IJABR Vol. 3(2):47 - 51 (2011)

Original Article

LEVELS OF CADMIUM AND NICKEL IN FIVE FISH SPECIES SOLD IN MOBIL FISH MARKET, MINNA, NIGERIA

Muhammad, H. L., Suleiman, M. S. and Umar, M. B.

Department of Biochemistry, Federal University of Technology, Minna, Nigeria.

Submitted: Dec. 12, 2010; Accepted: Nov. 18, 2011; Published: Dec. 30, 2011.

ABSTRACT

Five fish species were collected randomly from mobil fish market, Minna and were analyzed for cadmium (Cd) and nickel (Ni) using absorption spectrophotometer, model (Schimadzu AA650). The samples were digested. The concentration of Cd and Ni were determined in gills, muscles, and liver tissues. The concentration of Ni in the tissues of *Oreochromis niloticus* was higher than in other fish species; with its liver tissue having the highest value of $2.1x10^{-4} \pm 1.1x10^{-1}$ mg/g. Cadmium concentration in *Oreochromis niloticus* were lower than in other fish species, with the exception of the muscles of *Heterotis niloticus* with concentration as low as $7.8x10^{-6} \pm 7.1x10^{-4}$ mg/g. This result showed that both the highest concentrations of Ni ($2.1x10^{-4}$ $1.1x10^{-1}$ mg/g) and Cd ($3.8x10^{-5} \pm 1.8x10^{-2}$ mg/g) are within the World Health Organisation (WHO) acceptable limits of 0.4 mg/g and 0.2 mg/g respectively. The fishes purchased from mobil fish market, Minna are therefore safe for consumption.

Keywords: Cadmium, Nickel, low concentrations, *Oreochromis niloticus, Heterotis niloticus. **Clarias anguillaris, Mormyrus rume, Lates niloticus***

Correspondence:khadijahlami@gmail.com, +2348035960300.

INTRODUCTION

The concentration of cadmium in air has been estimated to range from 0.1-5 **µg/g** in natural areas, 2-15 **µg/g** in the urban areas and 15-150 µg/g in industrialized areas (ATSDR, 1999). High levels of cadmium have been rated around coastal areas and different concentrations are observed according to the depth of the ocean. Rivers transport cadmium from considerable distances of up to 50 km from the source where it exist in water as hydrated ion, inorganic complex (hydroxides, carbonates) or as organic complex with humid acid (Sanders, 1997). Cadmium in the liver induces the synthesis of metallothionein which is a high molecular weight metal binding protein. The cadmium is initially non-toxic, but the cadmium-metallothionein complex becomes nephrotoxic as it accumulates in the kidneys (Goyer, 1991; Dorian 1993).

Due to natural geochemical activity and weathering, nickel occurs in all soils, sediments and water. Absorption of divalent nickel (Ni^{2+}) into the fish body and the binding to a membrane (gills) prevents the proper functioning of the affected organs (USEPA, 2006). Among the aquatic fauna, fish is the most susceptible to heavy metal toxicants and is therefore more vulnerable to metal contamination than any other fauna (Nwaedozie, 1998). Fish quality can be affected by different forms of water pollution; physical, chemical and biological pollution. Chemical pollution is of great concern because it is responsible for high concentration of heavy metals in sea foods. Concentration of heavy metals in fish as prescribed by World Health Organization (WHO), and National Agency for Foods, Drug Administration and Control (NAFDAC), has its limits, above which they become toxicants to human and even the aquatic life. Nickel and Cadmium are toxicants because they tend to bioaccumulate in the tissues. Bioaccumulation means, an increase in the concentration of chemical in a biological system over time, compared to the chemical's concentration in the environment. The occurrence of cadmium and nickel depends to a large extent on; land type, location, soil type, activities around the area such as industrialization, mining, farming, refining activities, and textile manufacturing activities (Maduka, 2006). In some states which include Kaduna, Niger delta and Abia, fishes have been analyzed and found to have some traces of cadmium and nickel (Gabriel *et al.*, 2006). Cadmium and nickel were chosen for analyses in five fish species: *Clarias anguillaris* (Linne), *Oreochromis niloticus* (Linne), *Mormyrus rume* (Valenciennes), *Heterotis niloticus* (Cuvier), *and Lates niloticus* (Linne), because these fish species are very abundant in Minna fish market and are consumed more by the immediate community.

