METALS AND MINERAL NUTRIENT CONCENTRATION IN *Orechromis niloticus*, *Clarias gariepinus* AND *Chrysichthys furcatus* FROM BENUE RIVER, MAKURDI, NIGERIA

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ABSTRACT

Concentration of five metals and minerals, Iron (Fe), Zinc (Zn), Copper (Cu), Lead (Pb), Cadmium (Cd), Sodium (Na), Potassium (K), Ammonia (NH_3), phosphate($P0_4$) were determined in three species, of fish from the Benue River (Orechromis niloticus, Clarias gariepinus and Chrysichthys furcatus), at four different sampling stations. The levels of metals and minerals were assayed from the muscle, liver, kidney, and intestine and gills of the three species. Differences in all means concentration of metals and minerals were analyzed using F-LSD and comparisons were made between stations and the fish species, significant difference were shown between values of iron and ammonia nitrogen amongst the species and between upstream stations and downstream stations respectively.

Keywords: Metals, Nutrients, Fishes, Benue river

INTRODUCTION

Freshwater fishes are often subjected to pollution especially near industrial or populated areas. Metals have been known to exert a wide range of effects on fishes. These effects may include metabolic, physiologic behavioural and ecological (Fostner and Wittmann, 1981). Specific metabolic and physiologic effect includes disturbances in osmoregulation, respiration, and tissue damage (Tuarala, 1983, Tort *et al* 1984, Annune and Olademeji 1994), reduced energetic resources (Health, 1984) and poor performance (Steele, 1983).

In Nigeria metals from industries are indiscriminately discharge into water bodies without regard to the health of the aquatic life. Metal from the aquatic environment has been studied in water columns and sediments (Ajayi, 1981 and Okoye *et al* 1991), Histopathological changes and tissue accumulation in some fishes (Onwusers and Oladimeji, 1990. Ofojekwu *et al* 1993). Commenting on the environmental implications of Sunshine Batteries Industry, at Ikot Ikpene, Udosen *et al* (1987) warned against gross pollution of streams by wastes and effluents of domestics, commercial and industrial sources. According to them, concentrations of metals in the Batteries industry effluents were not high enough to present serious pollution problem. Their concentration could increase in future if steps were not taken to check rising trend in the amount of untreated effluents that enter the streams. Kakulu *et al* (1987) reported high level of heavy metals in fish and shellfish of the Niger Delta. There is however no information on the metal and mineral nutrient concentration in fishes from the Benue River. The aim of this paper is to present metal and mineral nutrient level in some selected fishes from the Benue River and also to establish a relationship between tissue and water concentration.

MATERIALS AND METHODS

The fishes ware taken to the Laboratory for identification using the Anthony (1982) method. In the Laboratory Specimen where filleted and 5 g each of the tissue (liver, kidney, Intestine, gills and muscle) was weighed, homogenized and digested wilt a mixture of nitric and percholoric acid in the ratio of 2:1. The resultant solution was evaporated to dryness on a hot plate and the white residue formed dissolved in 10 ml of 20% nitric acid.

The Sample Solution was diluted with 30 ml of de-ionized water and analyzed on a Buck Scientific Model 210-VGP computerized Atomic Absorption Spectrophotometer (AAS). Metals such as Fe, Zn, Cu, Pb, Cd, Cr, Na, and K were determined. All analysis were carried out in triplicates and the resulting data analyzed using condiscriptive statistics and two-way analysis of variance.

RESULTS AND DISCUSSION

Physico-chemical Characteristics: Table 1 slows the physico-chemical characteristic of Benue river. Dissolved oxygen in the river shows a range between 3.7 mg/l and 6.8 mg/l during the sampling period with a mean value of 5.7±0.64 these indicated that the river was well oxygenated, though the mean pH value indicated slightly acidic water. The temperature and biological oxygen demand with values of 28.03± 2.06 ^{0}C and 2.55±0.54 are within the normal range for fresh-water environment. The level of iron in water ranged from 6.2-21.0(mg/l) with mean value of 12.48± 4.64,(mg/l) these value together with that of

zinc (0.01-3.8 mg/l) and mean (1.39±1.44)mg/l shows high values that are above acceptable limit for fresh water body.

