Heavy Metals Contamination in the Tissues of *Clarias gariepinus* (Burchell, 1822) Obtained from Two Earthen Dams (Asa and University of Ilorin Dams) in Kwara State of Nigeria

Musa Idi-Ogede ABUBAKAR[1], Ibrahim ADESHINA[1*]

[1]Department of Aquaculture and Fisheries, University of Ilorin, Nigeria.

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Abstract: This study determined the levels of heavy metals contamination in the tissues of 400 *Clarias gariepinus* obtained from two dams (Asa and University of Ilorin) in Kwara State of Nigeria. *C. gariepinus*, (both male and female) between the mean weight of 149-154g and total length of between 28-34cm were investigated between the month of September and December, 2018. Copper (Cu), zinc (Zn), cadmium (Cd), chromium (Cr) and lead (Pb) in flesh, heart, kidney and livers of species from the two dams were determined using Atomic Absorption Spectrophotometer (AAS). The results showed that heavy metals contamination in the tissues sampled from Asa and Unilorin dams were in order of Zinc > Copper > Chromium. Cadmium and lead were not detected. Furthermore, *C. gariepinus* from Asa dam bioaccumulated heavy metals at higher concentrations than samples from Unilorin dam. Body weight, total length and age were found to be predisposing factors to heavy metals concentrations in the body of fish while sexes had no effect.The heavy metals concentration detected in *C. gariepinus* sampled from the two dams did not exceed the limits set by WHO and FAO suggesting that the fishes wholesome for human consumption.
Keywords: *Heavy metals, Flesh, Heart, Toxic metals, Fish.*

Nijerya'nın Kwara Eyaletindeki İki Toprak Barajından (Asa ve Ilorin Üniversitesi Barajları) Elde Edilen *Clarias gariepinus* (Burchell, 1822) Dokularında Ağır Metal Kirliliği

Özet: Bu çalışmada, Nijeryanın Kwara Eyaletindeki iki barajdan (Asa ve Ilorin Üniversitesi), elde edilen *Clarias gariepinus* türü balıkların dokularındaki ağır metal kirlenme seviyeleri belirledi. Ortalama 149-154 g ağırlık ile toplam uzunluk 28-34 cm arasındaki erkek ve dişi balık örnekleri Eylül-Aralık 2018 ayları arasında toplanmıştır. İki barajdan elde edilen örneklerin et, kalp, böbrek ve karaciğerlerindeki bakır (Cu), çinko (Zn), kadmiyum (Cd), krom (Cr) ve kurşun (Pb) düzeyleri Atomik Absorpsiyon Spektrofotometresi (AAS) kullanılarak belirlendi. Sonuçlar, Asa ve Unilorin barajlarından örneklenen dokulardaki ağır metal kontaminasyonunun, Çinko> Bakır> Krom şeklinde olduğunu gösterdi. Kadmiyum ve kurşun tespit edilmedi. Ayrıca, Asa barajından elde edilen *C. gariepinus* örneklerindeki ağır metal konsantrasyonlarının, Unilorin barajından alınan örneklerden daha yüksek olduğu belirlenmiştir. Vücut ağırlığı, toplam uzunluk ve yaş daha yüksek ağır metal düzeyine yatkınlığa neden olurken, cinsiyet ağır metal düzeyini etkilememiştir. İki barajdan alınan *C. gariepinus* örneklerinde tespit edilen ağır metal konsantrasyonu, WHO ve FAO tarafından belirlenen sınırları aşmamıştır. Bu nedenle bu barajlardan elde edilen balıkların insan tüketimi için sağlıklı olduğu kanaatine varılmıştır.
Anahtar Kelimeler: *Ağır metaller, Et, Kalp, Toksik Metaller, Balık.*

