

BIOACCUMULATION OF HEAVY METALS IN *Tilapia zilli* (GERVAIS, 1848) AND *Clarias gariepinus* (BURCBELL, 1822) FROM THOMAS DAM IN MAKODA LOCAL GOVERNMENT AREA, KANO

Rabi'u Ado Musa

Department of Pre-ND Science, Audu Bako College of Agriculture, P.M.B. 3159, Kano – Nigeria.

e-mail: rabiuadomusa@yahoo.com

ABSTRACT

Analysis of heavy metal accumulation in Tilapia zilli and Clarias gariepinus of average weights of 90.00 ± 0.32g and 90.87 ± 0.53g respectively from Thomas Dam in Makoda Local Government of Kano State were carried out. The results obtained showed that the mean concentration of [Ni] was 0.25 ± 0.03mg/dm³, [Pb] 0.06 ± 0.01mg/dm³, [Cu] 1.39 ± 0.15mg/dm³, [Cd] 0.17 ± 0.06mg/dm³ and [Fe] 0.29 ± 0.18mg/dm³ in Tilapia zilli while [Ni] in Clarias gariepinus was 0.22 ± 0.07mg/dm³, [Pb] 0.15 ± 0.03mg/dm³, [Cu] 1.13 ± 0.12mg/dm³, [Cd] 0.14 ± 0.01mg/dm³ and [Fe] 0.29 ± 0.13mg/dm³ respectively. The mean concentrations of Cd, Cu and Fe were within the tolerable limits of 0.8mg/dm³, 2.00mg/dm³ and 0.30mg/dm³ respectively and the mean concentrations of Pb and Ni were above the permissible limits of 0.05mg/dm³ and 0.02mg/dm³ respectively as recorded by United States Environmental Protection Agency (USEPA).

KEYWORDS: Bioaccumulation, *C. gariepinus*, Heavy metals, Makoda, *T. zilli*.

INTRODUCTION

In a rapidly industrializing world where many inorganic and organic substances, sometimes in high concentrations are constantly being introduced into water bodies, environmental contamination from heavy metals is of concern, because it exhibits behavior consistent with those persistent toxic chemicals (Chidi, *et al.* 2008). Unlike many organic contaminants that lose toxicity with biodegradation, metals cannot be degraded further, whilst the concentrations in biota can be increased through bioaccumulations (Akporhonor, *et al.* 2007).

Fish are often at the top of aquatic food chain and may accumulate large amount of some heavy metals, the consumption of toxic metals in contaminated fish has been linked to many disease condition in man. Some of these metals such as Cd and Hg results in impaired kidney function, poor reproductive capacity, hypertension, tumours and hepatic dysfunction. Moreover, lead causes renal failure and liver damage (Akporhonor, *et al.* 2007). In Nigeria, fish is an important source of protein, thus the contamination of fish by heavy metals is viewed with serious concern (Odoemelam, 2005). The aims of this research were to asses and compare the metal content in *Tilapia zilli* and *Clarias gariepinus* from Thomas Dam in Makoda Local Government of Kano State. The analysis revealed the metal content of these fishes and as such, their consumers will be advised accordingly.

MATERIALS AND METHODS

In the preparation of reagents, chemicals of analytical grade purity and distilled water were used. All glasswares were washed with detergent and rinsed with water before drying in the oven at 105°C, for 2 hours.

Sample Collection and Preparation

Forty samples each of *Tilapia zilli* and *Clarias gariepinus* were collected from Thomas Dam in

Makoda Local Government which is located along Kano – Kazaure road about 38km away from Kano. All the fish samples were washed and stored in polythene bags for analysis. The fish samples were dried for 3 days to constant weight in an oven at 60°C and were pounded in a mortar and pestle until a powder was produced which was stored in air-tight plastic container before analysis. All samples were analyzed in triplicate and mean values recorded.

