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Bioaccumulation of Some Heavy Metals in three Selected Fish Species from Chanchaga River, Minna Niger State, Nigeria

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ABSTRACT
Bioaccumulation of Some Heavy Metals in three Selected Fish Species from Chanchaga River, Minna Niger State The objective of this was to assess the seasonal level of accumulation of heavy metals in the organs of three commercial fish species (*Clarias gariepinus*, *Oreochromis niloticus* and *Auchenoglanis occidentalis*) from Chanchaga River. The fish were obtained from Chanchaga River from February to July. The weight of the fish species was recorded. One gram (1g) of the target organs (gill, intestine and liver) of each sample were dissected out for digested to determine the heavy metals accumulation using AAS (Atomic absorption Spectrophotometer). The result show that the concentration of Iron (Fe) was highest in the liver of *Auchenoglanis occidentalis* (123.1mg/kg) during the dry season. The concentration follows this order Fe>Zn>Mn>Cu>Pb. In wet season, the concentration of Copper was highest in the liver of *Oreochromis niloticus* (20.9 mg/kg) in followed this order Cu>Fe>Zn>Mn>Pb. The seasonal variation in concentration of heavy metals in the different fish organs showed that Zn and Fe had higher concentration during the dry season with (1.7 mg/kg and 41.8 mg/kg) respectively and the concentration of Mn and Cu was highest in the wet season with (1.6 mg/kg and 34.3 mg/kg) but there was no significant difference between both seasons. The result shows presence of some heavy metals in the organs of the selected commercial fish species. In most of the organs of the fish samples, the concentration of iron was said to be above the maximum tolerable values provided by international institutions. Chanchaga River it has shown evident of metal pollution as it reflected in the fish tissues.

Key words: Bioaccumulation, heavy metal, Fish Species River Chanchaga, Niger State

INTRODUCTION

Water which is a naturally existing element is one of the most valuable natural resources available to mankind. (Kurmar 2004). The quality of water has become a major challenge in the world today as it is being polluted by industrial and urban wastes generated mostly by human activities. The directly or indirectly, disposing of sewage, debris and runoff from agricultural farms are also found to be responsible for most of the contamination of the water and the eco-system at large. (Ghosh and Singh 2005). There are wide range of compounds which could either be organic or inorganic in nature that causes contamination of water by heavy metal. Some of the heavy metals present in rivers include: Cadmium, Lead, Arsenic, Zinc, Selenium, Mercury, Nickel etc. In recent times, the contamination of aquatic environment with heavy metals has affected the earth waters and this is mainly because they have toxic effect on aquatic organisms. (Macfarlane *et al*., 2000). Aquatic organism bioaccumulates these trace metals in minute amount over time which later increases over a period. Fishes have been observed to be a good accumulator of the organic and inorganic pollutants present in water (King and Jonathan 2003).

Over the years, records from the consumption of fish worldwide showed that there has been an increase with a growing need of their nutritional and therapeutic rewards to mankind. Fish is an important source of protein which is widely known but it also has ample contents of important minerals, vitamin and unsaturated fatty acid (Medeiros *et al*., 2012). The fish selected for this study, *Clarias gariepinus*, *Oreochromis niloticus* and *Auchenoglanis occidentalis* were chosen because of their economic importance, acceptability, hardiness and abundance. The aim of this study therefore is to evaluate the bio accumulation of heavy metals (Copper (Cu), Lead (Pb), Zinc (Zn), Iron (Fe) and Manganese (Mn)) in *Clarias gariepinus, Oreochromis niloticus and Auchenoglandis occidentalis* from Chanchaga River.

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MATERIALS AND METHODS

Study area

River Chanchaga is situated at the southern region of Minna, Niger State capital and falls between latitudes $6^0$31 N to $6^0$36 N and longitudes $9^0$31 E to $9^0$36 E. River Chanchaga supplies domestic water to Minna and its surroundings. It is also of economic importance because of fishing activities carried out by small villages along the flow and use the water for washing and waste disposal.

Sample collection

The fish samples were purchased from fishermen at the fish landing site of the river. The three species were bought from the fishermen. These fish were put in aseptic polythene bags and taken in icebox to the laboratory for further analysis.

