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Relationships Between Heavy Metal Content and Body Weight of Selected Freshwater Fish Species of the Lower Ikpoba River in Benin City, Nigeria

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The relationships between the heavy metals content and body weight of edible muscle of selected freshwater fish species of the lower Ikpoba river in Benin City Nigeria, were studied using the atomic absorption spectrophotometry technique. 27 samples of *Clarias gariepinus* (average wt: 110.80 ± 36.31g); 36 samples of *Channa obscura* (average wt: 65.20 ± 27.20g) and 18 samples of *Chromidotilapia guentheri* (average wt: 80.10 ± 31.70g) were used for the study. Mean heavy metals concentration (µg/g dry wt.) varied from Cd (0.02 ± 0.01), through Cu (0.25±0.07), Pb (0.40 ± 0.60) to Zn (6.0 ± 1.03) in *Clarias gariepinus* and through Cd (0.02 ± 0.03), Cu (0.04 ± 0.02), Pb (0.27 ± 0.05) to Zn (2.10 ± 0.02) in *Channa obscura* and through Cd (0.02 ± 0.05), Cu (0.30 ± 0.05), Pb (0.40 ± 0.2) to Zn (6.15 ± 1.70) in *Chromidotilapia guentheri*. Relatively low metal values were recorded in *Channa obscura*. Significant correlations were recorded between cadmium, lead, zinc and copper and body weight of *Clarias gariepinus* and *Chromidotilapia guentheri* ($P < 0.05$). However, in the predatory *Channa obscura*, statistical analysis showed that copper and zinc contents were significantly correlated while cadmium and lead were not ($P > 0.05$).

Key words**:** Heavy metal, Body weight, Fish muscle, Lower Ikpoba river, Benin City, Nigeria.

Introduction

Freshwater organisms including fish have the ability to concentrate heavy metals in their tissues to the concentration levels which are comprised of several orders of magnitude higher than those in water and sediment (Perttila *et al* 1982; Kiorboe *et al* 1983). The accumulation and biomagnification of heavy metal in the tissues of animals have recently received considerable attention (Deb and Santra 1997). Heavy metals accumulated in the organs of various organisms may be speedly transferred from the surrounding environment into the food chain (Adema *et al* 1972). Younger fishes tend to accumulate more metals which tend to decrease with the age of the fish (Benson *et al* 1976). A close relationships between the heavy metals content with age and size with some freshwater organisms such as *Mytilus edulis* were established by NAS (1980). These organisms including fish serve as bioindicators of heavy metal pollution in the aquatic environment.

A number of studies on heavy metal concentration in whole fish and fish organs in Nigerian waters were reported by several researchers including (Kakulu *et al* 1987; Fodeke *et al* 1989; Sadik 1990; Ezemonye 1992; Fufeyin 1994). Oguzie (1996) reported relatively high metal levels in some ubiquitous fish species of the lower Ikpoba river in Benin, even though the metal values were lower than values recommended in fish and fishery products by FAO (Nauen 1983). Neither of these studies reported the relationship between the heavy metal content and body weight of fish of different trophic levels especially those of inland water bodies in Nigeria such as the Ikpoba river in Benin City. This paper reports the correlations among cadmium, lead, zinc and copper content and body weight of selected freshwater fish species of commercial importance in the lower Ikpoba river in Benin City, Nigeria.