Introduction

Arising from the numerous activities of man who discharge toxic substances including heavy metals into the aquatic environment, imbalance has been created in the earth's ecosystem. According to Meadows et al. (1992), pollution of the aquatic and terrestrial environments including other types of environmental degradation in any community or society are due to the combined effects of population increase, urbanization, affluence and technological developments. Apart from natural sources, anthropogenic sources have been reported to be the principal source of pollutants arising from municipal wastes, refuse heaps, agricultural practices and industrial waste water (Smith, 1985). Rivers that are contaminated with heavy metals have negative effect on the ecosystem and aquatic organisms (Rosli et al., 2018; Sreedevi et al., 1992). Toxic contaminants are non-biodegradable and when accumulate in the tissue of consumers, could result in malfunction of nervous system (Lohani et al., 2008; Olaifa et al., 2004). While other metals such as Cu, Fe, Mn, Ni and Zn that are vital and needed micronutrients, they often resulted in malfunctioning of living tissues especially when their concentrations are higher (Bruins et al., 2000; Titilayo and Olufemi, 2014). These elements could promote beneficial or harmful effects on both flora and fauna in concentration dependent manner (ElSherif, 2012; Forstner and Wittmann, 1981). The position of fish in the food web also influences the level of metals accumulation from lower level to the higher level (Mansour and Sidky, 2002). The level of metals absorbed by fish serves as a good indicator in environmental assessment (Eric et al., 2017; Fowler et al., 1993). This bio-available fraction can be detected through the evaluation of the concentrations in the organisms. As an indirect measure of the abundance and bio-availability of metals in the aquatic environment, the bioaccumulation of metals by the tissues of aquatic organisms is of great importance (Mance, 1987). Metals are naturally occuring elements that become contaminants when human activities increase their concentrations above normal levels in the environment (Nzeye et al., 2014; Unger, 2002). Trace heavy metals are ubiquitous and getting into an organism via bioaccumulation and biomagnifications along the food chain (Papagiannis et al., 2004; Targuma et al., 2018). Therefore, trace metal contamination which could be from both natural and human activities has become a serious issue (Goher et al., 2014a) especially in fresh water (Kabata-Pendias and Pendias, 1992) because of its persistence, non-biodegradable in the tissue of organisms and environment (Goher et al., 2014b; Kalay and Canli, 2000). However, there is an increase in advocacy on effect of toxic metals especially from industrial and agricultural activities (Du Preez et al., 2003; Eric et al., 2017). Consumption of fish has been on the increase because of its health benefits (Forstner and Wittmann, 1981; Targuma et al., 2018). Also, fish has been used as bio-indicators of aquatic pollution by metals (Obasohan, 2007). It is generally believed that there is a strong relationship between the aquatic environment and the organism in relation to the heavy metals concentration in fish. Metal distribution between the different tissues depends on the mode of exposure and metallic pathwayss, which serve as a pollution indicator (Obasohan, 2007; Rosli et al., 2018). Nahle (2003) reported that acid rain is a form of pollutant caused by the emission of sulphurdioxide and nitrogen oxides to the atmosphere. Sawmill wastes are contaminated with wood preservatives such as pentachlorophenol, resin acids, dioxins and other toxic substances (Addision et al., 1991; Mansour and Sidky, 2002). These wastes when degraded or burnt emit toxic materials rich in various toxic chemicals including heavy metals. These hazardous substances eventually end up in inland water bodies through surface run-off water, windblown and deposited materials or as leachates from underground water sources (Forstner and Prosi, 1979). The metals could be absorbed by the fish and their accumulation may occur in various fish organs and tissues. Initially, early accumulation may take place in soft tissues but with prolonged exposure, they may bioaccumulate in the harder tissues and organs (Amiard, 1975; Henry, 2006). The accumulated metals are therefore an index of the pollution status of the water body and the fish. Due to their different roles in bioaccumulation process, fish tissues e.g. muscle, liver and gills are those more frequently used for analyses (Evans et al., 1993; Olaifa et al., 2004). Flesh (muscle) is preferred because it is main organs consumed by human, therefore constitutes the tool for the protection of public health (Reinfelder et al., 1998).

