Heavy Metal Concentrations of Some Fish Species Consumed in Ozoro, Delta State, Nigeria

*C. K Ojebah and K. Emumejaye
Department of Science Laboratory Technology
Delta State polytechnic, P.M.B 5, Ozoro
*Corresponding email: ckojebah@gmail.com

Abstract— This study investigated the heavy metal concentration of commonly consumed fish species in Ozoro, Delta State, Nigeria. The four fish samples procured from Ozoro daily market; Tilapia (Oreochromis niloticus), Mud Fish (Clarias anguillaris), Catfish (Ostariophysi Siluriformes) and Croaker fish (Micropogonias undulates) were used in this study. Each of the fish samples were cut into three parts; head, trunk and tail. Samples were then oven dried and ashed in electric furnace at temperature of 450^{0}C. The fish parts were digested using Nitric acid/Perchloric acid mixture (2:1). Heavy metal concentration was determined using Atomic Absorption Spectrophotometer (Varian Spectra AA 200 model). Results obtained showed that most of the metals were associated with the head. Zinc was the most dominant metal and ranged from 2.97 - 6.59mg/kg. Copper ranged from 0.94 - 3.13mg/kg; Pb and Cd concentration ranged from 0.06 - 1.36mg/kg and 0.00 - 0.30 mg/kg dry, respectively. The mean concentrations of the metals were below world mean average except lead. The presence of non essential elements (Pb and Cd) in the study calls for concern to the consuming populace of these fishes.

Index Terms— Concentration, Fish, Heavy metal, Head , Tail,

1 INTRODUCTION

Heavy metals are metals of high density usually greater than 5.00 to 6.00 g/cm³ and may have hazardous effects on plants and animal ecosystems when present above concentrations found naturally (Keepax et al., 2011). Heavy metals are potentially toxic (aluminiun, arsenic, cadmium, antimony, lead and mercury), semi-essential (nickel, vanadium, cobalt) and essential [copper, zinc, selenium, manganese, iron, etc] (Szentmihalyi and Then, 2007). These essential metals can be toxic effects when excessively taken (Tüzen, 2003; Ellias, 2009). Fishes are the most important organisms in the aquatic food chain. They are very sensitive to heavy metals contamination. Fishes are a great source of protein enhanced food the world over (Mansour and Sidky, 2002). Consumption of fish contaminated with heavy metals can have toxic effects on human health (Mai et al., 2006). Heavy metals once penetrated into the body through food chain may lead to serious diseases (Idzelis, 2007). Ingestion of heavy metals leads to numerous health challenges (Ayeloja et al., 2014).Various studies have been conducted on heavy metal bioaccumulation in the head, trunk and tail of fish collected from different freshwater aquatic systems (Asiagwu et al., 2009). The objective of this present study was to determine the occurrence and levels of some selected heavy metals (Copper, lead, cadmium and zinc) in head, trunk and tail of the fish, Tilapia, Mud fish, cat fish and crokers commonly consumed in Ozoro, Delta State Nigeria. There has been no reported study on this to the best our knowledge in the area and so this study will serve as a baseline for future references in Ozoro and environs.

2 MATERIAL AND METHODS

2.1. Description of the study area

The study was carried out in Ozoro, Delta State, Nigeria. Ozoro is a semi-urban town that is fast developing probably because of the state Polytechnic. Ozoro is the administrative headquarters of Isoko North Local government Area and lies between longitude 6°12′58″E and latitude 5°32′18″N (www.wikipedia.org).

2.2. Sampling and Analysis

Fish samples were purchased from daily market in the town. The fish were carefully cut into three parts; head, trunk and tail. The various parts were oven dried and thereafter ashed in an electric furnace at 450°C. 2g of the ashed fish parts were weighed into three separate beakers. 10ml of nitric/perchloric acid, ratio 2:1 were added to the samples and digested at 105°C for 1hour. HCl and water in the ratio 1:1 were added to the digested samples and the mixture heated for 30 minutes. The digestate was allowed to cool to room temperature and filtered into a 100ml volumetric flask using Whatman (No. 1) filter paper and made up to mark with distilled water. The samples were then analysed for heavy metals (Cu, Pb, Cd and Zn,) using Atomic Absorption Spectrophotometer (Varian Spectra AA 200).