MATERIALS AND METHODS

Reagents

All reagents were of analytical grades, and they included: hydrogen peroxide (6 % w/v), concentrated nitric acid (HNO_3) and formaldehyde.

Sample Collection

Five fish species of mixed sexes, weighing between 180 – 200 g were randomly collected from Minna fish market (a.k.a Mobil) in may 2008. The fishes were from the same source (shiroro Dam). They were dissected and three organs (liver, gills and muscles) were harvested and placed in 10 % formaldehyde. The samples were stored at the ice chamber in a refrigerator at -4^{0}C till ready for digestion.

Sample Digestion

Organ sample (2g) (wet weight) were weighed in an open beaker, 10 ml of freshly prepared 1:1 HNO_3 / H_2O_2 was added. The beaker was covered in a watch glass till initial reaction subsided. The beaker was placed on a hot plate, and the temperature gradually allowed to rise to 160 ^{0}C. The mixture was boiled for thirty five minutes till the volume reduced to about 4 ml. The digests were allowed to cool and 10 ml of distilled deionized water was added to it and filtered with Whattman no. 1 filter paper. The filtrate was rinsed thrice with distilled deionized water and transferred to 50 ml volumetric flask and made up to mark. The digests were kept in plastic bottles, till ready for use. This procedure applies to all other samples. Ni and Cd determinations were carried out using Atomic Absorption Spectrophotometer (AAS) at wavelength specific to each metal (Olaifa *et al.*, 2004).

RESULTS

The concentration of cadmium in gills, livers and muscles of *Clarias anguillaris* were $3.7x10^{-5}\pm 1.4x10^{-2}$, $3.7x10^{-5}\pm 1.4 x10^{-2}$, $2.2x10^{-5}\pm1.3 x10^{-2}$ and $1.5x10^{-5}\pm 6.2 x10^{-3}$, $1.5x10^{-5}\pm 1.3 x10^{-3}$,$9.3x10^{-6}\pm2.8x10^{-3}$ for *Oreochromis niloticus.* While the concentration for *Mormyrus rume and Heterotis niloticus* were $2.2x10^{-5}\pm 5.0 x10^{-1}$,$3.8x10^{-5}\pm 1.8 x10^{-2}$,$1.4x10^{-5}\pm 4.5 x10^{-3}$ And $1.8x10^{-5}\pm 1.4 x10^{-2}$, $3.3x10^{-5}\pm1.4 x10^{-2}$,$7.8x10^{-6}\pm 7.0 x10^{-5}$ *respectively and Lates niloticus* Contains $2.0x10^{-5}\pm 9.3X10^{-3}$,$3.0x10^{-5}\pm 2.1 x10^{-3}$,$1.1x10^{-5}\pm 2.5 x10^{-3}$. All of which are belo w the WHO and NAFDAC maximum limits respectively (Table 1)

Also, the concentration of Nickel in gills, livers and muscles of *Clarias anguillaris were* $7.1x10^{-5} \pm1.3x10^{-2}$, $1.1 x 10^{-4} \pm1.7x10^{-2}$, $4.5x10^{-5}\pm1.5 x10^{-2}$ and $8.0x10^{-5}$

±9.7x10^{-3} ,2.1x10^{-4} ± 1.1 x10^{-1}, 5.3x10^{-5}±1.7 x10^{-3} for *Oreochromis niloticus*. While concentration for *Mormyrus rume* and *Heterotis niloticus* were 6.3x10^{-5} ±1.3x10^{-2} 8.9x10^{-5}±1.7 x10 ^{3}5.3x10^{-5} ±7.2 x10^{-3}, 5.0x10^{-5} ±7.6x10^{-3}5.7x10^{-5} ± 4.1 x10^{-3} 3.7x10^{-5}±6.1x10^{-3} respectively and *Lates niloticus* contains 5.3x10^{-5} ±9.9x10^{-3}, 6.9x10^{-5}±8.0x10^{-3}, 3.7x10^{-5} ± 4.2 x10^{-3} concentration which are all below the WHO and NAFDAC maximum limits respectively (Table 2).