African catfish, *Clarias gariepinus* is an important and economic fish species in aquaculture in the tropical and subtropical countries (Adeshina et al., 2016) and has become the most farmed fish in Nigeria. Hence, Nigeria is ranked first the in the continent as the highest producer of farmed *Clarias gariepinus,* this, is unconnected with its quality flesh, tolerance to wide range of water quality parameters and attraction of high market price (Adeshina et al., 2018). The location of the fish in food chain renders its susceptible to heavy metals concentration which later passes to consumers. The accumulation of metals in fish depends upon their intake and elimination from the body (Mansour and Sidky, 2002)". Asa dam is located on River Asa (8_ 4400 N; 4_ 5600 E) about 5 km from the Ilorin metropolis. It has the length and storage capacity of 597 m and 43 million m^3 respectively (Araoye, 2009; Ayanshola, 2013). The University of Ilorin dam (Unilorin dam) is located on River Oyun (8_ 4600 N; 4_ 6700 E), providing water for the University community. The dam has a reservoir capacity of 1,800,000 m^3, live storage capacity of 1,540,000 m^3 and the length of the river is 48 km. The spill way has 14,000 m^3/day (Ayanshola, 2013). The location, proximity and fishing activities in Asa and University of Ilorin dams make it important dams. They serve as major source of fish to the Ilorin metropolis and its environs. The aim of this study was to determine the heavy metals contamination of tissues in *Clarias gariepinus* obtained from two earthen dams (Asa and University of Ilorin dams), Kwara State, Nigeria.

Materials and methods

Study Site: Asa dam and University of Ilorin dam are located in Ilorin, the capital of Kwara State, Nigeria.

Sample collection and transportation: Fish samples were collected from the two dams (Asa and Unilorin). The fish were weighed on a digital Scout Pro scale (Model: M1207) and the total length were measured using meter rule calibated in centimeter. Two hundred *Clarias gariepinus* weighing between 149-154 g (mean=152 g) and total length of between 28-34 cm (mean = 31 cm) were randomly obtained from each of the two dams using drag nets with the help of the local fishermen between the month of September and December 2018 (Table 1).

Table 1. Number and periods of fish collected.

Months	Number of Fish collected		Body weight (g) (Mean ± SD)		Total length (cm) Mean± SD	
	Asa dam	Unilorin dam	Asa dam	Unilorin dam	Asa dam	Unilorin dam
September	72	64	142±2.45	153±2.15	31.41±1.18	33.22±1.10
October	53	59	157±3.16	149±1.79	30.78±2.13	31.23±2.47
November	34	42	159±1.90	161±2.14	29.83±3.05	27.35±1.81
December	41	35	150±5.11	145±5.16	30.54±2.14	32.61±2.33
Total	200	200	152±3.16	152±2.81	30.64±2.13	31.10±1.93

The sex differential of African catfish was performed using genital papillae commonly used in *C. gariepinus* (Adeshina et al., 2016) while the age was determined by examined the growth rings in vertebrae (Pivnicka, 1974; Marzolf, 1955). The fish samples were tagged and put in separate sterile polythene bags and kept in an ice-chest for onward transportation to the laboratory where they were washed in flowing water to remove dirt. They were thereafter packed into clean plastic bags. All the fish samples were stored in deep freezer at -20^{o}C prior to preparation for analysis.

Table 2. Mean concentration of heavy metals in the tissues of fish samples from Asa and Unilorin dams.

