



**Determination of Heavy Metals Concentration in Some Fish Samples from River Rima (Kwalkwalawa) in Sokoto State, Nigeria**

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**Abstract**

*This research work was conducted to assess the levels of heavy metals namely; Fe, Pb, Cu, Cd and Zn in three fish samples Lates niloticus (Giwantuwa), Hyperupisus bebe occidentalis (kuma) and Clarias geriepinus(kulme), of River Rima (Kwalkwalawa). The analysis was performed using Atomic Absorption Spectroscopy (AAS). The results of the analysis suggested that there were high levels of the analyzed metals in Lates niloticus (Fe-0.4369, Pb-0.0102, Cd-0.0530), Hyperupisus bebe occidentalis (Fe-0.2003, Pb-0.0080, Cd-0.00356), and Clarias geriepinus (Fe-0.1888, Cd-0.1050) compared to the WHO/EU standards. However the concentrations of Cu and Zn in all the samples were found to be within the WHO/EU permissible limit. Therefore, the fishes obtained from this river have high concentration of Fe, Pb and Cd beyond the tolerable level, which indicated that as far as these metals are concerned, the fishes are unfit for human consumption. Consequently, close monitoring of metals pollution and the consumption of the fishes of River Rima (Kwalkwalawa) is recommended with a view to minimizing the risk of health of the population that depend on the river for their fish supply.*

**Keywords:** Heavy metal; Atomic absorption spectroscopy; Fish samples; Pollution; Concentration.

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## 1.0 INTRODUCTION

Pollution of different environments is due to human activities in recent years. One of such pollution is marine pollution by heavy metals. The heavy metals are accumulated in the marine environment then transferred into the marine organisms' .e.g. fishes by different ways. When their concentrations exceed the required levels, they become toxic and cause several health problems (Malik, 2004). The fishes became sick then die when too much contamination is happened (Gorham, 1975).

Recent studies have shown that human activities have created ecological pressure on the natural habitat of fish and other water organisms' overtime. There is an upsurge of interest in water as a result of this deleterious effect. Furthermore, factors such as high population growth accompanied by intensive urbanization, increase in industrial activities and higher exploitation of natural resources including cultivable land have caused increase in pollution (Atta *et al.*, 1997).

Aquatic foods have essential amino acids, fatty acids, protein, carbohydrates, vitamins and minerals. Among water food, fish are commonly consumed and hence, are a concerning link for the transfer of toxic heavy metals in human beings. Heavy metals have the tendency to accumulate in various organs of fish and water which in turn may enter into human metabolism through consumption causing serious health hazards (Khalifa *et al.*, 2010).

Bio-accumulation and magnification are capable of leading to toxic level of these metals in aquatic organisms, even when the exposure is low. The presence of metal pollutant in fresh water is known to disturb the delicate balance of the aquatic ecosystem. Fishes are notorious for their ability to concentrate heavy metals in their organs and since they play important role in human nutrition, they need to be carefully screened to ensure that unnecessary high level of some toxic trace metals are not being transfer to man through fish consumption (Adeniyi *et al.*, 2007).

The elevated concentration of heavy metals in aquatic environment is due to anthropogenic activities such as industrial, domestic, and agricultural effluents dump near water bodies. Biological magnification could lead to toxic level of these metals in aquatic organisms even at low temperature. This is a potential threat of public health because the water is supplied to public for domestic agricultural and industrial purposes, and to aquatic organisms especially; fishes from these water bodies are sold for human consumption (Chalapathi, 2012).

Their cumulative poisoning effects causes serious hematological and brain damage, anemia and kidney malfunction and can also accumulate the soil at toxic levels as a result of long term application of untreated contaminated river waters. Similarly, soil irrigated by water from these rivers may accumulate these heavy metals such as (Cr, Fe, Pb, Cu, Co, Cd, Zn. E.t.c) on the surface soil. When the capacity of the soil retain these heavy metals is reduced due to the repeated application of these waters, heavy metals leach into the ground water or soil solution available for plant intake (Zheng *et al.*, 2008). Heavy metals are produced from variety of natural and anthropogenic sources; they are indeed intrinsic natural constituents of our environment. In fluvial environment, however, metal pollution can result in from direct atmospheric deposition, geologic weathering or through the discharge of agricultural, municipal or industrial waste products (Dawson, *et al.*, 1998). Apart from the natural sources, several anthropogenic ones also contribute to metal concentrations in the environment. In recent times, industrial and mechanical activities have raised natural concentrations causing serious environmental problems. Aquatic environment is one of the receiving ends for pollutants, particularly heavy metals which are ploughed back into the food chains through bio-accumulation in plankton and invertebrates to fishes and finally biomagnified in man.

