International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:9, No:3, 2015

Heavy Metals (Pb, Cu, Fe, and Zn) Level in Shellfish (*Etheria elliptica)*, Water and Sediments of River Ogbese, Ondo State, Nigeria

O. O. Olawusi-Peters, O. E. Aguda, F. O. Okoye

Abstract**—**Investigations on the accumulation of heavy metals in water and sediments of river Ogbese were carried out between December 2010 and February 2011 using Atomic Absorption Spectrophotometer. *Etheria elliptica* a sessile organism was also used to determine the concentration of heavy metal in the aquatic environmental. In water, Cu had the highest concentration (0.55 – 0.13 mg/l ±0.1) while in sediments, the highest value obtained was in Fe (1.46-3.89mg/l±0.27). The minimum concentrations recorded were in Pb; which was below detectable level. The result also revealed that the shell accumulate more heavy metals than the flesh of the mussel with Cu in the shell exhibiting a negative correlation with all the metals in the flesh. However, the condition factor (K) value is 6.44, an indication of good health. The length-weight relationship is expressed as $W = -0.48 \times L^{1.94}$ ($r^2 = 0.29$) showing the growth pattern to be negatively allometric.

Keywords**—**Condition factor, *Etheria elliptica*, heavy metals, River Ogbese.

I. Introduction

AQUATIC organisms have the ability to accumulate heavy metals from various sources including sediments, soil erosion and runoff, air depositions of dust and aerosol, and discharges of waste water [3]. The mussel (*Etheria elliptica*) was used as bio-indicator due to its suitability based on the required criteria as a potential bio-monitoring agent for heavy metals in the aquatic environment. These criteria include; ability to tolerate and accumulate large concentration of pollutants; ability to withstand changes in temperature and salinity; availability throughout the year, easy identification and sufficient amount of tissue required for chemical analysis [20]. River Ogbese is one of the prominent water bodies in Ondo state, Nigeria in which several human activities (such as domestic, industrial and agricultural) are carried out. Pollution and contamination of the river arises from these human activities such that some trace metals (Zn, Fe, Pb and Cu) bio-accumulate in the sediment and tissues of aquatic organisms present within the water body [13]. The agricultural pollution arises from the chemicals and fertilizers used by the farmers within the community, who have large plantations of maize and rice on either side of the rivers. In addition, the domestic activities such as laundry, discharge of waste water etc occurs regularly in the water body. The goal of this work was to determine levels of heavy metals in the freshwater environment of River Ogbese using the mussel *E. elliptica* as a bio-indicator and to determine the length-weight relationship and condition factor of the mussel. In addition to this, the heavy metal concentration in the water and sediment of River Ogbese were determined to establish environmental quality of the water body.

O. O. Olawusi-Peters is with Fisheries and Aquaculture Technology Department, Federal University of Technology, Akure, Nigeria (phone: +234 816 400 5457; P.M.B: 704; e-mail: olaolaronke@yahoo.com).
O. E. Aguda, is with Fisheries and Aquaculture Technology Department, Federal University of Technology, Akure, Nigeria (phone: +234 810 003 1354; P.M.B: 704; e-mail: phunmilorlah2006@yahoo.com)..
F.O. Okoye is with Fisheries and Aquaculture Technology Department, Federal University of Technology, Akure, Nigeria (phone: +234 806 657 1825; P.M.B: 704; e-mail: feliciaoo2012@yahoo.com).

II. Materials and Methods

A. Study Area

River Ogbese lies between longitude 5°26'E ' and latitude 6°43'N The River runs through Ogbese town, a town which is about five kilometres from Akure, in Akure North Local Government Area of Ondo state, Nigeria. River Ogbese is one of the major perennial rivers in South Western Nigeria; it took its source from Awo Ekiti in Ekiti State. It flows for approximately 22km from its source to meet River Ose which is 265km long and discharges into the Atlantic Ocean through an intricate series of creeks and lagoons.