	Tissues	**Asa dam (Mean ± SD, mg/L)**	**Unilorin dam (Mean ± SD, mg/L)**
COPPER (Cu)	Flesh	0.20 ± 0.07^{aB}	0.14 ± 0.01^{bB}
	Heart	0.46 ± 0.14^{aA}	0.26 ± 0.11^{bA}
	Kidney	$0.52\pm 0.04^{a\ A}$	0.32 ± 0.03^{bA}
	Liver	0.55 ± 0.19^{aA}	0.21 ± 0.02^{bB}
ZINC (Zn)	Flesh	2.10 ± 1.04^{aB}	1.20 ± 0.16^{bB}
	Heart	2.04 ± 0.60^{aB}	1.91 ± 0.23^{aA}
	Kidney	3.27 ± 0.13^{aA}	2.14 ± 0.16^{bA}
	Liver	3.12 ± 0.05^{aA}	2.51 ± 0.51^{aA}
CHROMIUM	Flesh	0.04 ± 0.03^{aB}	0.03 ± 0.01^{aC}
	Heart	0.06 ± 0.06^{aB}	0.05 ± 0.16^{aC}
	Kidney	0.17 ± 0.05^{aA}	0.15 ± 0.11^{aA}
	Liver	0.15 ± 0.14^{aA}	0.12 ± 0.20^{aB}
CADMIUM (Cd)	Flesh	0.06 ± 0.09^{bB}	0.11 ± 0.14^{aA}
	Heart	0.15 ± 0.04^{Bb}	0.41 ± 0.21^{aA}
	Kidney	0.20 ± 0.06^{aA}	0.10 ± 0.10^{bA}
	Liver	0.24 ± 0.050^{aA}	0.23 ± 0.28^{aA}
LEAD (Pb)	Flesh	ND	ND
	Heart	ND	ND
	Kidney	ND	ND
	Liver	ND	ND

Mean with the same small letters superscript along the row are not significantly different at p<0.05; Mean with the same capital letters superscript along the column are not significantly different at P<0.05

Extraction of tissues from samples: A total number of four-hundred (400) fish samples were selected at random from the two dams (200 from each dam). The weight of each fish sample was measured on a digital scale. Asa dam samples weighed 151±5.07g while Unilorin samples weighed 153±0.54g. The fish were dissected and the tissues of interest (flesh, heart, kidney and livers) were isolated in triplicates (200 fish x 2 dams x 4 organs x 3 triplicates = 4800 samples). The tissues collected were cleaned with saline water (sodium chloride) and weighed before being packed in sachets and stored in a refrigerator while awaiting digestion.

Digestion: Frozen samples of flesh, heart, kidney and liver (4800 samples) were allowed to thaw at room temperature. An average wet weight of 0.5g was used for each sample. . Each sample was pulverized in a mortar. Each pulverized sample(0.5g) was mixed with 6ml HNO_3 (ANALAR) (65% Suprapur, Merck, Darmstdt, Germany) and 2ml H_2O_2 (Suprapur grade, Merck, Darmstdt, Germany). The mixtures were allowed to stand overnight in a beaker with a lid in a fume cupboard. The samples were then allowed to heat lightly the next day on a hot plate in a fume cupboard until the mixtures turned colourless. The digest were then allowed to cool at room temperature. The cooled digest were filtered using WHATMAN TYPE 1 filter paper into a 100ml Standard Flask. The filtered samples were then diluted with distilled water in the standard flask to reach the 100ml mark. The diluted samples were stirred vigorously and a portion of the stirred sample was collected in pre-washed transparent plastic bottles. The bottled digested samples were finally stored in a refrigerator to await metal analysis.

Analysis of heavy metal: The metals, Cu, Zn, Cr, Cd and Pb in the tissues (flesh, heart, kidney and liver) of fish samples from Asa and Unilorin dams were examined (Obasohan, 2007; Rosli et al., 2018). In brief, the atomic absorption spectrophotometer was standardized. Blank samples were run with each set of experiments. Significant variation among body weight, total length, ages, and sex of the fish in relation to the level of heavy metals were analysed using chi-square test.

Statistical analysis: Data were analyzed by one-way analysis of variance (ANOVA) and t-test for tissues and locations (between the dams), respectively using Statistical Product for Service Solution (SPSS version 16.0) for window. Statistical significance of differences between means was compared using Turkey (HSD) test. Also, Chi-square test was performed in order to determine the significance of heavy metal concentration and between males and females, 2 groups of body weight, 2 groups of total length and ages from both Asa and Unilorin Dams.