Heavy metals concentrations in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and associated biota (Camusso *et al.*, 1995) which generally exist in low levels in water and attain considerable concentration in sediment and biota (Namminga, *et al.*, 1976).

Most of the heavy metals that get deposited in most water bodies are due to those coming from coal and oil combustion, internal combustion engines, local point sources, and indirect deposition from air pollution, and bedrock geology and soils. This grave concern posed by heavy metals in the environment creates an immense threat to the existence of organisms thriving in the area, to the ecological integrity of the habitat as these heavy metals may enter the food chains, persist in the environment, bio-accumulate an

bio-magnify and increase the exposure to public health risk (Skejelkvale *et al.*, 2001).

Due to the toxicity and accumulation of heavy metals in biota, determination of heavy metals in commercial fish species have received considerable attention in different countries in the region and around the world. Such interest aimed at ensuring the safety of the food supply and minimizing the potential hazard effect on human health.

River Rima (Kwalkwalawa) has been chosen for this research because of its strategic location. The facts that the river passes through the university, its water is being used for domestic purposes by the neighboring villagers and for irrigation process by nearby farmers and precisely its fishes are being sold to the public for consumption, these made the determination of heavy metals level in the fishes a very important study.

## 2.0 MATERIALS AND METHODS

### 2.1 Study Area.

The study was carried out at River Rima (kwalkwalawa) which passes through Usmanu Danfodiyo University, Sokoto Nigeria. It lies between latitude 15° 5' 0"N and longitude 5° 15' 0"E of equator. Sokoto is located in the extreme end of north western Nigeria.

### 2.2 Sample Collection and Treatment

The samples *Lates niloticus* (Giwan ruwa), *Hyperupisus bebe occidentalis* (kuma) and *Clarias geriepinus* (kulme) were purchased from the fishermen at kwalkwalawa. Figures 1, 2 and 3 represent the samples obtained from the river. Fish samples were transported to the laboratory in a thermos flask with ice on the same day.



Figure 1. *Clarias niloticus* (kulme).



Figure 2. *Lates niloticus* (giwan ruwa).



Figure 3. *Hyperupisus bebe occidentalis* (kuma).

### 2.3 Samples preparation

The samples were prepared by using the method reported Eward *et al.* (2013). Each fish was properly cleaned by rinsing with distilled water to remove debris planktons and other external adherent and each separated into bone, skin and tail using both the plastic knife and razor blade. Different tissues were dried at room temperature for two weeks, (14 days).

The dried tissues were digested as following: 1.0 g of each was dissolved in 1 M nitric acid (10 ml), boiled to complete the dissolution and filtered. The obtained precipitate was washed with nitric acid (1M) and transferred to 25 ml volumetric flask and filled up to the level with de-ionized water. Atomic absorption spectrometer was used to run the samples.

### 3.0 RESULT AND DISCUSSION

Table 1: Heavy metals concentrations (mg/g).

S/N	SAMPLE/ CONC	IRON(Fe)	LEAD(Pb)	COPPER(Cu)	CADMIUM(Cd)	ZINC(Zn)
1	A	0.7560	0.0270	0.0071	0.0210	0.0630
2	B	0.3298	ND	0.0160	0.0620	0.05100
3	C	0.3298	0.0010	0.0033	0.0750	ND
4	D	0.0060	0.0010	0.0033	ND	0.0270
5	E	ND	0.0135	0.0030	0.0560	0.0270
6	F	0.5950	0.0106	0.00465	0,0562	0.0820
7	G	0.0061	0.0001	ND	0.0580	0.1556
8	H	0.0013	ND	0.0420	0.0483	0.0530
9	I	0.5590	ND	0.1420	0.2095	0.100

#### KEY:

- A = The skin part of *Lates niloticus* (Giwan ruwa)
- B = The bone part of *Lates niloticus* (Giwan ruwa)
- C = The tail part of *Lates niloticus* (Giwan ruwa)
- D = The skin part of *Hyperupisus bebe occidentalis* (kuma)
- E = The bone part of *Hyperupisus bebe occidentalis*(kuma)
- F = The tail part of *Hyperupisus bebe occidentalis* (kuma)
- G = The skin part of *Clarias geriepinus* (kulme)
- H = The bone part of *Clarias geriepinus* (kulme)
- I = The tail part of *Clarias geriepinus* (kulme)
- Nd = Not detected

Table 2: Average concentrations of heavy metals in each of the fish samples in (mg/g).