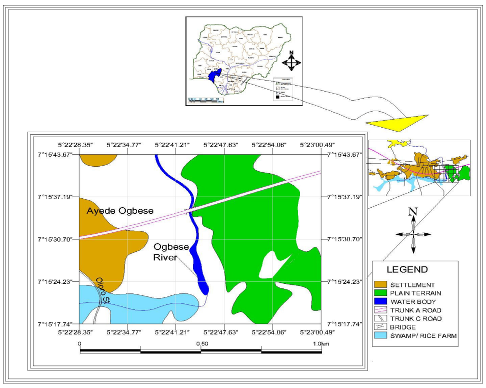

Fig. 1 The map of River Ogbese

B. Water and Sediment Samples

Samples (water and sediments) were collected thrice from three different points (50m apart). Water samples were collected following the procedure described [15]. Polyethylene sampling bottles used were pre-conditioned with 5% HNO_3 and rinsed thoroughly with distilled de-ionized water. At each point, the bottles were rinsed at least three times; pre-cleaned polyethylene sampling bottles were immersed about 10 cm below the water surface. One (1) litre of water were taken at three points, immediately acidified with 10% HNO_3 to a pH of less than 2 and transported to the laboratory in an ice bath. The samples were filtered through a 0.45 µm micropore membrane filter and kept at 4°C before heavy metal determination.

In the same points, bottom sediments were collected into pre-cleansed polyether bag using a stainless van-ven grab; air dried at room temperature for few days, sieved with 200mm mesh screen. The sediment was digested by the method described by EPA-ROC, 1994; 1 g of sediment was taken into 100 ml conical flasks; moistened with distilled water and 10ml of aqua regia - HNO_3:HCL (1:3) was added, boiled to almost dryness, cooled and leached with 5ml of 6M H_2SO_4,then 5ml distilled water was added, allowed to boil for 10mins, cooled, filtered and the filtrate was made up to 50ml. Buck 211 Atomic Absorption Spectrophotometer (AAS) was used for heavy metal determination in water and sediments

C.Mussel Samples

Twenty (20) samples of *Etheria elliptica* with shell length ranges between 6.1cm – 11.5cm and weighed between 8.9g – 78.6g were collected from the fishermen in River Ogbese. The sampled mussels were placed in plastic bags together with the river water and transported to the laboratory. The selected mussels were allowed to depurate their gut content in ambient freshwater for 48hrs and stored frozen at -20°C until required for analysis. The mussels were thawed at room temperature, rinsed with distilled water to remove extraneous materials e.g. sediments then the length and weight were measured using a caliper and mettler Toledo sensitive electronic weighing balance (Model PB 8001) to the nearest centimeter (0.01cm) and gramme (0.01g). The length-weight relationship was determined using;

$$W = aL^b \quad [23]$$

where, W = Weight of mussel (g); a = Intercept; L = Length of the mussel shell (cm); b = Regression constant (slope). Also, the condition factor was calculated using;

$$K = 100W/L^3$$

The soft tissues of the mussel were removed from the shells using a stainless steel scalpel. The soft tissues were dried to a constant weight in an oven at 60° C and ground in a ceramic mortar. Each individual tissue was digested with conc. HNO_3 by the method described [5]. The shell were cleaned with a nylon brush under running distilled water, dried at 60°C for 20hrs and weighed. The cleaned shells were ashed in a muffle furnace at 400°C for 18hrs after which the calcite and nacreous shell layers were separated and weighed [6]. The nacre samples were then digested in conc. HNO3 and made up to volume with double distilled de-ionized water. The tissue and shell digests were analyzed on Buck 211 Atomic Absorption Spectrophotometer (AAS).

III.RESULTS AND DISCUSSION

The mean concentrations of the heavy metals (Fe, Zn, Cu, and Pb,) in the water and sediment of river Ogbese are shown in Table I. The results confirmed the varying degrees of accumulation of the heavy metals in different columns within the river; the highest heavy metal concentrations were found in the sediments. Iron (Fe) has the highest mean value (2.04±0.79) in the sediment and there is a significant difference between Fe and Cu (>0.01) with r = 0.80 while Cu and Zn have a negative correlation (r= -0.337) as shown in Table II. In water, Cu has the highest mean value (0.24±0.15) and significantly different (>0.01) with Zn (r=0.986) and Fe (r = 0.929). The concentration of heavy metal in the sediment of River Ogbese is higher than the concentration obtained in the water. This agrees with the study of sediment from Wadi Hanifah, which contained very high significant amounts of heavy metals when compared with their concentration in water [1]. As such, sediments act as the most important reservoir or sink of metals and other pollutants in the aquatic environment [11]. Heavy metal contamination in sediment can affect the water quality and bioaccumulation of metals in aquatic organisms, resulting in potential long-term implication on human health and ecosystem [9]. The high concentration of iron in the sediment of River Ogbese is expected because it has been reported that iron occurs at high concentration in Nigeria soil [2], [4], [12]. The high content of iron in the sediment may be because of the clayey material that forms the river bed [14]. In both sediment and water, the lowest concentrations were recorded in Pb (0.01); a concentration that is incomparable with the high values obtained by Kolo-Creek, Nigeria [7] and Wetland lake, Al-Asfar [10]. The concentrations (Cu, Fe and Zn) obtained are relatively low compared to the permissible limits of WHO (1993), WHO (2004) and FEPA (1991). The values obtained in Pb were within the limit of WHO (1993) but lower than the permissible limit of WHO (2004), FEPA (1991). The result of this study revealed that the water is safe for the various domestic activities being used for; however, improved waste management and monitoring policy should be ensured to prevent serious contamination [16], [17], [8].