2.3. Statistical Analysis

The data obtained were processed statistically and presented as mean ± standard error of mean. Statistical significance of comparison of data was analysed using one way analysis of

variance (ANOVA), followed by LSD's multiple range tests, using the software, statistical package for social science (SPSS) version 21 windows software and significance level at p values < 0.05 was considered significant.

3 RESULTS AND DISCUSSION

Table 1: Concentration of Heavy metals (mg/kg) in some fish species from Ozoro

Sample	Parts	Metal Concentration (mg/kg dry)			
		Cu	Pb	Cd	Zn
Tilapia (Oreochromis niloticus)	Head	2.85±0.05	1.27±0.00	0.29±0.01	7.35±0.05
	Trunk	4.67±0.01	1.02±0.01	0.11±0.02	5.38±0.03
	Tail	1.87±0.01	1.17±0.01	0.09±0.01	5.63±0.02
Mud Fish (Clarias anguillaris)	Head	2.95±0.05	0.35±0.00	0.02±0.01	3.58±0.08
	Trunk	3.28±0.03	0.43±0.01	0.05±0.00	2.46±0.05
	Tail	1.23±0.01	0.96±0.01	0.00	2.86±0.01
Catfish (Ostariophysi Siluriformes)	Head	2.74±0.02	1.23±0.00	0.30±0.05	7.05±0.02
	Trunk	2.48±0.00	1.36±0.02	0.20±0.09	7.16±0.09
	Tail	1.60±0.10	0.89±0.00	0.04±0.03	5.57±0.04
Croaker fish (Micropogonias undulates)	Head	1.97±0.03	0.63±0.01	0.08±0.01	4.43±0.04
	Trunk	1.65±0.05	0.32±0.00	0.00	3.75±0.05
	Tail	0.94±0.05	0.06±0.02	0.00	2.84±0.09

Table 2. Mean Concentration of Heavy metal (mg/kg) in some fish species from Ozoro

Sample/ Metal	Cu (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Zn (mg/kg)
Tilapia (Oreochromis niloticus)	3.13±0.82[a]	1.15±0.07[a]	0.16±0.06[a]	6.12±0.62[a]
Mud Fish (Clarias anguillaris)	2.49±0.64[b]	0.58±0.19[b]	0.02±0.02[b]	2.97±0.33[b]
Catfish (Ostariophysi Siluriformes)	2.27±0.35[b]	1.16±0.14[a]	0.18±0.08[a]	6.59±0.51[a]
Croaker fish (Micropogonias undulates)	1.52±0.30[c]	0.34±0.17[b]	0.03±0.03[b]	3.67±0.46[b]

Values are expressed as mean±SEM. ANOVA followed by LSD's multiple range tests. Values not sharing a common superscript differ significantly at P<0.05.

Table 3. Comparison of the mean of heavy metal concentrations in present study with that of the other Researchers

	Fish specie	Mean Metal Concentration (mg/kg)				
Location		Cu	Pb	Cd	Zn	Reference(s)
North Central Nigeria	Tilapia	0.19	-	-	6.12	Igwemmar et al., 2013
	Catfish	0.12	-	-	2.93	Igwemmar et al., 2013
	Croaker	0.20	-	-	5.20	Igwemmar et al., 2013
South South Nigeria	Tilapia	0.41	0.34	0.19	0.31	Omuku et al., 2008
	Catfish	0.15	0.14	0.05	0.18	Omuku et al., 2008
	catfish	3.09	0.36	0.25	34.87	Kelle et al., 2013
South West Nigeria	Tilapia	0.24	0.39	0.07	0.44	Ayeloja et al., 2014
	Catfish	0.11	0.46	0.12	0.46	Ayeloja et al., 2014