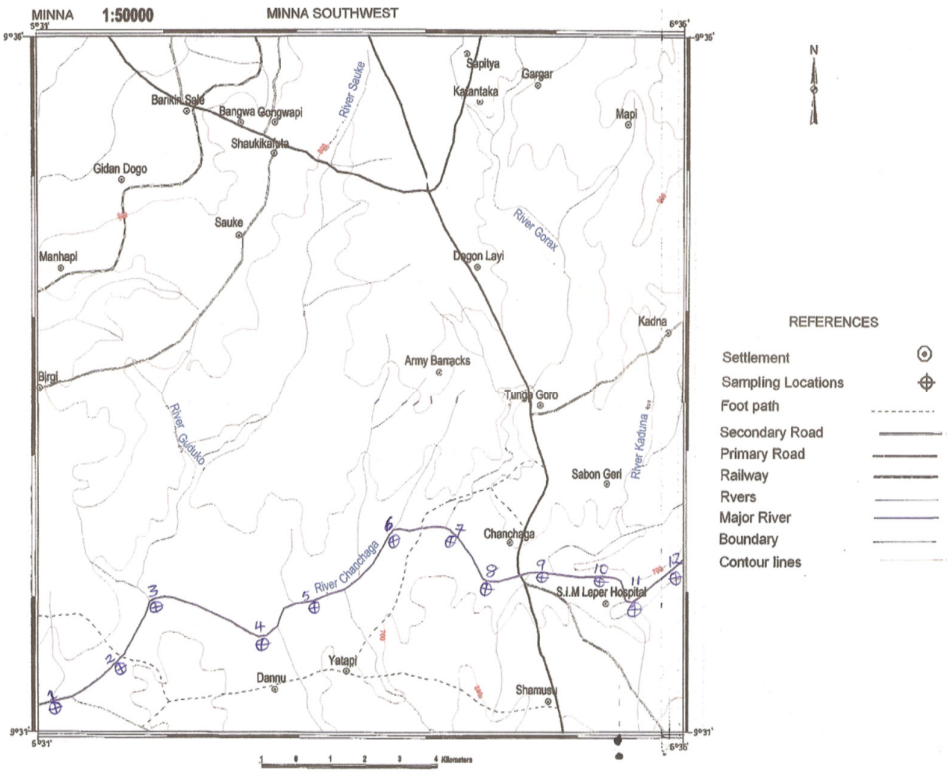

Fig 1: Map of Minna showing River Chanchaga

Digestion of samples

Prior to digestion, samples were rinsed with flowing water and dissected with sterile dissection tools to remove the gills, liver and intestine. Wet method of digestion was used to carry out the analysis. The weight of the three fish species was taken and 1g of organs of each of the sampled fish was weighed into a 100ml beaker, 10ml of 3:1 acid mixture was added (Nitric acid and perchloric acid). The mixture was then transferred to a hot plate and digested at a temperature of 150˚C until total dissolution was achieved and the samples became clear. The samples were then made up to 50ml mark with distilled water and transferred to a 60ml sample bottle after filtering through a 0.45µm membrane filter and reading taking with atomic Absorption spectrophotometer (AAS), (APHA 1995). Atomic absorption spectrophotometer (APHA 1995) was used to determine the level of various heavy metals. Each element had a specific hollow cathode lamp in default condition using flame absorption mode and using the calibration curve to determine the concentration.

Statistical analysis

One way statistical analysis of variance (ANOVA) was used to analyse the data and the differences in the mean concentration of metals on fish samples were determined using Duncan Multiple range test. The probability of $P \leq 0.05$ was used to evaluate the significant differences.

RESULTS AND DISCUSSION

Table 1 show heavy metal concentration in fish organs. The variation of the heavy metals accumulated in the different of fish species during dry season were significant ($P<0.05$).

Table 1: Heavy metals concentration in different fish organs during the dry season in Chanchaga River

Fish Species	Heavy metals (mg/100g)				
	Mn	Cu	Zn	Fe	Pb
CG	1.5^{b}	1.5^{b}	2.1^{a}	11.7c	ND
CL	1.0^{b}	1.2^{b}	1.6^{ab}	53.7^{b}	ND
CI	2.8^{a}	0.7^{b}	1.9^{ab}	36.5^{b}	ND
AG	2.1^{a}	6.3^{a}	1.7^{ab}	26.8^{b}	ND
AI	1.4^{b}	0.3^{b}	1.6^{ab}	44.7^{b}	ND
AL	0.6^{b}	0.5^{b}	1.1^{b}	123.1^{a}	ND
OI	1.5^{b}	0.7^{b}	1.7^{ab}	38.3^{b}	ND
OL	1.6^{b}	5.7^{ab}	1.5^{ab}	24.0^{b}	ND
OG	2.2^{a}	5.8^{a}	2.4a	17.2^{c}	ND
±SE	0.4	0.2	0.3	16.4	

Mean column value carrying the same superscript are not d significantly different ($p>0.05$)

Key:CG –*Clarias* gill, CL – *Clarias* liver, CI – *Clarias* intestine, *Auchenoglanis* gill, AI – *Auchenoglanis* intestine, AL – *Auchenoglanis* liver, OI – *Oreochromis* intestine, OL *Oreochromis* liver, OG – *Oreochromis* gill, ND – Not Detected