TABLE I
HEAVY METALS CONCENTRATIONS (MG/L) IN WATER AND SEDIMENT OF RIVER OGBESE

Heavy metals		Min	Max	Mean	Std. Dev	WHO 1993 [16] permissible limit	WHO 2004 [17] permissible limit	FEPA1991 [8] permissible limit
Zinc	water level	0.05	0.24	0.10	0.06	3	5	20.00
	sediment level	0.19	0.52	0.37	0.11			
Iron	water level	0.13	0.21	0.16	0.02	0.5-50	-	-
	sediment level	1.46	3.89	2.04	0.79			
Lead	water level	0.00	0.01	0.01	0.00	0.01	0.05	<1.00
	sediment level	0.00	0.02	0.01	0.01			
Copper	water level	0.13	0.55	0.24	0.15	2	1.00	<1.00
	sediment level	0.46	1.75	1.04	0.42			

TABLE II
THE CORRELATION MATRIX OF HEAVY METALS IN SEDIMENT AND WATER OF RIVER OGBESE

	Sediments				Waters			
	Zn	Fe	Pb	Cu	Zn	Fe	Pb	Cu
Zn	1				1			
Fe	0.23	1			0.93**	1		
Pb	0.05	0.04			0.24	0.31	1	
Cu	-0.33	0.80**	0.05	1	0.98**	0.92**	0.34	1

The shell length of the mussel (*Etheria elliptica*) ranged from 6.1-11.5cm and the weight range from 8.9-78.6g. The length-weight relationship is expressed as W = -0.48 x L $^{1.94}$ (r^2 = 0.29) showing the growth pattern to be negatively allometric (Fig 2). Also, the K value is 6.44, an indication of good health. A weak correlation coefficient exist between the heavy metals and the Total length and a weak but positive correlation (r = 0.33) exist between the weight and total length of the shellfish (as shown in Table III). A correlation coefficient of -0.36 and -0.44 were observed between zinc in the flesh and shell respectively; an increase in shell or flesh of mussel will likely have a minute reduction in the zinc concentration. The R^2 values showed that heavy metal concentration in flesh and shell does not depend on the total length and weight of the mussel. The coefficient range between -0.02 and 0.15 with the lowest (-0.02) recorded in total length on copper (flesh) and iron (shell) while the highest (R^2 = 0.15) was observed in the effect of total length on Zinc (shell) as shown in Table III. This indicates that the zinc (shell) is 15 percent dependent on the total length. The concentration of heavy metals in the flesh ranged between 0.04-0.11mg/l Cu, 0.06-0.33mg/l Zn, 0.29-0.70mg/l Fe while in shell, the range is between 0.04-0.15mg/l Cu, 0.06-1.59mg/l Zn and 0.54-1.04mg/l Fe. Lead is not detected in both flesh and shell of the mussel.

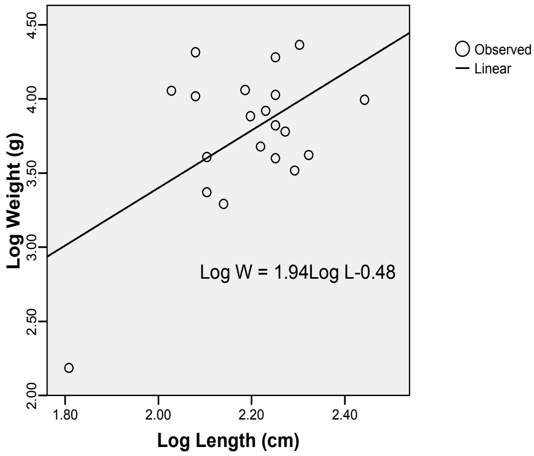

Fig. 2 Length-weight relationship of *Etheria elliptica* from River Ogbese, Ondo State Nigeria