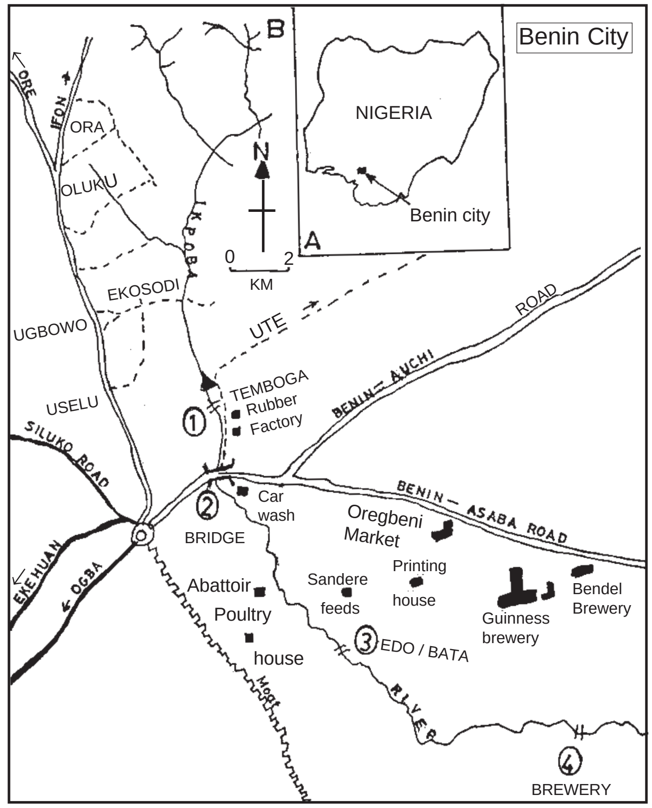
Materials and Methods

Study location. The main features of the study area including the sampled zones had earlier been described by Oguzie (1999) and are presented in Fig 1.

Sample collection and preparation. Fish samples were collected between April 1991 and June 1992 by means of gill nets, cast nets and baited hooks at varying depths of the lower Ikpoba river. The specimens used for the study included 27 *Clarias gariepinus* (Teugels) (18.60-110.80g); 36 samples of *Channa obscura* (Gunther) (12.50-650.20g) and 18 *Chromidotilapia guentheri* (Sauvage) (10.5-80.10g). Fish lengths (cm) and fresh weights (g) were determined with a measuring board and a top loader (Mettler PE.360) respectively. The edible muscle tissue of each fish (~100g) was obtained by dissection and placed in petri-dishes. They were oven dried at 80 ˚C for 24 h. Each dried sample was weighed and milled separately by means of a porcelain mortar. They were kept in labelled plastic packs, sealed and stored prior to analysis.

Digestion and analysis. Edible muscle samples were digested using the organic extraction technique described by Sreedevi *et al* (1992).

1g sample was in each case placed in a 50ml Kjeldahl flask. 10ml nitric acid, 2ml perchloric acid and 2ml sulphuric acid (5:1:1 ratio) were respectively added to muscle samples in the flask. Contents of each flask were digested with moderate heat under a hood. Digestion was terminated with the appearance of white fumes. Digestates were diluted to 10ml with distilled water and further boiled for a few minutes. They were allowed to cool and subsequently filtered into 50ml volumetric flasks. A Varian Techtron Spectr AA 10 (model 65) Atomic Absorption Spectrophotometer was used for heavy metal analysis by the method previously described by Oguzie (1996). Triplicate samples were analysed. Standard and blank samples were run with each set of experiments. The correlation coefficient analysis and its statistical tests followed the method of Alder and Roessler (1972).



Source Federal Surveys Nigeria 1964

Fig 1. The study area; A. Nigeria showing Benin city; B. The study river showing the four samplimg zones.

Results and Discussion

Presented in Table 1 are mean concentration values (mg/g dry wt.) of heavy metals in the edible muscle of *Clarias gariepinus, Channa obscura* and *Chromidotilapia guentheri*, while, Figs 2, 3 and 4 show the relationships between the metal contents in the muscle tissue and body weight of the fish species.

Based on the data presented, the range for Cd content varied from 0.01 to 0.08µg/g with highest value (0.08 µg/g) recorded in *C.guentheri*. A uniform mean Cd value (0.02µg/g) was recorded in the three fish species studied. Pb content varied from 0.20µg/g in *C.guentheri* to 1.25µg/g in *C.gariepinus* with lowest mean value (0.27±0.05 µg/g) in *C.obscura*. The range for Zn varied from 2.30µg/g in *C.obscura* to 8.15µg/g

Table 1

Concentration values (µg/g dry wt.) of heavy metals in the edible muscle of selected fish species of the lower Ikpoba river

Species	Average wt. g	No of samples	Heavy Metals Cd	Cu	Pb	Zn
Clarias gariepinus	110.80g	27	0.01-0.06[a]	0.09-0.35	0.30 - 1.25	5.30 - 7.50
	±36.31g		0.02[b]±0.01	0.25±0.07	0.40±0.60	6.00±1.03
Channa obscura	65.20g	36	0.01-0.05	0.02-0.92	0.25-0.40	2.30 - 2.90
	±27.20g		0.02±0.03	0.04±0.02	0.27±0.05	2.10±0.02
Chromidotilapia guentheri	80.10g	18	0.01-0.08	0.15-2.15	0.20 - 00.50	4.25 - 8.15
	±31.70g		0.02±0.02	0.30±0.05	0.40±0.02	6.15±1.70

N.B. a, range; b, mean ± S.D.

in *C.guentheri* with lowest mean value (2.10±0.02µg/g) in *C.obscura*, while Cu content varied from 0.02µg/g to 2.15 µg/g with highest mean value (0.30±0.05 µg/g) in *C.guentheri*.

