al*. (2017) and Canli & Atli (2003) reported variations in accumulations of heavy metals in organs of fish species in different aquatic environments. Although the presence and concentrations of the metals were attributed to factors such as feeding behavior, physicochemical parameters, age, size and bioaccumulation of the fish.

Given the significant role liver plays in metabolism particularly in detoxification of body as observed by Jakimska *et al*. (2011), the relatively high accumulations in the fish liver recorded in the study site could be as a result of the functions it continually performs in detoxification of the fish metabolic processes. The concentration of the different heavy metals varies in different organs. In liver, Cu and Zn happen to be relatively high and Pb and Cd were relatively low. These findings are in line with El-Moselhy *et al*. (2014); Zhao *et al*. (2012); Jakimska *et al*. (2011); Nakayama *et al*. (2010) and Khaled, (2004) who observed high accumulation of Cu and Zn in fish liver. This could be because of the anthropogenic activities that take place in and around the river. They further observed that essential metals like Cu, Zn and Fe are mainly accumulated in the liver.

Fish in river Ngadda are exposure to pollution due to the influx of wastewater from the discharged points. Given that, gills are the main pathway in which water pass through during respiration, there is therefore the tendency in the cause of this process some pollutant, heavy metals inclusive may be trap to the gills membrane. In the present study Pb and Cd are relatively highly deposited in the gills membrane as indicated by the result whereas, Cu and Zn were found to be relatively low due to less uptake by the organ. This was affirmed by El-Moselhy *et al.* (2014) that Pb is mainly accumulated in gills. This finding is in line with Farombi *et al.* (2007) who reported higher value of Pb in *Clarias gariepinus* from Ogun River, Nigeria. However, this finding is lower than the study.

In terms of flesh, despite its significance in diet, yet the findings have proven that the deposit of Cd, Pb and Zn in flesh of *Clarias gariepinus* where relatively very low. This goes to show that flesh of *Clarias* were save from deposit of high concentration of metals. this is also attested by Elnabris *et al.* (2013) who earlier reported that consequent of the inactive nature of fish flesh in accumulating heavy metals, concentration are always recorded low. This confirmed the observed decrease in bioaccumulation rates of Cu, Cd, Pb and Zn in flesh of *Clarias gariepinus* in this study. However even the highest concentration of Cu, Cd, Pb and Zn in all the organs in the study did not exceed the permissible limit set by WHO standard. This could be explained by the activities that take place and also period of exposure to pollution and physicochemical parameters. These findings are consistent with the study of Bhuyan *et al.* (2016); Akan *et al.* (2012); Copat *et al.* (2012); Staniskiene *et al.* (2006); who reported low concentration of Cu and Zn among others in fishes of Meghna River Bangladesh and River Benue in Vinikilang, Adamawa, Nigeria.

Both Cu and Zn are essential metal but when in high concentration they are threat to both fish and humans as well. As observed by Gainey and Kenyon (1990) Exposure of fishes to Cu concentrations leads to low cardiac activity and reduced heart beat rate. As observed from most researches it is documented that mining, municipal wastewater disposals, human activities, industries and agricultural run-offs promote the rapid increase of heavy metal pollution in the environment (Nakayama *et al.*, 2010; Jakimska *et al.*, 2011; Ali *et al.*, 2013). Despite the fact that the values obtained falls within the given standard yet the fish in river Ngadda are at risk because of the indiscriminate disposal of solid and liquid waste in and around the river there is an amount of bioaccumulation of heavy metals in aquatic life, especially in *Clarias gariepinus* thereby posing health risk to human through consumption