Results

Among the heavy metals detected in the tissues sampled from Asa and Unilorin dams were Copper (Cu), Zinc (Zn) and Chromium (Cr) and presented in Table 2.

Copper: The highest mean concentration of copper in the sample from Asa dam was found in the liver while the lowest mean concentration was in the flesh. However, in the sample from University of Ilorin dam, the highest mean concentration was detected in the kidney while the lowest mean concentration was also in the flesh. The overall highest mean concentration of copper was found in the liver of fish samples from Asa dam samples with value 0.553±0.19mg/L while the overall least was found in the flesh of the sample from University of Ilorin dam with value 0.141 ± 0.01mg/L. There were significant difference (P<0.05) in the bioaccumulation of copper between the flesh, heart, kidney and liver of fish samples from Asa dam and University of Ilorin dam respectively (Table 2).

Zinc: The highest mean concentration of zinc in the samples from Asa dam was found in the kidney while the lowest mean concentration was observed in the flesh. In the fish samples from University of Ilorin dam, the highest mean concentration was also in the liver while the lowest mean concentration was in the flesh. The overall highest mean concentration of zinc was found in the kidney of the samples from Asa dam (3.270±0.13 mg/L) while the overall least was found in the flesh of the samples from University of Ilorin dam (1.200±0.16mg/L). There was a significant difference (P<0.05) in the concentration of zinc in the samples from Asa dam and samples from Unilorin dam (Table 2).

Chromium: The highest mean concentration of chromium in the samples from Asa dam was found in the kidney while the lowest mean concentration was observed in the liver. However, in the sample from University of Ilorin dam, the highest mean concentration of chromium was also detected in the kidney while the lowest mean concentration was in the flesh. The overall highest mean concentration of chromium was found in kidney of the Asa dam samples with the value 0.171±0.05mg/L while the overall least was found in the flesh with value 0.034±0.01mg/L. There was also a significant difference (P<0.05) in the bioaccumulation of chromium in the flesh, heart, kidney and liver of fish samples from Asa dam and University of Ilorin dam respectively (Table 2). Furthermore, Table 2 shows the result of toxic heavy metals levels in fish sampled from Asa and Unilorin dams. Cadmium was highest in liver samples from fish selected from Asa dam while heart has highest cadmium level in fish from Unilorin dam. There were significant difference in the level of cadmium in flesh, heart, kidney and liver between the two dams (P<0.05). Lead was not detected in fish sampled from both Asa and Unilorin dams.

Table 3 depict that the heavy metals concentrations in the tissues of fish is affected by the fish features. There were significant differences in the levels of Cu, Zn, Cr and Cd in relation to body weight, total length and age of the fish while sexes have not significant effect to the heavy metals concentration in fish. In other words, body weight, total length and age of the fish serves as associated factors in the level of heavy metals in the fish.

Discussion

Heavy metals are easily absorbed by aquatic life forms and accumulation may occur in higher concentration (Omoregie et al., 2002; ElSherif, 2012). Fish can take up heavy metals in their diets and bioaccumulate them at different rates in their muscles and organs (Phillips and Rainbow, 1994). According to Rainbow et al. (1990), the rate of accumulation and ability of the fish to detoxify particular metals differ greatly. This might account for the variation in the concentration of heavy metals found in the *Clarias gariepinus* obtained from Asa dam and University of Ilorin dam respectively. The mean concentrations of heavy metals in the flesh of *C. gariepinus* obtained from the two dams are higher than those from other tissues (heart, kidney and liver), thus supporting the idea of bioaccumulation in the flesh (muscle). This finding is in agreement with the findings of Murphy (1978) who reported that edible flesh of fish accumulated more metals. The concentration of Zn was higher in the flesh of *C. gariepinus* samples obtained from Asa dam. This is in line with the findings of Senthil et al. (2008), Titilayo and Olufemi (2014), Erick et al. (2017), Nzeye et al. (2014) who reported significant bioaccumulation of metals in fish flesh. The concentration of Cu was significantly the same in the flesh of both samples (Asa dam and Unilorin dam). The highest concentration of Zinc