Malaysia	Tilapia	-	0.34	0.04	55.72	Abdulali et al.,(2012)
Palestine	Tilapia	0.64	0.12	-	-	Kamal et al.,(2013)
South South Nigeria	Tilapia	3.13	1.15	0.16	6.12	Present study
	Catfish	2.27	1.16	0.18	6.59	Present study
	Croaker	1.52	0.34	0.03	3.67	Present study
FAO/WHO	Tolerance in fish	30	0.50	0.50	40	WHO (1989)

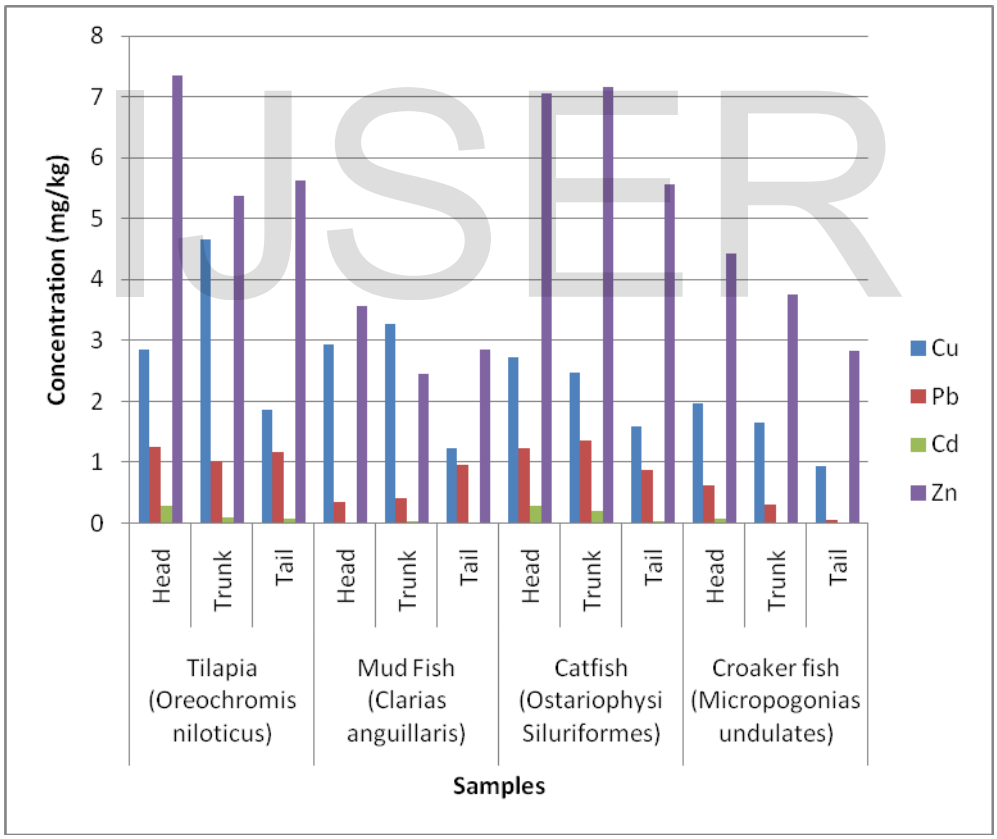

Figure1. Comparison of the distribution of Zn, Cd, Pb and Cu on the head, Trunk and Tail of Tilapia, Mudfish, Catfish and Croaker fish sold in Ozoro