Table 1: Concentration of Cadmium (mg/g) in Gills, Livers and Muscles of Five Fish Species

Species	Gills	Livers	Muscles	WHO (mg/)	NAFDAC (mg/l)
Clarias anguillaris	3.7x10^{-5}± 1.4x10^{-2}	3.7x10^{-5}± 1.4 x10^{-2}	2.2x10^{-5}±1.3 x10^{-2}	0.2	0.00
Oreochromis niloticus	1.5x10^{-5}± 6.2 x10^{-3}	1.5x10^{-5}± 1.3 x10^{-3}	9.3x10^{-6}± 2.8 x10^{-3}	0.2	0.00
Mormyrus rume	2.2x10^{-5}± 5.0 x10^{-1}	3.8x10^{-5}± 1.8 x10^{-2}	1.4x10^{-5}± 4.5 x10^{-3}	0.2	0.00
Heterotis niloticus	1.8x10^{-5}± 1.4 x10^{-2}	3.3x10^{-5}±1.4 x10^{-2}	7.8x10^{-6}± 7.0 x10^{-5}	0.2	0.00
Lates niloticus	2.0x10^{-5}± 9.3X10^{-3}	3.0x10^{-5}± 2.1 x10^{-3}	1.1x10^{-5}± 2.5 x10^{-3}	0.2	0.00

Table 2: Concentration of Nickel (mg/g) in Gills, Livers and Muscles of Five Fish Species

Species	Gills	Livers	Muscles	WHO (mg/g)	NAFDAC (mg/l)
Clarias anguillaris	7.1x10^{-5} ±1.3x10^{-2}	1.1 x 10^{-4} ±1.7x10^{-2}	4.5x10^{-5}±1.5 x10^{-2}	0.4	0.03
Oreochromis niloticus	8.0x10^{-5} ±9.7x10^{-3}	2.1x10^{-4} ± 1.1 x10^{-1}	5.3x10^{-5}±1.7 x10^{-3}	0.4	0.03
Mormyrus rume	6.3x10^{-5} ±1.3x10^{-2}	8.9x10^{-5} ± 1.7 x10^{-3}	5.3x10^{-5} ±7.2 x10^{-3}	0.4	0.03
Heterotis niloticus	5.0x10^{-5} ±7.6x10^{-3}	5.7x10^{-5} ± 4.1 x10^{-3}	3.7x10^{-5} ± 6.1 x10^{-3}	0.4	0.03
Lates niloticus	5.3x10^{-5} ±9.9x10^{-3}	6.9x10^{-5} ± 8.0 x10^{-3}	3.7x10^{-5} ± 4.2 x10^{-3}	0.4	0.03

DISCUSSION

The result indicated a generally low concentration of cadmium and nickel in the tissues of all the five fish species sampled when compared with the World Health Organization (WHO) acceptable limits of 0.4 mg/g and 0.2 mg/g for nickel and cadmium respectively. The same is the case with the standard limits of National Agency for Foods, Drug Administration and Control acceptable limits of 0.3 mg/g and 0.0 mg/g for nickel and cadmium respectively. The zero limit standard of NAFDAC for cadmium might be due to its non biological role in living organisms. Nickel is an essential element that plays an important role in urease and dehydrogenase activities and absence of which retards growth or cause the death of living organisms. Nickel is highly tolerable by organisms except the divalent state Ni^{2+}. Cadmium unlike nickel, plays no biological role in humans, and its presence or continuous bioaccumulation in fish tissues poses a threat to man. Thus bioaccumulation may likely occur if the fishes are able to absorb the metals in their tissues and as cadmium plays no role in metabolism, it may be sulphur-seeking and binds to $S\text{-}CH_3$ and S-H groups in enzyme proteins. Cd^{2+} and Zn^{2+} are similar in their chemical properties including size. Cd^{2+} replaces Zn^{2+} in enzymes that contain the latter.