Procedure

1.0g portion of ground fish samples were weighed into a Kjeldahl's flask and 10cm³ of HNO₃ and 2cm³ HClO₄ mixture were added. The mixture was swirled and the digestion was carried out in a fume cupboard on a hot plate until a clear solution was obtained after the disappearance of brown fumes of NO₂. The solution was cooled, filtered and made up to 50cm³ mark in a volumetric flask with 0.2% HNO₃ (Odoemelam, 2005). Blank solution were prepared. The solutions were analysed for Nickel, lead, Iron, Copper and Cadmium using ALPHA 4 model, Atomic Absorption Spectrophotometer (AAS). A calibration plot of absorbance against concentrations of each element under investigation was constructed and finally the concentration of each element was determined from the calibration curve by extrapolation.

RESULTS AND DISCUSSION

The concentration of nickel in the fish samples analysed indicates that *T. zilli* have the highest mean concentration of 0.25 ± 0.03mg/dm³ and *C. gariepinus* recorded 0.22 ± 0.07mg/dm³. The observed bioaccumulation pattern may be due to pollution from natural or environmental activities; this is in comparison with Agumadu (2009).

The concentration of lead in the fish samples analysed shows that *C. gariepinus* have the highest mean concentration of $0.15 \pm 0.03\text{mg/dm}^3$, while *T. zilli* had $0.06 \pm 0.01\text{mg/dm}^3$ respectively. This may be due to the presence of highest concentration of lead which usually occurs in surface soil at depths of 1-5cm, this is in agreement with the findings of Agumadu (2009). The observed bioaccumulation pattern in all the fish samples analysed may be due to wide distribution of lead in the earth's crust; as a result of its frequent use in lead acid batteries, solder, rust inhibitors and plastic stabilizers (Ayodele and Ahmed, 1996). The concentration of iron in the fish samples analysed shows that *T. zilli* have the highest mean concentration of $0.29 \pm 0.18\text{mg/dm}^3$ and *C. gariepinus* recorded $0.29 \pm 0.13\text{mg/dm}^3$. This may also be due to its wide distribution in the earth's crust. It is the second most abundant

metal in the earth's crust of which it accounts for about 5% as recorded by Knepper (1981) and Elinder (1986).

The concentration pattern for copper in the fish samples analysed shows that *T. zilli* have the highest mean metal concentration of $1.39 \pm 0.15\text{mg/dm}^3$ while *C. gariepinus* recorded $1.13 \pm 0.12\text{mg/dm}^3$ respectively. This high accumulation could be due to wide application of copper in pest control, as organic dyes, as feed additives, in seed disinfectants, as fungicides and algicides (USEPA, 1987).

The concentration pattern for cadmium in the fish samples analysed shows that *T. zilli* have the highest mean metal concentration of $0.17 \pm 0.06\text{mg/dm}^3$ and *C. gariepinus* had the value of $0.14 \pm 0.01\text{mg/dm}^3$ respectively. The bioaccumulation observed in all the fish samples analysed was below the maximum permissible limit of 0.8mg/dm^3 (Alinnor, 2008).

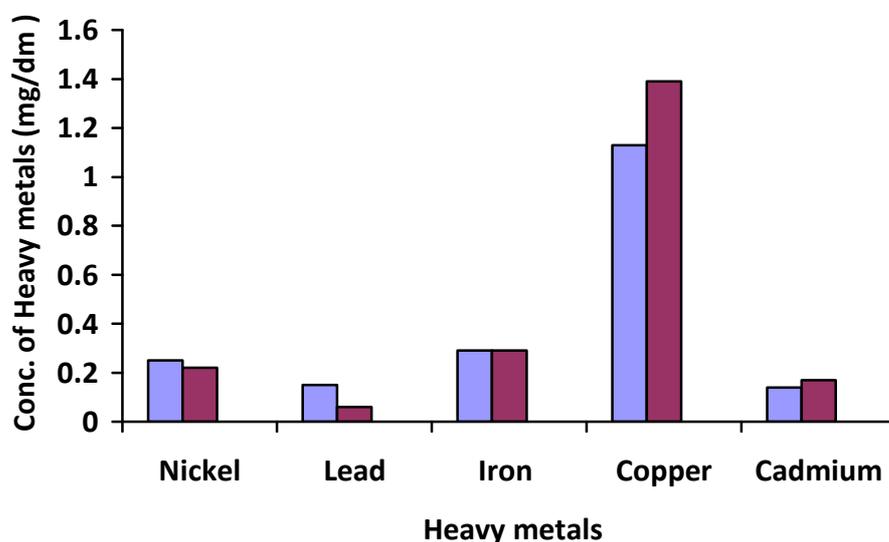


Figure 1: Mean Bioaccumulation of heavy metals in *Clarias gariepinus* and *Tilapia zilli*.