The data obtained for heavy metal contents in fish (mg/kg dry) are presented in Table 1 and Figure 1 below. Although these results are generally low, they are higher than values obtained in tilapia as reported by Omoku et al (2008)

from Ethiope River in Delta State, Nigeria and this call for a serious concern. A critical look at the analytical results showed the ranges of the essential elements zinc and copper in the fish samples to be 2.97 to 6.59mg/kg and 0.94 - 3.13mg/kg respectively. Zinc was the most predominant metal in this study and zinc concentration was highest in the head and least in the trunk except in Catfish as shown in table 1 and figure 1. Dominance of zinc in the studied fish species agrees with the finding of other researchers Table 3 (Igwemmar et al., 2013; Omuku et al., 2008; Kelle et al., 2013; Ayeloja et al., 2014). The zinc value obtained compared favourably with that obtained for catfish (Igwemmar et al., 2013). Similarly copper was mainly distributed in the trunk and least in the tail in Tilapia and Mud Fish except in Catfish and Croaker fish where it is mainly distributed in the head and least in the tail (table 1 and figure 1). The mean concentration of zinc in the studied samples follows in the order Catfish > Tilapia > Croaker fish > Mud Fish (Table 2) whereas that of copper follows in the order: Tilapia > Mud Fish > Catfish > Croaker fish. Catfish and Tilapia show a higher level of Zn and Cu than *Mud* fish *and* Croaker fish and varies *significantly at P<0.05* when compared. Mean concentrations of Zn found in all fish samples studied are all less than 50 mg/kg and, well below the guideline level (MAFF 1995) and 40mg/kg tolerance level permitted by FAO/WHO, (1989). Zinc plays a significant role in many enzymatic reactions (Erum, et al., 2009). The deficiency of zinc in the body can lead to the inability of the human body to maintain zinc (Dilek and Ahmed, 2006; Erum et al., 2009). Cu results obtained in the studied samples were slightly higher than those reported by other researchers (Table 3) except (Kelle et al., 2013). Cu concentrations in all the fish samples were quite below the guideline level of 20 mg/kg (MAFF 1995) and FAO/WHO (1989) tolerance level of 30mg/kg..

The non-essential metals Pb and Cd ranged from 0.06 - 1.36mg/kg and 0.00 - 0.30 mg/kg, respectively. The concentration of non-essential element Pb was highest in the head in Tilapia and Croaker fish except in Mud fish and Catfish where it was highest in the tail and trunk respectively (Table 1 and Figure 1). Comparing the level of cadmium and lead in the various fish samples sold in Ozoro market shows that they vary *significantly at P<0.05*. The cadmium result compared well with result obtained by Omuku et al 2009 for Tilapia and Kelle et al., 2013 for catfish and varies slightly from others (Table, 3). Lead (Pb) results in this study were higher than that reported by other researchers in catfish and Tilapia (Table, 3). Lead in all the samples were higher than the tolerance level of 0.5mg/kg allowed by FAO/WHO (1989) except croaker fish. Lead is toxic by substituting zinc in heme synthesis and obstructing the function of heme-synthesizing enzymes (Goyer and Clarkson, 2001). National Academy of Science/National Research Council (1993) reported that substitution of calcium by lead resulted in toxicity of several vital enzyme systems in the central nervous system. This toxicity impaired the development and function of enzymes involved in the production and transport of neurotransmitters.

4. CONCLUSION AND RECOMMENDATIONS

This study revealed that the fish samples, Tilapia, Catfish, Mudfish and Croaker fish consumed in Ozoro, contain heavy metals; copper, lead, cadmium and zinc, in varying concentrations. However, results obtained were below FAO/WHO permissible except for lead.

The concentrations of the non essential metals lead and cadmium in this present study calls for concern considering their toxic nature, therefore periodic monitoring by relevant regulatory authorities is recommended to ensure safety of the fish consuming populace.

REFERENCES

[1] Keepax, RE., Moyes, L.N. and Livens, F. R. (2011).Speciation of heavy metals and radioisotopes. In: Environmental and Ecological Chemistry vol II. Encyclopedia of Life Support Systems (EOLSS). available from http://www.eolss.net/Sample-Chapters/C06/E6-13-03-05.pdf

[2] Szentmihalyi, K. and Then, M. (2007). Examination of microelements in medicinal plants of the carpathian basin. *Acta Alimentaria. 36:231-236.*

[3] Tüzen, M. (2003). Determination of heavy metals in fish samples of the MidDam Lake Black Sea (Turkey) by graphite furnace atomic absorption spectrometry. *Food Chemistry. 80:119-123.*

[4] Ellias, LD. (2009). Chemical and toxicological studies on hazardous waste sites in Harris country. M.Sc. Thesis. Faculty of Science, Texas Solution University, USA.

