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Bioaccumulation of Heavy Metals in Freshwater *Clarias anguillaris* and *Parachanna africana* from Lake Geriyo in Yola, Nigeria

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ABSTRACT

This study was carried out to determine the bioaccumulation of heavy metals in *Clarias anguillaris* and *Parachanna africana* from lake Geriyo Yola, Nigeria using Energy Dispersive X-ray Fluorescence (EDXRF) spectrophotometer. The results in (mg kg^{-1}, dry weight) showed different levels of Cr, Cu, Mn, Fe, Ni, Zn and Pb in the two fish species. The order of heavy metals accumulated by *C. anguillaris* and *P. africana* are Cr>Fe>Zn>Mn>Cu>Ni>Pb and Ni>Fe>Zn>Cu, respectively. The levels of Cr, Mn and Ni in *C. anguillaris* and in Ni in *P. africana* were higher than WHO and FEPA recommended Maximum Permissible Limits (MPL) in fish, while the levels of Zn, Cu and Pb were below the standards. The results suggest that lake Geriyo has high pollution loads of these heavy metals in fishes and could pose a health hazards to man. Consequently, close monitoring of heavy metal loads in lake Geriyo is recommended with a view to minimizing the risks to health of the population that depend on the lake for their water and fish supply.

Key words: Heavy metals, bioaccumulation, lake Geriyo, *C. anguillaris*, *P. africana*, Nigeria

INTRODUCTION

The accumulation of heavy metals by aquatic fauna and flora has become a problem of increasing concern to ecologists and other scientists. Heavy metals are widespread pollutants of major environmental concern as they constitute one of the most hazardous substances, non-degradable and persistent with serious degradation on aquatic ecology (Kalay and Canli, 2000). Besides their natural occurrence, heavy metals enters the aquatic environments, rivers, lakes and oceans through increase in population, urbanization, agricultural practices, industrial and domestic wastewaters, storm water runoff, direct solid waste dumping, soil erosion and atmospheric deposition (Sarika and Chandramohanakumar, 2008). Fish can accumulate heavy metals to hazardous levels with no visible sign in the aquatic environments (Forstner and Wittman, 1981).

Anthropogenic activities such as mining operations, petroleum exploration and agricultural practices, industrial and municipal wastes have increased the concentrations of heavy metals in the lakes, rivers and stream which have caused concern regarding heavy metal bioaccumulation and human health hazards (Forstner and Wittman, 1981). Bioaccumulation has been reported by several authors (Mathis and Cummings, 1973; Alabaster and Lloyd, 1980; Biney *et al*., 1994).

All heavy metals are potentially harmful when consumed above the recommended standard limits. At low concentrations, Cd, As, Pb and Hg are toxic and they compete for sites with essential metabolites, replacement of essential ions, reactions with-SH groups of Adenosine Diphosphate (ADP) and Adenosine Triphosphate (ATP) (Alloway and Ayres, 1993).

This study was carried out to determine the bioaccumulation of heavy metals by fishes which are associated with potential health hazards to man.

MATERIALS AND METHODS

Lake Geriyo is located at the out-skirts of Jimeta Yola metropolis on the North-West direction on (longitude 12°25'E and between latitude 9°8'N and 9°17'E). The lake is a natural one that started as a small gulley, but was later expanded and filled with water from the rains and some influx from River Benue. The lake has been subjected to intense irrigation and it is a center for metal scraps market Upper Benue River Basin Development Authority.

Sample collection: Two fish species (5-10 individuals of each species) namely, *C. anguillaris* measuring 40.57±1.30 cm and weighing 1000.30±30.71 g and *P. africana* 35.56±1.29 cm and weighing 567.20±15.21 g were bought from the local fishermen on the bank of the lake, during the month of April 2007. They were thereafter stored in a plastic cooler with ice flakes.

Sample preparation of fish: The two species of fish were oven dried to constant weight at 105°C. The dried samples were ground to powder and quartered to give representative sample weight. 0.5 g of the powdered fish samples were weighed and three drops of organic binder were added to each and were pressed with 10 tons hydraulic press to form pellet of each fish samples. Three replicate of pellets of each fish sample were prepared.