Tables 2 and 3 shows metal and nutrients concentration in tissues of *C. gariepinus*, O. *niloticus* and *C. furcatus* sampled from the river while table 5 shows mean values from the pooled data.

Result shows high level of ammonia-nitrogen (NH_3 $^{-N}$) and iron (Fe) in the tissue of the three fish species studied, with *C. furcatus* having the highest concentration in tissues with mean kidney concentration of 95.66 ± 3.56 mg/g of ammonia-nitrogen and 47.8 ± 19.79 mg/g of iron. Respectively low concentration of ammonia-nitrogen and iron was found in the muscle of *C. gariepinus* with values of 2.67±0.21 mg/g and 1.59±0.49 mg/g respectively. The least concentration of lead was recorded in the gills of *C. gariepinus* with values of 0.004 ± 0.001 mg/g, in the liver of *O. niloticus* with values of 0.004 ± 0.0008 mg/g and in the intestine of *C. furcatus* with values of 0.006 ± 0.0003.

A two-way analysis of variance of metal and nutrient concentration in tissues of fish along the stations indicated that the concentration of all the metal and nutrient at down stream station B_3 and B_4 were significantly different from those observed at upstream station (B_1 and $B_{2)}$ ($P< 0.001$). This could result from the high concentration of human activities in as evidence in domestic sewage that predominate the down stream station which drain the main town of Makurdi. The values of metal and nutrient concentration in the liver and kidney generally showed higher concentration when compared with other tissues for all the fish species. The general high level of iron may be due to its high concentration in the sediments and water as reported by Okayi *et al* (200l). The mean concentration in zinc copper, lead and cadmium reported in this study are suitable and adequate for aquatic production as the value reported were below the standard set by the Australian Nation Health and Medical Research Council for metal concentration in aquatic food thus: Zn (1000.0 mg/g), copper (30.0 mg/g), lead (2.0 mg/g) and cadmium (2.0 mg./g) (Babington *et al.,* 1977). Metals and nutrient uptake in body tissue of the three-fish species were found to be in the order of the kidney >liver >gills >muscles for *C gariepinus* and kidney >gills > liver>muscle for *O. niloticus* and in the order of kidney >liver >intestine >gills >muscles for *C. furcatus*. This order was similar to the study of Annune *et al* (1993) on the accumulation of trace metals in tissues of freshwater fishes. Okoye *et al.* (1991) reported anthropogenic heavy metal enrichment of Cd, Co, Cu, Cr, Fe, Mn, Ni, Pb and Zn in the Lagos lagoon and implicated land based urban and Industrial wastes sources. Pollution studies on 26 rivers in some southern and northern states of Nigeria (Ajayi and Osibanjo, 1981) showed that, with the exception of iron. The concentration of most trace metals in the surface waters and tissue of aquatic animals are generally lower than the global average levels for surface waters. Analyses of sediments and fish from the Nigeria delta area of Nigeria (kakulu and Osibanjo, 1987) revealed that the level of Cd, Cu, Fe, Mn, Pb and Zn were higher in shell fish than in finfish, with the exception of the lead level in some shellfish; levels of these metals were generally lower than WHO recommended limits in foods.

REFERENCES

AJAYI, S. O. and OSIBANJO, O. (1981) Pollution Studies on Nigeria rivers. *Environment pollution, 2(B):* 87 – 95.

AJAYI, T. R. (1981). Statistical analysis of steam sediment data from the Ife-Iiesha area of southwestern Nigeria. *Journals of Geochemistry and Exploration, 11:* 539 – 548.

ANNUNE, P. A. and OLADIMEJI, A. A. (1994). Acute toxicity of cadmium to juveniles of *Clarias gariepinus* (Teugels) and *Oreochromis nilotocus* (Trewavas). *Journal of Environment Science and Health A29:* 135 – 136.

ANTHONY, A. D. (1982). *Identification of Nigerian fresh water fishes.* Poothokaran Publishers Aranttukara, Trichard India, 618 pp.

BABINGTON, C. N., MACKAY, N. T., CHROJKA, R. and WILLIAMS, X. X. (1977). Heavy metals, selenium and arsenic in nine species of Australian commercial fish. *Australian Journal of Marine and Freshwater Research, 28:* 277 – 286.