	IRON(Fe)	LEAD(P b)	COPPER(C u)	CADMIUM( Cd)	ZINC(Z n)
LATES NILOTICUS	0.4369	0.0102	0.005357	0.0530	0.0380
HYPERUPISUS BEBE OCCIDENTALIS	0.2003	0.0080	0.00356	0.0374	0.0590
CLARIAS GERIEPINUS	0.1888	0.00003	0.0033	0.1050	0.1087

Table 1 shows the levels of heavy metal contamination in fish samples obtained from River Rima (Kwakwalawa), these include *Lates niloticus*, *Hyperupisus bebe occidentalis* and *Clarias geriepinus*. Result of the analysis shows that the sample A, B, and F showed higher concentrations of heavy metals than the rest of the samples and didn't follow any particular pattern. This may be explained with the fact that the heavy metals accumulate in fish samples at different extent (Khalifa *et al.*, 2010).

Iron (Fe) had the second highest concentration of all the heavy metals analyzed in sample F (0.5950mg/g) while the highest concentration of Fe was recorded in sample A (0.7560mg/g). The concentrations of Fe in samples B, C, D, G, H and I (in mg/g) were 0.225, 0.3298, 0.006, 0.0061, 0.0013 and 0.5590 respectively. The level of Fe in A, B and F (the skin, bone of *Lates niloticus* and tail of *Hyperupisus bebe occidentalis* respectively) were higher than the ones reported by (Oboh *et al.*, 2007) (0.02447mg/g) in their study of heavy metals levels in fish samples taken from River Niger using *Citharinus citharus* except in the skin parts of *Hyperupisus bebe occidentalis* (sample D), *Clarias geriepinus* (sample G) and bone part of *Clarias geriepinus* (sample H) where the level of Fe were a bit lower than the value, while it's not detected in the bone part of *Hyperupisus bebe occidentalis* (sample E). This may be explained with the fact that the fish samples accumulate different metals to a different extent (Khalifa *et al.*, 2010).

Lead concentration in the skin part of *Lates niloticus* recorded the highest contamination (0.0270mg/g) of all the samples analyzed, while the lowest (0.0001mg/g) was recorded in the skin part of *Clarias geriepinus* (sample G). 0.0035mg/g, 0.0135mg/g, 0.0106mg/g, 0.0010mg/g, 0.0001mg/g were the concentrations obtained for samples B, E, F, D and G respectively. The skin parts of *Lates niloticus*, bone and tail of *Hyperupisus bebe occidentalis* (i.e. sample A, E, and F) gave Pb concentrations that were higher than the 0.004mg/g obtained by Indrajit *et al* (2011) in their study of heavy metals levels in fish sample taken from River Yemuna (Delhi)

India using Tilapia fish samples. Also, the body parts contamination of Pb 0.003mg/g obtained by Indrajit *et al* (2011) was lower than the ones obtained in this study for samples A, E and F. For the average Pb concentrations in *Clarias geriepinus*, 0.00003mg/g obtained was lower than the 0.00703mg/g recorded by Odumuyiwa in her study of heavy metals level in *Soleasolea* spp from Lagos, but for *Hyperupisus bebe occidentalis* and *Lates niloticus*, the 0.0080mg/g and 0.0102mg/g recorded was on the low side. Pb is a well-known toxicant and it has deleterious effect even at low concentration on human being (Abida *et al.*, 2009). It reduces neuro-psychological function leading to intelligence quotient deficiency and also it leads to reduction in nerve conduction.