Determination of heavy metals in fish by energy dispersive X- ray fluorescence (EDXRF): The modified version of Emission Transmission (E-T) (Kump, 1996; Angeyo *et al*., 1998; Funtua 1999) method was used. The pellet of each fish sample was put into X-ray fluorescence spectrophotometer sample holder and it was bombarded with high energy electrons of ^{109}Cd (22.1 keV). Fluorescent X-rays was produced which passes to the silicon lithium detector, through Mo target as a source of monochromatic X-rays. The spectrum of energy generated on the detector was processed to obtain analytical data. The intensity of the fluorescent X-rays on the detector would be proportional to the concentration of the individual element of interest in the sample.

RESULTS AND DISCUSSION

The mean concentrations of heavy metals in two species of fish from lake Geriyo (mg kg^{-1}, dry weight) and that of water in (mg L^{-1}) and set standards are shown in Table 1. Cu values ranged from 1.44±0.06 to 2.65±0.05 mg kg^{-1} and it was recorded in both species. Cr value was 21.4±0.6 mg kg^{-1} and it occurred in *C. anguillaris*. It was the most accumulated. Cr and Cu in the two fishes could b e attributed to the fact that chemicals made from salts of arsenic, chromium and copper mixed soluble formation (as copper-chronic-arsenate preservative) being used to prevent fungi and pest attack which provide a potential source of chemical spills and drainage within the catchments area of the lake (Forstner and Wittman, 1981) Ni values ranged from 1.11±0.01 to 7.12±0.01 mg kg^{-1} and it occur in both fishes. Pb value was 1.06±0.06 mg kg^{-1} it was the least and it was present in *C. anguillaris* only. Pb and Ni presence in the lake could be

Table 1: Mean concentration of heavy metals in fish from lake Geriyo and WHO and FEPA set standards

Heavy metals (mg kg^{-1}, dry weight)	Fish samples		WHO (1985)	FEPA (2003)
	C. anguillaris	*P. africana*		
Cr	21.40±0.60	BDL	0.15	0.15
Cu	1.44±0.06	2.65±0.05	3.00	1-30
Mn	3.71±0.02	BDL	0.50	0.50
Fe	9.45±0.13	5.70±1.30	NS	NS
Ni	1.11±0.01	7.12±0.01	0.60	0.50
Zn	6.04±0.06	4.13±0.02	10-75	75.00
Pb	1.06±0.06	BDL	2.00	2.00

BDL: Below detectable limits, NS: Not specified

attributed to the fact that they are naturally found in surface waters due to weathering of minerals and soil erosions (USEPA, 1997). It could also be due to auto exhaust and phosphate fertilizers.

Mn value 3.17±0.02 mg kg^{-1} and it was found in *C. anguillaris* only. Zn values ranged from 4.13±0.02 to 6.04±0.06 mg kg^{-1} and it was present in *C. anguillaris* and *P. africana*. Cr, Cu, Zn and Mn are concentrated in the sediments of lakes and rivers as well as in aerobic and anaerobic bacteria. *C. anguillaris* and *P. africana* are bottom feeders, they therefore concentrate Mn, Zn from sediments and bacteria as well as in fertilizers (Shahunthala, 1989). Fe values ranges from 5.7±1.3 to 9.45±0.13 mg kg^{-1} was detected in *P. africana* and *C. anguillaris*. It could be due to metal works, run-of from rusted metallic pipes and the dumping of metal scraps from metal scraps market on the bank of lake Geriyo.

The levels of Cr, Mn and Ni are higher when compared with WHO and FEPA standard limits and the consumption of these fishes could cause health hazards to man. The levels of Cu, Zn and Pb are lower than WHO and FEPA in the fishes and it could be due to the fact that Cu and Zn have least value in water of lake Geriyo.

CONCLUSION

Lake Geriyo is contaminated with Cr, Mn and Ni. The fish species *C. anguillaris* and *P. africana* were contaminated with Cr, Mn and Ni to varying levels. The lake has been subjected to intense irrigation and pollution loads coming up stream of river Benue during the rainy season to the lake is a major factors for high heavy metal levels in the lake and fishes.

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