Table 2: Heavy metals concentration in fish organs during the wet season

Fish species	Heavy metals (mg/100g)				
	Mn	Cu	Zn	Fe	Pb
CG	1.9^{b}	9.6^{b}	2.4^{a}	14.4^{c}	ND
CL	1.6^{b}	1.3^{c}	0.8^{e}	56.5^{ab}	ND
CI	2.4^{b}	0.9^{c}	$1.5^{b\text{-}e}$	27.1^{bc}	ND
AG	1.5^{b}	3.9^{a}	1.6^{bcd}	27.0^{bc}	ND
AI	2.0^{b}	1.5^{b}	1.2d^{e}	53.8^{ab}	ND
AL	12.2^{a}	1.4^{b}	1.2d^{e}	71.0^{a}	ND
OI	2.9^{b}	2.5^{b}	1.3^{cde}	30.3^{bc}	ND
OL	1.5^{b}	20.9^{b}	2.1^{ab}	17.8^{c}	ND
OG	2.1^{b}	2.4^{b}	2.0^{abc}	10.8^{c}	ND
±SE	1.3	1.6	0.2	10.0	

Mean column value carrying the same superscript are not differ significantly

CG –*Clarias* gill, CL – *Clarias* liver, CI – *Clarias* intestine, *Auchenoglanis* gill, AI – *Auchenoglanis* intestine, AL – *Auchenoglanis* liver, OI – *Oreochromis* intestine, OL *Oreochromis* liver, OG – *Oreochromis* gill, Not Detected

Table 3: Seasonal variations of heavy metals in various organs of fish species

Season	Heavy metals (mg/100g)				
	Mn	Cu	Zn	Fe	Pb
Dry	1.6^{a}	2.5^{a}	1.7^{a}	41.8^{a}	ND
Wet	2.7^{a}	4.9^{a}	1.6^{a}	34.3^{a}	ND
±SE	0.6	1.6	1.0	8.4	

Mean column value carrying the same superscript are not significantly different ($p>0.05$)

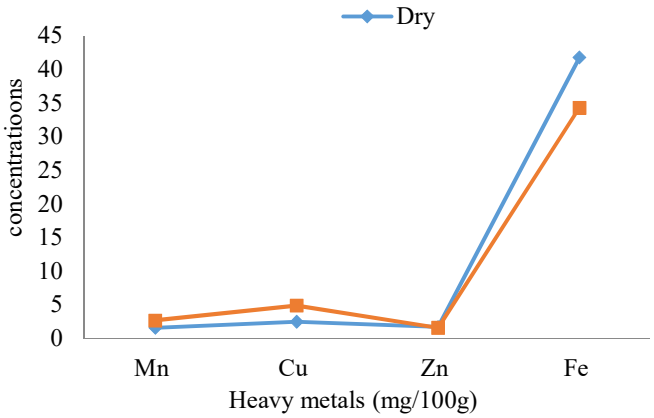

Fig. 1: Mean seasonal variation of heavy metals in various organs of fish species from River Chanchaga in dry and wet season

The result obtained indicates the variation of heavy metals present during the wet and dry season. It was also observed that there was no significant difference in the metals (Mn, Cu, Zn and Fe) during the dry and the wet season however, Pb was not detected. This could have been because there was little or no quantity of Pb present in the water. However, Zn and Fe have a higher concentration in the dry season while Mn and Cu have their highest concentration in the wet season. This variation in season (dry and wet season) might have resulted from the changes in temperature of the season, the level of runoff and the level of water in the river which is in correlation with the report from (Akan.et.al.,2009). There was a noticeable difference in the quantity of the different metals and their concentrations in the fish organs which is in correlation with the study by Zhang and Cheng. (2007) on fishes from Pahang estuary which showed that the variations in the quantity of heavy metals in different fish species could be the consequence of ecological demands, metabolism and eating behaviour and body size (Tuzen and Yilmaz, 2010).

It was observed that the concentration of Cu in AG and OL were similar but significantly different from other in the dry season. This could be due to the different feeding habits the fish exhibits and seasonal variation in the taxonomical composition of their trophic stages regarding the quantity of heavy metals accumulated in the body of the fish. The concentration of Cu was increased in quantity though not significantly difference in the season. This could be because of uncontrolled input into the water due to human activities. The high concentration of Cu could be because of sewage disposal and debris which agrees with the report of (Oguzie, 2003) who reported that sewage sludge if released into the water may lead to a higher concentration of Cu, Cr, Zn and Pb.

In the wet season, it was observed that the Al accumulates the highest concentration of Mn, followed by Ol. This shows that the liver has the tendency to accumulate an increased accumulation of heavy metals irrespective of the uptake route which agrees with the findings of (Jovanovic *et al*., 2011) that the liver is regarded a beneficial monitor of water contamination with metals as their concentration in the liver are often proportional to those available in the environment.