(3.270mg/L) was observed in the samples from Asa dam. This finding may not be unconnected with effluents from dungs, which are transported to the dam through run-off water. According to Forstner and Prosi (1979), Targuma et al. (2018) Zinc is a product of animal food and is readily concentrated in excretions of adult animals excreting an average of 7 and 20mg Zn daily.

Table 3. Influence of body weight, total length, sex, and age of Clarias gariepinus on heavy metals concentrations from Asa dam and Unilorin dams.

Parameters		Heavy metal concentrations (mg/L)				
		Asa Dam				
		Cu	Zn	Cr	Cd	Pb
Body weight (g)	130-149	0.33±0.02^{b}	2.07±0.23^{b}	0.05±0.01^{b}	0.10±0.01^{b}	ND
	150-169	0.53±0.01^{a}	3.20±0.12^{a}	0.16±0.02^{a}	0.22±0.01^{a}	
	p-value	0.002	0.001	0.034	0.003	
Total length (cm)	25.0-19.9	0.31±0.01^{b}	2.14±0.03^{b}	0.04±0.01^{b}	0.08±0.01^{b}	
	30.0-34.9	0.49±0.02^{a}	3.35±0.12^{a}	0.13±0.01^{a}	0.16±0.01^{a}	
	p-value	0.023	0.011	0.004	0.007	
Age (years)	1.0-1.5	0.35±0.02^{b}	2.31±0.04^{b}	0.18±0.01^{b}	0.12±0.01^{b}	
	1.5-2.0	0.56±0.01^{a}	3.59±0.16^{a}	0.24±0.02^{a}	0.17±0.01^{a}	
	p-value	0.033	0.016	0.008	0.027	
Sex	Male	0.36±0.03^{a}	2.52±0.06^{a}	0.11±0.02^{a}	0.14±0.01^{a}	
	Female	0.38±0.01^{a}	2.77±0.12^{a}	0.14±0.01^{a}	0.14±0.02^{a}	
	p-value	0.062	0.182	0.083	0.175	
		Unilorin Dam				
Body weight (g)	130-149	0.20±0.02^{b}	1.55±0.07^{a}	0.04±0.01^{b}	0.26±0.01^{b}	ND
	150-169	0.27±0.02^{a}	2.33±0.21^{a}	0.14±0.03^{a}	0.17±0.02^{a}	
	p-value	0.031	0.051	0.008	0.016	
Total length (cm)	25.0-19.9	0.23±0.02^{b}	1.42±0.04^{b}	0.03±0.01^{b}	0.24±0.02^{a}	
	30.0-34.9	0.29±0.01^{a}	2.37±0.31^{a}	0.17±0.03^{a}	0.16±0.01^{b}	
	p-value	0.001	0.043	0.032	0.002	
Age (years)	1.0-1.5	0.20±0.03^{b}	1.02±0.03^{b}	0.01±0.00^{b}	0.21±0.01^{a}	
	1.5-2.0	0.27±0.01^{a}	2.45±0.15^{a}	0.15±0.02^{a}	0.19±0.02^{a}	
	p-value	0.022	0.005	0.003	0.050	
Sex	Male	0.23±0.01^{a}	1.26±0.02^{a}	0.03±0.01^{a}	0.23±0.04^{a}	
	Female	0.22±0.04^{a}	1.29±0.08^{a}	0.03±0.01^{a}	0.21±0.06^{a}	
	p-value	0.092	0.105	0.064	0.835	

Mean with the same small letters superscript along the column and within the same parameter are not significantly different at P<0.05;

Copper was significantly higher in the heart of Asa dam sample. Zinc was significantly the same in both samples. Chromium was higher in the heart of Asa dam sample than those from University of Ilorin dam.