Heavy metals in water sample

The significant differences in accumulation of Cd, Cu, Zn and Pb in the different sampling locations differs due to the locations and anthropogenic activities likely practiced. As revealed from the result low level of some of the metal concentration may be due to the activities that take place along the river as well as the natural purification of the river and physical parameter. However, the indiscriminant dumping of solid waste, cottage and municipal wastewater over time when care not taken it will accumulate and exceed the permissible limit of heavy metal as indicated by the level of Cd recorded in the study. The high level of Cd concentration which might be attributed to the fact that Cd does not break down but it can change form into different species and compounds. Moreover, the human activities of the studied environment such as dumping of solid waste, application of fertilizers, sewage sludge, abattoir, cottage industries, and municipal wastewater disposal might be the reason of the high level of the Cd deposit because it is a non-degradable, cumulative pollutant; continued releases are of global concern. Note, Cd is a metal with no known beneficial properties that support life (Nordberg *et al.*, 2007; Eisler 2000; Eisler 1985). Even at low concentrations it is toxic to all life, including humans,

and microorganisms (ATSDR, 2008; Nordberg *et al.*, 2007; Eisler ,2000; Eisler ,1985). It causes cancer, birth defects and genetic mutations (Eisler, 2000; Nordberg *et al.*, 2007).

The concentration of Cd, Pb, Zn and Cu in water obtained from the samples locations are however lower when compared with some studies like Nirmal-kumar *et al.* (2008) and Itanna (2002) who reported similar higher mean values of Cd, Pb, Zn and Cu in water obtained from polluted River Pariyej in India and River Kera, Addis Ababa. The low level of Pb, Zn and Cu concentration may be due to the activities that take place along the river when compared to Kera and Pariyej Rivers.

Heavy metals in sediment

The concentration of heavy metals in sediment as reveal from the result, the differences in the locations in relation to Cd, Pb, Cu and Zn concentration cloud be view as a result of the anthropogenic activities that take place along the river sites. Note, the point where these samples are obtained where the discharged point of different formation of wastewater some of this point are discharged wastewater from abattoir which consist of blood, animal waste and other forms of waste produced from animal processing, some of the point are discharged from municipal which are predominantly domestic wastewater, toilet waste, car wash and other forms of sanitation and some are discharged from markets which consist of sanitation, raw food processing, solid waste dumping among others.

The relatively low level of Cd, Pb, Zn and Cu established in location B which is the point where discharged from Gamboru market may be attributed to the constituent and forms of the wastewater discharged while the relatively high concentration of Cd, Pb, Zn and Cu in location A and C might be because of indiscriminate dumping of solid waste, discharged of municipal and abattoir wastewater and also the locations are near roads where various anthropogenic activities such as burning of tyres, excretes among other which all these pollutant easily found their self into the river through run off and wind actions. The differences in the levels of the Cd, Pb, Zn and Cu recorded may be due to the variation in activities that result in the generation of the wastewater, the constituents of the pollutant they produced and the solid waste dumping in the river trough and been that sediments are serving as storage of element in the aquatic environment. This is in conformity with the study by Stephen *et al.*(2001) that sediment serve as sink for wide range of contaminant including heavy metals from various sources. As reveals by the findings, it is evident that the concentration magnitudes were below the permissible limit by implication there are within the acceptable level. However, Akan *et al.* (2010) reported otherwise as their findings indicated above the limit. Whereas Albering (1999) reported findings similar to this study which are within the permissible limit set by standard. Since the heavy metals concentration in this study is within the permissible limit set by standard, it could be concluded that the harm of the toxic effects because of their accumulation is less. Though it is within the permissible limit continuous accumulation over time may lead to high concentration and could lead to serious harm.

Conclusion

The study investigated the concentrations of heavy metals (Cd, Cu, Pb, and Zn) in *Clarias gariepinus* fish from River Ngadda in Maiduguri, Nigeria. The results showed that the metal concentrations in the fish were within permissible limits, indicating that the fish is safe for consumption. However, the presence of Cd in the water exceeded the threshold limit, suggesting potential contamination sources. The strong positive correlations among the metals suggest common contamination sources. Overall, the study highlights the need for continued monitoring of heavy metal concentrations in fish and water sources to ensure the safety of aquatic ecosystems and human health. Further studies are recommended to identify the sources of contamination and develop strategies to mitigate their impact.

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