Table 1: Mean concentration of heavy metals in *Clarias gariepinus* and *Tilapia zilli*.

Fish species	Heavy metals				
	Nickel	Lead	Iron	Copper	Cadmium
<i>Clarias gariepinus</i>	0.22 ± 0.07	0.15 ± 0.03	0.29 ± 0.13	1.13 ± 0.12	0.14 ± 0.01
<i>Tilapia zilli</i>	0.25 ± 0.03	0.06 ± 0.01	0.29 ± 0.18	1.39 ± 0.15	0.17 ± 0.06

The highest mean nickel concentrations of $0.25 \pm 0.03\text{mg/dm}^3$ from *T. zilli* and $0.22 \pm 0.07\text{mg/dm}^3$ in *C. gariepinus* analysed were much higher than the tolerable limit value of 0.02mg/dm^3 recorded by WHO (2003). Nickel is a skin allergen, it penetrates the skin very slowly and appears distributed to all organs, primarily the kidneys, lungs and liver (Agumadu, 2009).

The principal vehicle for the transport of lead from the intestine to the various body tissues is the red blood cell in which lead is bound primarily to haemoglobin (Moore, 1988). The displayed mean concentrations of lead $0.15 \pm 0.03\text{mg/dm}^3$ found in *C. gariepinus* and $0.06 \pm$

0.01mg/dm^3 in *T. zilli* were much higher than the tolerable limit value of 0.05mg/dm^3 established by WHO (1999). Acute lead poisoning in man causes severe dysfunction in the kidney, reproductive system, liver, brain and the central nervous system (Bhatia, 2006). Lead poisoning from environmental exposure may cause mental retardation in children, while mild lead poisoning causes anaemia (Bhatia, 2006).

The highest mean iron concentrations of $0.29 \pm 0.18\text{mg/dm}^3$ from *T. zilli* and $0.29 \pm 0.13\text{mg/dm}^3$ in *C. gariepinus* were within the maximum permissible limit of 0.30mg/dm^3 recorded by WHO (1999).

Autopsies have shown haemorrhagic necrosis and sloughing of areas of mucosa in the stomach with extension in to the submucosa (Bothwell, 1979).

Copper is an essential element, fish do not accumulate copper to levels that are likely to be toxic to animals and humans (Zwarsch and Mills, 1981). The mean copper concentrations of $1.39 \pm 0.15 \text{ mg/dm}^3$ obtained from *T. zilli* and $1.13 \pm 0.12 \text{ mg/dm}^3$ in *C. gariepinus* were below the maximum permissible limit of 2.00 mg/dm^3 observed by WHO (2003), this is in comparison with the findings of Zwarsch and Mills (1981). Copper deficiency is very rare in human and some of its symptoms are retarded growth, bone demineralisation and depigmentation of the skin (Onianwa, et al. 2001).

There is no known nutritive use of cadmium (Ibrahim, 2008), the highest mean cadmium concentrations of $0.17 \pm 0.06 \text{ mg/dm}^3$ in *T. zilli* and $0.14 \pm 0.01 \text{ mg/dm}^3$ from *C. gariepinus* were

below the maximum permissible limit of 0.80 mg/dm^3 (Alinnor, 2008), this is also in agreement with the report of Shu'aibu and Ayodele (2002). High intake of cadmium can lead to kidney damage (Ibrahim, 2008).

CONCLUSION

Analyses of *Clarias gariepinus* and *Tilapia zilli* showed that the concentrations of Fe, Cu and Cd were within the tolerable limits while that of Pb and Ni were above the permissible limits of USEPA (1984), these accumulation of heavy metals in fish may be due to aquatic nature of the environment, indiscriminate use of pesticides, fungicides, algicides and other chemicals during fishing activities and the genetic control of different types of fish species. All these are factors that contribute to the bioaccumulation pattern of heavy metals in *Clarias gariepinus* and *Tilapia zilli*.