The correlation coefficients between cadmium, lead and zinc and body weight for *C. gariepinus* (Fig 2) were 0.75, 0.58 and 0.73 respectively. These values were significantly correlated ($P < 0.05$). Though the correlation coefficient for copper, was low (0.29), the value was also significantly correlated ($P < 0.05$). The correlation coefficients of cadmium, copper, lead and zinc for *C. guentheri* (Fig 3) were 0.61, 0.85, 0.84 and 0.83, respectively. The values were all significantly correlated ($P < 0.05$). Though poor correlation coefficients were recorded for *C. obscura*, statistical analysis, however showed that copper and zinc contents were significantly correlated while cadmium and lead were not ($P > 0.05$) (Fig 4).

The heavy metal content in the muscle tissue of fish might be related to the feeding habits and distribution pattern of the fish. Metal uptake in fish was reported to occur through absorption across the gill surface or through the digestive tract during food intake (Brooks and Rumsby 1974).

The low metal concentration recorded in the muscle tissue of *C. obscura* may be attributable to its food habits being a

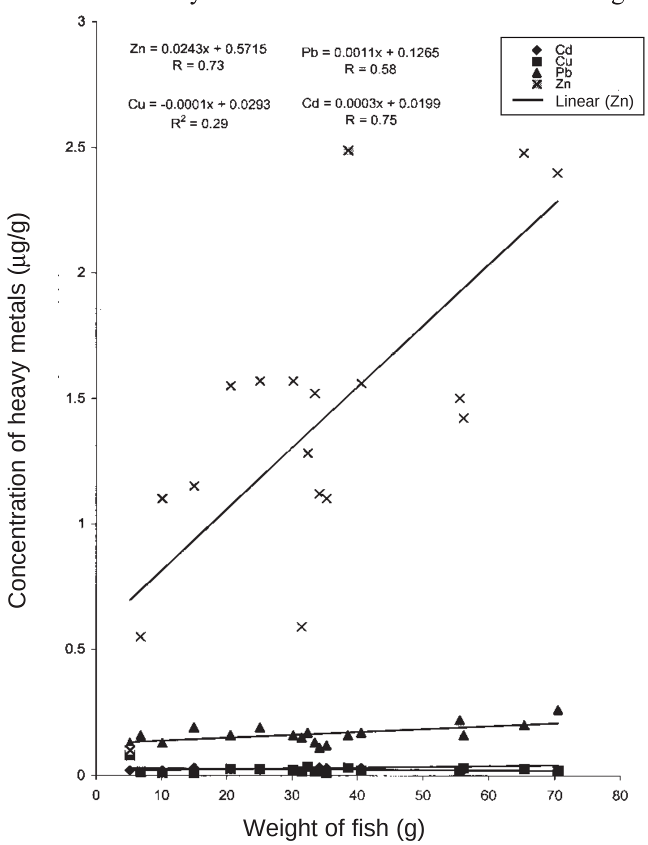


Fig 2. Heavy metals concentration - Body weight relationships of *Clarias gariepinus*.