FOSTNER, U. I and WITTMANN, G. T. W. (1981). *Metal pollution in aquatic environment.* Berlin Springer. 124 pp.

HEALTH, A. G. (1984). Changes in tissues and enylsptes and water content of bluegill, *Lippies machilas*.

KAKULU, S., OSIBANJO, E. O. and AJAYI, S. O. (1987). Comparison of digestion methods for trace metal determination in fish. *International Journal of Environmental and Analytical Chemistry, 30:* 209 – 217.

OFOJEKWU, P. C. ENOWSPAMBONG. E. and OKARA, O. (1993). Acute toxicity of metals and synthetic detergents to *Clarias gariepinus*. *Book of Abstracts, Nigeria Association for Aquatic Sciences, Volume?:* 7 – 9.

OKAYI, R. G., JEJE, C. Y. and FAGADE, F. O. (2001). Seasonal patterns in the zooplankton community of river Benue (Makurdi), Nigeria. *African Journal of Environmental Studies. 2(1):* 9 – 19.

OKOYE, B. C. C., OLADAPO, A. A. and AJAO, E. A. (1993). Heavy metals in the lagoon sediments. *International Journal of Environmental Studies, 37:* 35 – 41.

ONWUSERS, B. G. and OLADIMEJI, A. A. (1990). Accumulation of metals and histopathology in *Oreochromis niloticus* exposed to treat NNPC Kaduna Nigeria, Petroleum refinery effluents. *Eccotoxicology and Environmental Saspy,* 19: 123 – 124.

STEELE, C. W. (1983). Comparison of the behavior and acute toxicity of copper to sheep head Atlantics croaker and pinfish. *Marine Pollution Bulletin, 14:* 425 – 428.

Table 1: Physical Characteristic of Benue River Makurdi, Benue State

Parameters	No	Min.	Max	Mean and S.E.
Dissolved Oxygen (mg/g)	48	3.7	6.8	5.07±0.64
Temperature (°C)	48	24.0	31.0	28.03±2.06
PH	48	4.5	7.4	6.67±0.49
SDT (m)	48	0.16	0.81	0.42±0.22
BOD_5 (mg/g)	48	1.2	3.9	2.55±0.54
Alkalinity ($CaCo_3$ mg/1)	48	25	100	68.9±17.45
NH_3^{-N} (mg/1)	48	0.20	0.62	0.44±0.12
Iron (mg/1)	16	6.2	21.0	12.48±4.64
Zinc (mg/1)	16	0.01	3.8	1.39±1.44
Copper (mg/1)	15	0.12	1.20	0.64±0.25
Lead (mg/1)	16	20.01	1.45	0.78±0.48

Table: 2: Metal and nutrients concentrations in *Clarias garipinus,* Orechromis niloticus and Chrysichthys furcatus tissues from Benue River