The skin parts of *Lates niloticus* (sample A) had the lowest Cu concentration of 0.00071 while the tail part of *Clarias geriepinus* (sample I) had the highest with 0.142mg/g. Cu concentrations in samples C, D, E, F and H were 0.0160mg/g, 0.0033mg/g, 0.0030g/g, 0.00465mg/g and 0.0420 respectively. The tail parts of the *Lates niloticus* (sample c), the skin, bone and tail parts of *Hyperupisus bebe occidentalis*, (samples C, D, E and F) contained more Cu content than that reported by indrajit *et al.*, (2011) 0.0023mg/g. On the other hand, Cu was not detected in the bone and the skin parts of *Latesniloticus* and *Clarias geriepinus* (sample B and G). Cu concentration recommended by WHO and EU is well above all the concentration showed by the samples. The major sources of release are mining operations, agriculture, sludge from publicly owned treatment works (POTWs) and municipal and industrial solid waste. Mining and milling contribute the most waste. Cu is released to water as a result of natural weathering of soil and discharges from industries and sewage treatment plants.

The Cd concentrations are generally high in all the samples. The tail part of *Clariasgeriepinus* (sample I) led the rank with 0.2095mg/g of Cd content followed by the tail part of *Lates niloticus* (sample C) with 0.0750gm/g, sample A, B, E, F, G, and H had concentrations of 0.0210mg/g, 0.0620mg/g, 0.0560 mg/g,

0.0562mg/g, 0.0580mg/g and 0.0483 in that order. In comparison with the work of Indrajit *et al* (2011) showed that the bone and the skin parts of *Lates niloticus* and that of *Clarias geriepinus* (samples B and G) had concentrations higher than the 0.0571mg/g obtain by Indrajit *et al* (2011). Also, the bone parts of both the *Hyperupisus bebe occidentalis* and *Clarias geriepinus* together with the tail part of *Hyperupisus bebe occidentalis* (samples E, F and H) gave concentrations of Cd higher than 0.0410mg/g recorded by Indrajit *et al.* (2011). The average concentrations of Cd in both *Lates niloticus* and *Hyperopisus bebeoccidentalis* given in Table 2, (0.0530mg/g and 0.0374mg/g) were found to be lower than the 0.1024mg/g recorded by Odumuyiwa while that of *Clariasgeriepinus* is higher. However, by considering the standards of 0.003ppm (0.0002mg/g) given by WHO and 0.005ppm (0.0005mg/g) by EU, the levels of Cd in all the samples analyzed were dangerously high. Sources of Cd include electroplating, erosion of natural deposition, discharge from metal and plastic refineries, battery and paint waste, mining as well as sewage. It occurs mostly in association with Zn and gets into the water from the corrosion of Zn-coated galvanized

#### 4.0 CONCLUSION

Heavy metal evaluation in consumable marine organism is of vital significance for establishing pollution mitigating strategies, especially in the local communities where illiteracy is high. In the present study, it was established that, the fishes obtained from the Kwalkwalawa River have high concentration

#### 5.0 REFERENCE

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pipes and fittings. It penetrates the body via the food eaten and water drunk. Cd can cause kidney disease and injuries the renal, pulmonary, skeletal and testicular. In addition, it has been recognized as a carcinogen. Renal failure tends to be the fatal due to the sensitive nature of the kidneys if there is a high concentration of Cd (Zheng *et al.*, 2008).

Zn had the highest concentration in sample G (0.1556mg/g) while the second highest concentration was observed in sample I (0.100mg/g) the concentration of Zn in sample A, B, D, E, F and H (in mg/g) were 0.0630,0.0510, 0.0270, 0.0670, 0.0820 and 0.0530 respectively the level of Zn in A, E and F (the skin part of *Lates niloticus*, the bone and the tail part of *Hyperupisus bebe occidentalis*) were higher than the one obtained by Indrajit *et al.*, (2011) (0.0561mg/g). Table 2 show the average heavy metals content of each of the sample used in this research; *Lates niloticus* and *Hyperupisus bebe occidentalis* had an average concentration of 0.0380mg/g and 0.052mg/g that was lower than the one obtained by (Odumuyiwa Oyeperu, 2009), (0.07908) in her study of heavy metals level in *Soleasolea* spp from Lagos lagoon while that of *Clarias geriepinus* is higher than the result of her study.

of Fe, Pb and Cd beyond the tolerable level, which indicated that as far as these metals are concerned, the fishes are unfit for human consumption. Therefore, the relevant government agencies should take this into consideration for appropriate decision making.

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