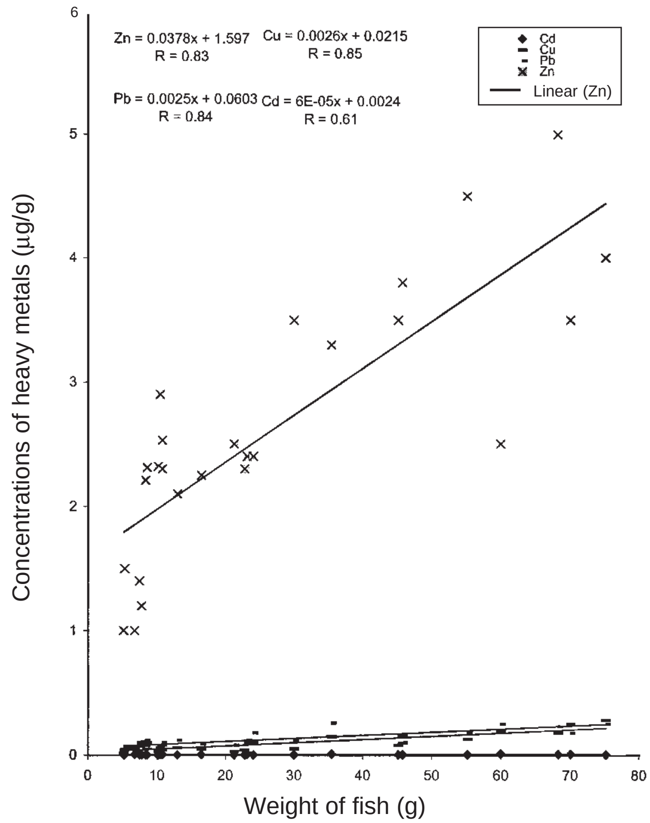


Fig 3. Heavy metals concentration - Body weight relationships of *Chromidotilapia guentheri*.

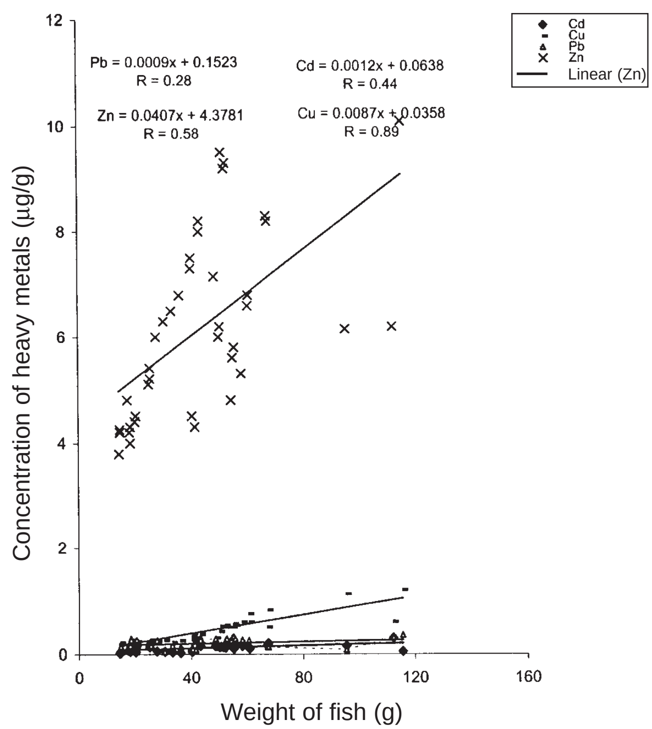


Fig 4. Heavy metals concentration - Body weight relationships of *Channa obscura*.

pre-datory fish that is reported to stalk its prey in the open water column (Reed *et al* 1967). The heavy metal contents in the fish muscle tissue arising from food intake may be able to reflect the level of metal pollution of the lower Ikpoba river probably due to the distribution pattern of this predatory fish species previously reported by Oguzie (1996).

C. gariepinus and *C. guentheri* are considered bottom dwelling species. They occasionally plunge their head deep between plant roots where they take up load of sediment (rich in heavy metals) from which they sift out and consume edible particles including worms, insect larvae and materials of plant origin (Reed *et al* 1967). This report clearly suggests that based on their trophic status, the heavy metal content of their muscle tissues arising from food intake would probably reflect the corresponding heavy metal concentrations of the lower Ikpoba river.

Bottom sediment, which Nishida *et al* (1982) described as "bank" for heavy metals invariably contain relatively high levels of the various food items consumed by these omnivorous and detritivorous fish species which tend to change their feeding niche when the preferred food is in short supply. Since it was reported (Reed *et al* 1967) that these fish species visit the bottom sediments frequently in search of food, hence it is logical to infer that they will concentrate relatively high levels of heavy metals in their muscle tissues.

Studies on trophic relationships among fish species by Lowe-McConnell (1975) show that the ability to use many different foods effectively is an important characteristic of ubiquitous species which have better chance than specialists of becoming widely distributed and which could be effectively used as bioindicators.

The close relationships between the heavy metals content and body weight of *C. gariepinus* and *C. guentheri* and the corresponding poor relationships of *C. obscura* seems to support the view that trophic status and distribution pattern play important role in the accumulation of heavy metals in fish tissues in the aquatic environment.

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