REFERENCES

- Agumadu A.N. (2009). Determination of Heavy Metals in Underground Waters of Kano Metropolis. M.Sc. Dissertation. Department of Pure and Applied Chemistry, Bayero University, Kano. Pp 9-53.
- Akporhonor, E.E. Iwegbue, C.M.A. Egwaikikhide, P.A. and Emua, S.A. (2007). Levels of Cadmium, Lead and Mercury in Organs of some fish species from Warri River, Nigeria. *Journal of Chemical Society of Nigeria* 1 (32) :221-226.
- Alinnor, I.J. (2008). Determination of heavy metals in leaves of pumpkin (*Telferia occidentalis*) and spinach (*Amaranthus cruetus*) along major highways in Owerri, South Eastern Nigeria. *Journal of Chemical Society of Nigeria* 1 (33) :150-155.
- Ayodele, J.T. and Ahmed, A. (1996). Monitoring air pollution in Kano by chemical analysis of scot pine needles for Heavy metals. *Journal of Chemical Society of Nigeria*. 1 (21) :80-85.
- Bhatia, S.C. (2006). Environmental Chemistry. CBS Publisher, New Delhi, India. Pp 350-370.
- Bothwell, T.H. (1979). Iron Metabolism in Man. Blackwell, Oxford, England. Pp 15-21.
- Chidi, E.D. Victor, O.N and Chidi, O. (2008). Heavy metal concentrations in Urban waterwells: A case study of Owerri municipal. *Journal of Chemical Society of Nigeria* 2 (33) :89-93.
- Elinder, C.G. (1986). Iron , In: Friberg, L., Nordberg, G.F., Vouk, V.B (ed) .*Handbook on the Toxicology of Metals*. Amsterdam, Elsevier Science Publishers. Pp 664-679.
- Ibrahim A.M. (2008). Proximate Analysis and Determination of Some Metals in: Dates (*P. doctylifera*), Tilapia Fish (*cichlid*), Soya Beans (*glycin max*), Cow milk and Chicken egg. MSc. Dissertation. Department of Pure and Applied Chemistry, Bayero University, Kano. Pp 5-13.
- Knepper, W.A. (1981). Iron. In: *Kirk-Othmer Encyclopedia of Chemical Toxicology*. New York, NY. Wiley Interscience. Pp 735-753.
- Moore, M.R. (1981). Maternal Lead Levels after Alterations to Water Supply. *Lancet*. 2:203-204.
- Odoemelam, S.A. (2005). Bioaccumulation of trace elements in fish from Oguta lake in Nigeria. *Journal of Chemical Society of Nigeria* 1 (30) :18-20.
- Onianwa, P.C. Adeyomi, A.O. Iduwu, E.O. and Ogabiela, E.E. (2001). Copper and zinc contents of Nigeria foods and estimates of the adult dietary intakes. *Journal of Food Chemistry* 1 (72): 89-95.
- Shu'aibu, U.O.A. and Ayodele, J.T. (2002). Bioaccumulation of four heavy metals in leaves of *Calitropis procera*. *Journal of Chemical Society of Nigeria* 1 (27) :26-27.
- United States Environmental Protection Agency (USEPA) (1984). Manganese. *Health Assessment Department*. Environmental Criteria and Assessment Office. Cincinnati, OH, USA. Pp 11-25.
- United States Environmental Protection Agency (USEPA) (1987). Summary Review of the Health Effects Associated with Copper. Health Issue Assessment. Cincinnati, OH, USA. Pp 13-27.
- World Health Organisation (WHO) (1999). Guidelines for Drinking Water Quality, WHO, Geneva. Pp 160-220.
- World Health Organisation (WHO) (2003). Guidelines for Drinking Water Quality, WHO, Geneva. Pp 90-120.
- Zwarsch, M.A. and Mills, J.G. (1981). Heavy metal accumulation by some vegetable crops grown on sewage-amended soils. *Canadian Journal of Soil Science*. 2 (25):243-245.