[5] Mansour, SA. and Sidky, MM. (2002). Ecotoxicological Studies Heavy Metals Contaminating Water and Fish from Fayum Governorate, Egypt. Food Chemistry.78(1):15-22. doi:10.1016/S0308-8146(01)00197-2

[6] Mai, H.X., Zhang, Y.W., Si, R., Yan, Z.G., Sun, L.D., You, L.P. and Yan, C.H. (2006). High-Quality Sodium Rare-Earth Fluoride Nanocrystals: Controlled Synthesis and Optical Properties. *Journal of the American Chemical Society.128(19):6426-6436.*

[7] Idzelis, R. L., Ladygien, R. Sinkevicious, S. (2007) Radiological of game of game and dose estimation for hunters and members of their families. *Journal of Environmental Engineering and Landscape Management 15(2): 99 - 104*

[8] Ayeloja, A. A., George, F. O. A., Shorinnmade, A. Y., Jimoh, W. A., Afolabi, Q. O. and Olawepo, K. D. (2014). Heavy Metal Concentration in Selected Fish Species from Reservoir Ibadan Oyo State South-Western Nigeria. African *Journal of Environmental Science and Technology, 8 (7): 422 - 427*

[9] Omuku, P. Asiagwu, A.K. Chinweuba A.J. and Okoye, P.A.C. (2008). Assessment of heavy metal load of Owah-Abbi (Ethiope) river, Delta state, Nigeria. *Oriental Journal of*

Chemistry Vol. 24(3), 813-820

[10] Igwemmar, N. C. Kolawole, S. A. Odunoku S. O. (2013). Heavy Metal Concentration in Fish Species Sold In Gwagwalada Market, Abuja. International Journal of Science and Research (IJSR), 2(11):2319-7064

[11] Kelle H.I, Ngbede,E. O, Oguezi,V. U and Ibekwe,F C (*2015).* Determination of Heavy Metals in Fish (*Clarias gariepinus*) Organs from Asaba Major Markets, Delta State, Nigeria *American Chemical Science Journal 5(2): 135-147,*

[12] Abdulali, K.A, Taweel, M.S and Ahmad, A.K (2012) Analysis of heavy metal concentrations (*Oreochromis niloticus)* from four selected ,markets in Selangor, Pennisular Malaysia. *Journal of Biological sciences 12(3): 138 – 145*

[13] Kamal,J.E, Shareef, K.M and Nizam, M.E. (2013) Heavy metal concentrations in some commercially important fishes and their contribution to heavy metals exposure in Palestinian people of Gaza Strip (Palestine), *Journal of the association of Arab universities for basic and applied sciences* 13(1) : 44- 51

[14] FAO/WHO (1989) Evaluation of certain food additives and the contaminants mercury, lead and cadmium. WHO technical report, series no 505.

[15] MAFF, (1995). Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1993. Aquatic Environment Monitoring Report No. 44. Directorate of Fisheries Research, Lowestoft.

[16] Erum,Z., Iftikhar, I. N and Sheikh, M. U. (2009). Market basket Survey of Selected Metals in Fruits from Karachi City (Pakistan). *Journal of Basic Applied Science, 5:47-52*.

[17] Dilek, D. and Amet A. (2006). Heavy metal levels in vegetables in turkey are within safe limits for Cu, Zn, Ni and Exceeded for Cd and Pb. Journal Food Quality,29:252 – 265.

[18] Goyer, R. A and Clarkson, T. M. (2001). Toxic effects of metals in Klaassen C. D., (ed) Casarett and Douls's Toxicology, New York, McGraw Hill, pp 811-868

[19] NAS/NRC- National Academy of Sciences/Natinal Research Council (1993). Measuring lead exposure in infants, children and other sensitive populations. Washington, DC, pp 31 - 98