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Bioaccumulation of Lead, Copper and Antimony in Freshwater Fishes Caught from Onitsha Segment of the River Niger, Anambra State, Nigeria

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Abstract

The gills, flesh, intestines and skins of three freshwater fish (*M. Anguilloides, G. niloticus, and H. longifilis*) caught from River Niger Anambra segment was carefully dissected for heavy metal determination using Atomic Absorption Spectrophotometer (AA 240FS). The maximum concentrations of heavy metal studied were detected in the gill while the lowest concentrations were detected in the intestines. The highest concentration of lead detected was in *G. niloticus* while the lowest concentration was in *H. longifilis*. For copper the highest concentration were in *M. Anguilloides* and *G. Niloticus* with *H. longifilis* showing the lowest concentrations. Antimony was detectedable only in the skins of the fish with highest concentrations in *H. longifilis* and the lowest concentration in *M. Anguilloides*. Variations in the parameters determined were found to be statistically significant at $p < 0.05$.

Keywords: Bioaccumulation; Heavy Metals; Fishes; River Niger; Onitsha; Anambra State

Introduction

Aquatic environment is a recipient of domestic and industrial waste; this could be brought about through deposition erosion, petroleum hydrocarbons, emission from automobile exhaust or even direct application, such as pesticides [1]. These wastes get to water body and sediment giving rise to aquatic pollutants, contaminants or toxicants which further affect the aquatic organism such as fish. Fish are important sources of essential minerals, vitamins, unsaturated fatty acids, and are consumed very much globally [2]. Despite the nutritional components and the therapeutic benefits of the nutrients contained in fish, they normally accumulate heavy metals from food, water, and sediments [3]. This fact presents good indicator of heavy metals contamination in water [4]. Fish possess all the qualities of a bioindicator [5] they have been used to indicate whether water is clean or polluted and thus are excellent biomarkers of metals in water. The gills, skin flesh and digestive tract are potential sites of absorption of water-borne chemicals.

Heavy metals are natural elements known for their rather high atomic mass and their high density (of at least 5 g cm^{-3}) [6]. Some heavy metals are either essential nutrients (typically iron, cobalt, and zinc), or relatively harmless (such as ruthenium, silver, and indium), but can be toxic in larger amounts or certain forms [7]. Other heavy metals, such as cadmium, mercury, and lead, are highly poisonous [8]. Heavy metal pollution is one of the most important environmental problems these days. It is growing with inevitable pace, endangering humans, animals, and plants [9].

The Onitsha segment of the River Niger is surrounded by a lot of commercial and industrial activities. These industrial and commercial activities generate all forms of wastes including heavy metals which are readily disposed into the River Niger. The heavy metals that have accumulated in fish or other aquatic organisms indirectly introduced into man either through the use of the water or the consumption of the aquatic organisms. A lot of fishing activities take place in Onitsha segment of River Niger with fish from the River meeting the protein requirements of the inhabitants within the area. This study aims at determining the levels of some heavy metals lead (Pb), Copper (Cu) and Antimony (Sb) in gills, flesh, intestines and skin tissues of three commercially important species of fishes (*Mormyrups Anguilloides, Heterobranchus longifilis and Gymnarchus niloticus*) caught within Onitsha segment of River Niger Anambra State, Nigeria.

Materials and Methods

Three fish samples of uniform size and about 25 cm in length and weight of about 350 g were collected from Marina area of Onitsha segment of River Niger Anambra State using cast nets which were thrown by the fisher men and withdrawn by the means of line attached to its opening. The fish caught by the net were collected, washed to remove plankton debri and other things attached to the body, weighed and preserved in refrigerators at -10 °C. The fish parts (gills, intestines, flesh, and skin) were dissected dried at 70 °C for 24 hours. The dried samples were then ground in homogenizer. The heavy metal concentrations were determined according to APHA [10] method. The extract was diluted to 1L with distilled water and the diluted extract was measured by atomic absorption spectrophotometer spectra AA model number 220FS, the limits of detection for these metals are lead (0.0003 ppm) copper (0.0001 ppm) and antimony (0.001 ppm).

Results and Discussion

	Lead	Copper	Antimony
Gills	0.253	0.009	n.d
	±0.004	±0.001	±0.000
Intestines	0.223	0.011	n.d
	±0.001	±0.001	±0.000
Flesh	0.906	0.002	n.d
	±0.008	±0.001	±0.000
Skin	0.4	0.008	0.009
	±0.141	±0.004	±0.004

Table 1: Distribution of heavy metals in *Mormyrups anguilloides* from River Niger (mgkg^{-1} ±SD)

	Lead	Copper	Antimony
Gills	0.201	0.009	n.d
	±0.001	±0.003	±0.000
Intestines	0.186	0.01	n.d
	±0.004	±0.003	±0.000
Flesh	0.402	0.006	n.d
	±0.001	±0.001	±0.000
Skin	0.436	0.008	0.086
	±0.008	±0.001	±0.001