The result showed that the concentration of heavy metal is more in the shell than the flesh (Fig. 3). Although, in the flesh, Fe has the highest concentration; iron is an essential trace element required by all forms of life, it played a major role in catalyzing various enzymatic activities. The concentration obtained is lower than 50mg/l of WHO, 1993 standard value for aquatic organisms [16]. The highest accumulated metals in mussels were Pb [18], [19]. The highest concentration of Zn was observed in the shell (1.04); Zinc is also an essential element and its *in vivo* levels are regulated by most organisms. Zinc is not biomagnified rather the absorption of zinc by aquatic organisms tends to be from water not food; only dissolved zinc tends to be bio-available and the bioavailability depends on the physical and chemical characteristics of the environment, such as: pH, dissolved organics, water hardness, competing ions and biological processes [20]. The lowest concentration of Cu in the flesh of some green mussel (*Perna viridis*) was recorded in Pahang, Malaysia [22]. The low concentration of Cu in the tissue of the mussel is an indication of the need for some level of Cu to maintain the normal body functions. The various concentration obtained in different mussel might be due to various mechanisms which include homeostatic processes in the body in response to varying metabolic demands and entrapment of Cu under certain conditions by additional mucilage production/extrusion by the animal [21].

The concentration of heavy metals in the sediment and water were higher than the shell and flesh of the mussel. This is because trace metals piled up on aquatic beds and is eventually accumulated by filter feeder organisms such as the mussels, oysters and fish. In filter-feeding bivalves like mussels, particulate matters are carried in suspension by currents of water pumped through their incurrent siphon, across the gills, then out to the excurrent siphon. They are passed through the body without being digested depending on the size, shape and other physical characteristics of the particles [18], [19].

TABLE III
THE CORRELATION AND REGRESSION MATRIX OF THE MUSSEL

	Correlation		Regression	
	TL	W	T L (R^2)	W (R^2)
TL	1.00	0.33	-	0.06
Cu_{flesh}	-0.18	0.26	-0.02	0.02
Zn_{flesh}	-0.36	-0.10	0.08	-0.05
Fe_{flesh}	0.06	-0.07	-0.05	-0.05
Cu_{shell}	0.04	-0.09	-0.05	-0.05
Zn_{shell}	-0.44	-0.23	0.15	0.00
Fe_{shell}	0.18	-0.04	-0.02	-0.05
W	0.33	1.00	0.06	-

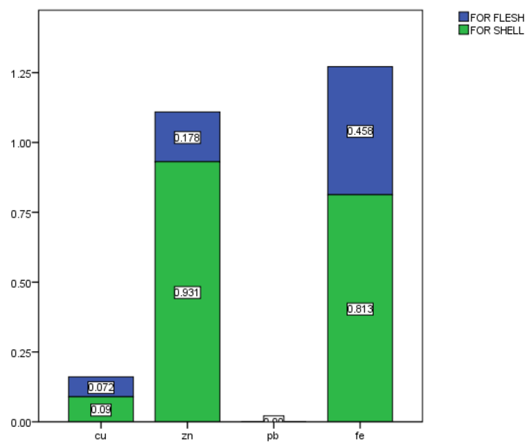

Fig. 3 The mean concentration (mg/l) of Heavy metals (Cu, Zn, Pb and Fe) in Flesh and Shell of Mussel (*Etheria elliptica*)

REFERENCES

[1] Abdel-Baki A. S., Dkhil M. A. and Al-Quaraishy S., Bioaccumulation of some heavy metals in tilapia fish relevant to their concentration in water and sediment of Wadi Hanifah, Saudi Arabia African Journal of Biotechnology, 10(13) 2011, pp2541-2547.

[2] Asaolu S. S., Ipinmoroti K. O., Adeyinowo C. E., Olaofe O., Interrelationship of heavy metals concentration in water, sediment as fish samples from Ondo State coastal Area, Nig. *Afr. J. Sci 1*, 1997, pp 55-61.

[3] Asaolu S.S., Chemical Pollution Studies of Coastal Water of Ondo State. Ph.D Thesis, Fed. Univ. Technol., Akure, 1998, Pp 45- 52.

[4] Asaolu S. S. and Olaofe O., Biomangification factors of some heavy and essential metals in sediments fish and crayfish from Ondo State coastal region Bio. Sci. Res. Comm. 16, 2004, pp 33-39.

[5] Borg, H., E d n, A., Holm., Skold, E., Determination of metals in fish livers by flameless atomic absorption spectroscopy Wat. Res. 15, 1981, pp1291-1295.