It was observed that Mn and Cu were positively correlated in the dry season. This could be that as a result of the reduced quantity of water, when Mn increases, Cu increases also and vice versa. A similar observation was obtained between Fe and Cu and Fe and Zn. However, there was a positive and highly significant correlation between Fe and Zn.

Table 4: Heavy metal correlation concentration during dry season of the sampling period.

	MN	CU	ZN	FE
MN				
CU	-0.05908 0.7743			
ZN	-0.08298 0.6869	0.35788 0.0668		
FE	0.15982 0.4355	-0.17666 0.3781	**-0.52824**** 0.0046	

**=Significant at p=0.01

Table 5: Heavy metal concentration relationship in wet season

	MN	CU	ZN	FE
MN				
CU	-0.05908 0.7743			
ZN	-0.08298 0.6869	0.35788 0.0668		
FE	0.15982 0.4355	-0.17666 0.3781	**-0.52824**** 0.0046	

**=Significant at p=0.01

Similarly, in the wet season, Zinc was positively correlated with Mn and Cu. This means that as the concentration of one increase the other invariably increases and vice versa. There was a similar interaction between Fe and Cu and between Fe and Zn. However, there was a negative correlation and highly significant difference (P<0.01) between Fe and Zn. This implies that as the concentration of Fe increases, the concentration of Zn reduces and vice versa. This might have led to the increase in the mass of water during the wet season.

The result from this research work indicates the presence of heavy metals (Mn, Cu, Zn and Pb) in selected fish species organs from River Chanchaga during the wet and dry season in varying quantities. The results also showed that metal accumulation varied between organs and species depending on some specific factors like swimming patterns, feeding habit and age in the geographical region. Chanchaga River has shown evident of metal pollution as it reflected in the fish tissues There is need for proper monitoring of this water body for effective sustainability and elimination of any health risk because from the River.

REFERENCES

APHA. (1995). America public Health authority. Standard methods for examination of water and Waste waters. 16th Edition. Washington D.C, 1193Pp.

Akan, J. C., Abdulrahman, F. I., Sodipo, O. A. and Akandu, P. I. (2009). Bioaccumulation of some heavy metals of six fresh water Fishes caught from Lake Chad in Doron Buhari, Maiduguri, Borno State, Nigeria, *Journal of Applied Sciences in Environmental Sanitation*, 4:103-114.

Ghosh, M., Singh, S.P, (2005). Review on phytoremediation of heavy metals and utilization of it's by products: *Applied Ecology Research*, 3(1):1-18.

Kumar, A, 2004, Water pollution: New Delhi, A.P.H publishing corporation, 199Pp.

King R. P and. Jonathan, G. E. (2003). Aquatic Environmental Perturbations and Monitoring, African experience, USA 204Pp.

MacFarlane, G. R. and Burchette, M. D. (2000). Cellular Distribution of Copper, Lead and Zinc in the Grey. Mangrove, *Avicienna marina* (Forsk) Vierh, *Aquat. Bot*. 68, 45-59.

Medeiros, R. J., dos Santos L. M., Freire, A. S., Santelli, R. E., Braga, A. M. C. B. and Krauss, T. M. (2012). Determination of Inorganic Trace Elements in Edible Marine Fish from Rio de Janeiro State, Brazil. *Food Control*, 23:535-541.

Oguzie, F. A. (2003). Heavy metals in Fish, Water and Effluents of lower Ikpoba River in Benin City, Nigeria. *Pakistan Journal of Science and Industrial Research,* 46:156-160.

Jovanovic, B., Mihaljev, Z., Maletin, S. and Palic, D. (2011). Assessment of heavy metal load in chub liver (Cyprinidae – Leuciscus cephalus) from the Nisava River (Serbia) *Biologica,* 2(1):51-58.

Tüzen, M. and Yilmaz, A. B. (2010). Determination of heavy metals in fish samples of the Mid Dam Lake Black Sea (Turkey) by graphite furnace atomic absorption spectrometry. *Food Chemistry*, 80:19 -123.

Yilmaz, A. B. (2003). Levels of Heavy Metals (Fe, Cu, Ni, Cr, Pb and Zn) in Tissue of *Mugil cephalus* and *Trachurus mediterraneus* from Iskenderun Bay. Turk. Environ. Res. 92: 277–281.

Zhang, W. and Cheng, C. Y. (2007) Manganese Metallurgy Review. Part I: Leaching Of Ores/Secondary Materials and Recovery of Electrolytic/Chemical Manganese Dioxide. *Hydrometallurgy,* 89:137–159.