Cd-containing enzymes do not perform the same function as Zn-containing enzymes, and its presence in tissues when bound to metallothioneins allows it to be transported to the blood by the erythrocyte or bound to large molecular weight proteins. It was observed that the concentration of nickel in tissues was twice higher than that of cadmium in the whole fish species; this therefore suggests that there may be a source of nickel in fish-feeds or the aquatic environment where the fish were breed. The concentration of nickel in *Oreochromis niloticus* was highest in gills. This value is low when compared with the WHO acceptable limit of 0.4 mg/g. In general, nickel and cadmium concentrations in all the fish species were higher in gills and livers than in muscles. This may be due to the fact that liver is the centre of metabolism and all agents pass through it before their final destination. The gills however have lots of fluids passing through them leading to subsequent absorption.

CONCLUSION

It can be concluded that fishes sold in Minna fish market (a.k.a Mobil) at the time of this research contained very low level of nickel and cadmium. This therefore means that fishes purchased from this fish centre are safe for human consumption. Bioaccumulation of these little but very significant concentration of cadmium can lead to toxicity over time.

REFERENCE

ATSDR (Agency for Toxic substances and Disease Registry) (1999). Study of female workers at a lead smelter; an examination of the possible association of lead exposure with decreased bone density and other health outcomes. Atlanta: US Department of health and Human services. (16): 65-71

Baron, M. G., (1995) Bioaccumulation and bioconcentration in aquatic organisms, In:*Handbook of Ecotoxilogy, Pp 652 – 662*

Dorian, P (1993).review of Healt effects of methylmercury. American Technical Report. 24:35-65.

Gabriel Oze, Rita Oze, Clifford Anunuso, Cynthlia Ogukwe, HarrisonNwanjo, and Knennedy Okorie (2006). Heavy Metal Pollution of Fish Qua-Ibo River Estuary. Possible Implications for Neurotoxicity

The Internet Journal of Toxicology 3(l): 45-60.

Goyer R.A (1991). Selected Trace metals in Fish, sediment and water from freshwater Tarbella Reservoir Toxical and Environmental chemistry 39: 201-205

Maduka H.C.C. (2006). Water Pollution and Man's Health. *The internet journal of gastroenterology. 4(1): 1-1 1*

Muhammad, H. L. (2009). Bioaccumulation of heavy metals in fish tissues collected from Goronyo dam and its two Tributaries and Rima River Sokoto, Nigeria. *unpublished. Pp93 - 103*

NAFDAC Act 11 on Food and Drugs (1999-No.19)

Nordberg, K. (1972), Fish mercury distribution in Massachusetts, USA lakes *Environment Toxicology and Chemistry 18(7) Pp 1385 - 1389*

Nwadozie, J.M. (1998). The determination of Heavy Metals pollution in Some Fish Samples from River Kaduna *journal of Chemical Society. Nigeria 23, 21-23*

Olaifa, F.E., Olaifa A.K., Ade Laja. (2004). Heavy Metal Contamination of (*Clarias gariepinus*) from a lake and fish farm Ibadan. *African Journal of Biomedical Research volume 7. 145-1 48.*

Sanders, M.J (1997). A field evaluation of the fresh water . river crab, *Potamonantes warren,* as a Bioaccumulative indicator of metal pollution. M.sc thesis, Faculty of Natural Sciences Rand Africaans University, Johannesburg, South Africa. M. 123

Skeaf, J. and King P (1999). Canada centre for mineral and Energy Technology (CANMET). Natural Resources Canada, Report MMSL 97-089, Ottawa. Pp48.

USEPA (2006). Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms, 2nd edn. Environmental monitoring and support. Loboratory office and Resource Development.cincinnati ohio. EPA/6004-89/001pp56

WHO (1996). Total dissolved solids in Drinking-water .Background document for development of WHO *Guidelines for Drinking-water Quality.* Originally published in Guidelines for drinking-water quality, 2nd ed.Vol. 2. *Health criteria and other supporting information.* World Health Organization, Geneva.

Yousuf, M.H.A and El-shahawi, M.S (2000). Trace metals in lethrinus lengan fish from Arabian Gulf: Metal accumulation in Kidney and Heart Tissues: Bulletin of Environmental contamination and Toxicology. 62: 293-30