[6] Bourgoln. B. P., A rapid and inexpensive technique to separate the calclte and nacreous layers in Mytilus edulls shells. Mar environ Res 25, 1988, pp 125-129.

[7] Ebenezer A and Eremasi Y, Determination of heavy metals in water, sediments and Tilapia zilli from Kolo-creek, Ogbia local government area, Bayelsa state, Nigeria, Scientia Africana, 11(1), 2012, pp44-52.

[8] FEPA, Guidelines and Standards for Environmental Pollution Control in Nigeria. 1st Edn., Federal Environmental Protection Agency (FEPA), Lagos, Nigeria, 1991, pp 238.

[9] Fernandes C., Fontainhas-Fernandes A., Peixoto F., Salgado M. A., Bioaccumulation of heavy metals in *Liza saliens* from the Esomriz-Paramos coastal lagoon, Portugal. Ecotox. Environ. Saf., 66, 2007, pp 426-431.

[10] Gehan H. F and Abel A. F., Limnological studies on the wetland lake, Al-Asfar, with special References to Heavy metal Accumulation by fish, American J. of Env. Sci 7(6), 2011, pp515-524.

[11] Gupta A, Rai D. K, Pandey R. S, Sharma B., Analysis of some heavy metals in the riverine water, sediments and fish from river Ganges at Allahabad. Environ. Monit. Assess. 157, 2009, pp 449-458.

[12] Nwajei G. E., Gagophien P. O., Distribution of heavy metals in the sediments of Lagos Lagoon, Pak. J. Sc. Ind. Res. 43, 2000, pp 338-340.

[13] Olawusi-Peters, O. O., Ayo-Olalusi C. I. and Adeyemi T. V., Bioaccumulation of some trace element (Zn, Fe, Pb and Cu) in the gills and tissues of Clarias gariepinus and Oreochromis niloticus in River Ogbese, Ondo State, Nigeria. J. Envt. Chem. and Ecotox. 6(2), 2014, pp 6-12.

[14] Olowu R. A., Ayejuyo O. O., Adewuyi G. O., Adejoro I. A., Denloye A. A., Babatunde A. O., and Ogundajo A. L., , Determination of Heavy Metals in Fish Tissues, Water and Sediment from Epe and Badagry Lagoons, Lagos, Nigeria .E-Journal of Chemistry,7(1), 2010, p p215-221.

[15] Öztürk, M., Özözen, G., Minareci, O. and Minareci, E., Determination of heavy metals in fish, water and sediments of Avsar Dam Lake in turkey. Iran. Journal of Environment, Health. Science and Engineering 6(2), 2009, 73-80.

[16] WHO, Guidelines for Drinking-Water Quality: Recommendations. 2nd Edn., World Health Organization, Geneva, ISBN-92: 4 154460, 1993, pp 51.

[17] WHO, Guidelines for Drinking-Water Quality: Recommendations. 1st Edn., World Health Organization, Geneva, ISBN-10: 9241546387 , 2004, pp 515.

[18] Soumady D. and Asokan S., A study on trace metal accumulation in selected organs of *Perna viridis* in Nagapattinam coastal waters, Tamil Nadu, India, *Inte. Pharm. Sci.,* 1(2), 2010, pp42-47.

[19] Dumalaganan H. G. D. and Gonzales A. C., Trace metal content in mussels, *Perna viridis* L., obtained from selected seafood markets in a metropolitan city, *Bull.Environ. Contam. Toxicol.*, 84(1), 2010, pp492-496.

[20] Mihajlo J, Ana S., Slavković-Beskoski L, Ilija T., Sandro D. and Slavka S., Mussels as a bio-indicator of the environmental quality of the coastal water of the Boka Kotorska Bay (Montenegro). *J. Serb. Chem. Soc. 76* (6) , 2011, pp933–946.

[21] Pyatt, F. B, Metealfe, M. R and Pyatt, A, Copper bioaccumulation by the freshwater snail Lymnaea peregra: A toxicological marker of environmental and human health, Environ. Toxicol. Chem., 22, 2003, pp561-564.

[22] Kamaruzzaman B.Y, Mohdzahin M. S., Akbar J. B., Jalal, K. C. A., Shahbudin S. M, Al-Barwani and Goddard J. S., Bioaccumulation of some metals by Green mussel Perna viridis (Linnaeus 1758) from Pekan, Pahang, Malaysia. Int. J. Biol. Chem. 5(1), 2011, pp 51-60.

[23] Pauly, D., Some simple methods for the assessment of tropical fish stock. FAO Fish Tech. Pap No. 234, 1983, pp: 52.