Table 2: Distribution of heavy metals in *Heterobranchus longifilis* from River Niger (mgkg^{-1} ± SD)

	Lead	Copper	Antimony
Gills	0.998	0.009	n.d
	±0.011	±0.001	±0.000
Intestines	0.292	0.011	n.d
	±.003	±0.001	±0.000
Flesh	0.361	0.007	n.d
	±0.001	±0.001	±0.000
Skin	0.704	0.005	0.409
	±0.006	±0.003	±0.006

Table3: Distribution of heavy metals in *Gymnarchus niloticus* from River Niger (mgkg^{1} ±SD)

The concentrations of heavy metals in the different parts (gills, intestines, flesh and skin) of *M. anguilloides, H. longifilis* and *G. niloticus*, studied are shown in Tables 1-3. The concentrations of heavy metals in the parts of the fish studied were gills> intestines >skin>flesh. Lead detected ranged from 0.186 mgkg^{-1} ± 0.004- 0.998 mgkg^{-1}± 0.011. The highest concentration detectable was 0.998 mgkg^{-1} ± 0.011 in the gills of *G. niloticus* and the lowest concentration detectable was 0.186 mgkg^{-1} ± 0.004 in the intestines of *H. longifilis*. In the gills the highest concentration 0.998 mgkg^{-1}± 0.011 was detected in *G. niloticus*, and the lowest concentration 0.201 mgkg^{-1} ± 0.001 was detected in *H. longifilis*. In the intestine the highest concentration 0.292 mgkg-1 ± 0.001 detected was in *G. niloticus* and the lowest concentration 0.186 mgkg^{-1} ± 0.004 detected is in *H. longifilis*. In the flesh the highest concentration 0.906 mgkg^{-1} ± 0.008 detected was in *G. niloticus* while the lowest concentration 0.361 mgkg^{-1} ± 0.001 detected was in *G. niloticus*.

In the skin the highest concentration 0.704 mgkg^{-1} ± 0.006 detected was in the *G. niloticus* and the lowest concentration 0.400 mgkg^{-1} ± 0.141 was in the *M. Anguilloides*. For lead the order of heavy metal concentration in parts of the fish is skin>gills>intestine>flesh. Lead is the most common heavy metal contaminant in the environment which affects the intelligent quotients and academic achievement in children, causes neurotoxicity [11], affects mineral content of plants [12] and death of organisms [13-15]. Lead has other effect such as delayed embryonic development, suppressed reproduction, and inhibition of growth, increased mucous formation, neurological problems, enzyme inhalation and kidney dysfunction [16,17]. In research carried out by Abu and Nwokoma [18] lead concentration detected in tissues of crab collected ranged 0.42-1.13 mgkg^{-1} and are slightly higher than the concentration detected in this study.

The concentrations of copper ranged from 0.006 mgkg^{-1} ± 0.001- 0.011 mgkg^{-1} ± 0.001. In the gills the highest concentration 0.011 mgkg^{-1} ± 0.001 was *G. niloticus*, and the lowest concentration 0.006 mgkg^{-1} ± 0.001 was detected in *H. longifilis*. In the intestine all the fishes showed an approximate concentration of 0.01 mgkg^{-1}. In the flesh the highest concentration 0.007 mgkg^{-1} ± 0.001 detected was in *G. niloticus* while the lowest concentration 0.002 mgkg^{-1} ± 0.001 detected was in *M. anguilloides*. In the skin the highest concentration 0.008 mgkg^{-1} ± 0.001 detected was in the *H. longifilis* and *M. anguilloides* while the lowest concentration 0.005 mgkg^{-1} ± 0.003 detected was in the *G. niloticus*. The order of concentrations of copper in the parts of the fish is intestines>gills>flesh>skin. Copper has been shown to be toxic to marine organisms [19-21].Copper is involved in various metabolic processes, such as neurotransmitter function, iron absorption from the intestine or synthesis of hemoglobin it is also a component of many enzymes.

The concentrations of antimony ranged from 0.009 mgkg^{-1} ± 0.004 -0.409 mgkg^{-1} ± 0.006. In the gills there was no detectable concentration of heavy metals in all the fish. In the intestine there was no detectable concentration of antimony in all the fish. In the flesh there was no detectable presence of antimony in all the fish. Antimony was detected mostly in the skin, the highest concentration 0.409 mgkg^{-1} ± 0.006 detected was in *G. niloticus* and the lowest concentration 0.009mgkg^{-1} ± 0.004 detected was in the *M. anguilloides*. Exposure to antimony for a long time causes irritation of the eyes, lung and skin diarrhea, severe vomiting and stomach ulcers [22].

Conclusion

The freshwater investigated accumulated heavy metals in their gills, intestines, flesh and skin with the concentrations being higher in the gills. This shows that these heavy metals are released from various sources to the environment. This release has negative effects on the environment, aquatic species and even man. There is the need for monitoring, legislation and enforcement on the controlled release of these materials into the environment.

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