Fish tissue	Trace metals and nutrient concentration (mg/g)								
	NH_3	PO_3	Fe	Zn	Cu	Pd	Cd	Na	K
					Clarias garipinus				
Muscle	2.67	0.02	1.59	0.021±0.005	0.02	0.012	0.002	0.04	0.02
	±0.21	±0.01	±0.49		±0.002	±0.006	±0.0004	±0.005	±0.002
Liver	15.06	0.06	8.05	0.17	0.0	0.07	0.022	0.21	0.12
	±3.96	±0.006	±2.26	±0.05	0.0	±0.03	±0.0008	±0.05	±0.03
Kidney	19.5	0.14	13.1	0.24	0.13	0.14	0.02	0.26	0.14
	±2.81	±0.009	±0.12	±0.02	±0.005	±0.016	±0.005	±0.04	±0.026
Intestine	18.46	0.13	10.33	0.03	0.0001	0.003	0.01	0.3	0.11
	±1.31	±0.08	±0.82	±0.002	±0.00004	±0.0004	±0.004	±0.026	±0.021
Gills	13.77	0.11	7.6	0.06	0.0002	0.005	0.004	0.16	0.15
	±1.44	±0.03	±0.86	±0.004	±000049	±0006	±0.001	±0.007	±0.012
					Orechromis niloticus				
Muscle	2.72	0.02	1.5	0.022	0.034	0.001	0.042	0.012	-
	±0.32	±0.002	±0.057	±0.005	±0.005	±0.0005	±0.002	±0.0012	
Liver	14.31	0.16	7.62	0.158	0.16	0.004	0.12	0.031	-
	±0.94	±0.05	±2.93	±0.046	±0.086	±0.0008	±0.04	±0.0014	
Kidney	25.5	0.12	11.8	0.28	0.18	0.01	0.36	0.18	-
	±1.40	±0.005	±1.04	±0.38	±0.017	±0.001	±0.09	±0.11	
Intestine	-	-	-	-	-	-	-	-	-
Gills	17.49	0.16	9.11	0.08	0.007	0.003	0.32	0.12	-
					Chrysichthys furcatus				
Muscle	3.14	0.02	1.96	0.01	0.046	0.003	0	0.042	0.02
	±0.21	±0.04	±0.31	±0.005	±0.02	±0.0004		±0.03	±0.007
Liver	23.94	0.16	16.21	0.21	0.27	0.012	0.005	0.306	0.2
	±0.79	±0.05	±9.54	±0.16	±0.024	±0.005	±0.0002	±0.13	±0.016
Kidney	95.66	0.26	47.8	1.03	0.4	0.133	0.03	0.68	0.4
	±3.55	±0.04	±19.79	±0.08	±0.06	±0.002	±0.0049	±0.04	±0.004
Intestine	15.92	0.09	9.33	0.06	0.0002	0.006	0.002	0.2	0.11
	±1.60	±0.002	±0.43	±0.008	±0.000012	±0.0003	±0.0005	±0.07	±0.03
Gills	11.53	0.13	6.89	0.06	0.0001	0.005	0.003	0.26	0.08
	±1.94	±0.03	±0.60	±0.004	±0.00004	±0.0004	±0.0004	±0.03	±0.001

Table: 3: Comparison of mean concentration of metals and nutrients in the tissues of *Oreochromis niloticus, Clarias gariepinus* and *Chrysicthis furcatus* from upstream and downstream stations using pooled data

	NH_3	PO_4	Fe	Zn	Cu	Cd	Pd
				O. niloticus			
Up stations	12.81*	0.065	6.01*	0.12	0.09	0.04	0.004
(B_1 and B_2)	7-25.5	0.018-0.12	1.56-11.8	0.021-0.28	0.02-0.18	0.003-0.13	0.001-0.01
Down station	10.52	0.08	3.68	0.09	0.13	0.01	0.003
(B_3 and B_4)	2.64-18.4	0.01-0.16	1.5-5.79	0.02-0.15	0.03-3.73	0.001-0.006	0.001-0.006
				C. gariepinus			
Up station	6.39*	0.04	3.68	0.043	0.046	0.023	0.006
	2.0-10.1	0.02-0.06	1.5-0.79	0.02-0.06	0.02-0.06	0.007-0.03	0.002-0.01
Down Stations	13.95*	0.07	8.33*	0.147	0.147	0.053	0.013
	2.35-19.5	0.05-0.14	1.59-13.1	0.002-022	0.002-022	0.003-0.14	0.006-0.02
				C. furcatus			
Up stations	7.49*	0.045	4018*	0.035	0.085	0.007	0.005
	3.14-11.85	0.02-0.07	1.6-6.6	0.01-0.05	0.04-0.12	0.002-0.012	0.005-0.005
Down Stations	55.85*	0.21	36.68*	0.704	0.33	0.133	0.031
	36.03-75.6	0.16-0.26	25.7-47.6	0.37-1.03	0.36-0.4	0.133-0.133	0.03-0.03

TAURALA, H. (1983). Relationship between secondary lamellar stripe and dorsal aortic oxygen tension in salmon Gardner: with gills damaged by/ *Annals of Zoology, 20:* 236 – 238.

TORT, I., TORRES, P. and HIDALGO, S. (1984). Short-Cadispian effects on gsp tissue metabolism. *Marine Pollution, 15:* 448 – 450.

DOSEN, E. D., IBOK, U. J. and UDOESSIEN E. I. (1987). Environmental pollution implication of sunshine batteries industry, Ikot Epkene in Akwa-Ibom state of Nigeria. *12th annual conference of chemical society of Nigeria at Calabar, Sept. 23rd – 25th.*