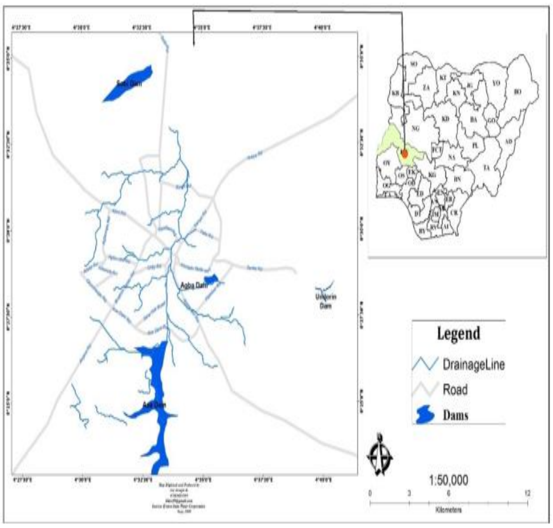

Figure 1. Map of Ilorin showing the location of the two dams. Inset: map of Nigeria showing the states Source: Clement et al., 2015

Copper bioaccumulation was significantly higher in the kidney of the sample from Asa dam than the kidney of sample from University of Ilorin dam. Zinc bioaccumulated significantly in the kidney than in the other tissues which might be based on specific metabolism process and co-enzyme catalyzed reactions in the kidney. Zinc bioaccumulated significantly higher in the liver of Asa dam than those from University of Ilorin dam. The high concentration of copper in the liver can be ascribed to the binding of Coppper to metallothionein in the liver, which serves as a detoxification mechanism. Copper, though essential in the diet can be harmful when taken in large amounts. The harmful toxicity is largely attributed to its cupric (Cu^{2+}) forms (Dahunsi et al., 2012; El Sherif, 2017; Nzeye et al., 2017; Olaifa et al., 2004). Low levels of chromun and cadmium in both samples may be attributable to the fact that the fish feeds on aquatic plants. Aquatic plants have been reported to take up quantifiable levels of heavy metals (Ndiokwere, 1984; Rosli et al., 2018). Lead was not detected which might be due to the fact that the two dams are not polluted by lead. Low levels of lead have been reported in some water bodies by Idodo-Umeh and Oronsaye (2006), Henry (2006) and Eric et al. (2017). The concentrations of heavy metals observed in this study are lower than values recommended for portable drinking water by World Health Organization (WHO, 1985). The values recorded are within the recommended levels for fish food by the Food and Agricultural Organization of the United Nations (FAO) (Nauen, 1983). The heavy metals concentration detected in *C. gariepinus* sampled from the two dams did not exceed the limits set by WHO and FAO thereby making the fishes better for human consumption. Thus, *C. gariepinus* obtained from Asa dam and Unilorin dam are safe for human consumption. Furthermore, the study indicated that body weight, total length and age of the fish are factors associated with the level of heavy metals in fish. This is supported by the fact that fish is located at the top of the aquatic food chain, hence, they accumulate metals from both water and food chain and likely pass it to the consumers. In view of the importance of the two dams in Kwara State, it is recommended that more researches and studies should be conducted on the two dams, Fisheries unit of Kwara State Ministry of Agriculture should collaborate with Department of Aquaculture and Fisheries, University of Ilorin to show case the natural endowments of the two dams, Kwara State Ministry of Agriculture, Kwara State Ministry of Water Resources, Kwara State Environmental Protection Agency (KWASEPA) and University of Ilorin should ensure that findings from this research are widely circulated among the inhabitant of the state on the safety level of the fishes in the two dams for human consumption and appropriate authorities should ensure that the current trends of heavy metals from the two dams are not exacerbated.

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****Corresponding Author:** Ibrahim ADESHINA, Ph.D
Department of Aquaculture and Fisheries, University of Ilorin, Nigeria.
e-mail: adesina.i@unilorin.edu.ng