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Heavy Metals Concentrations in Commercially Available Fish of The Black Volta At Buipe In Northern Region Of Ghana

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Abstract

The purpose of the study was to gather information and evaluate the status of fish produced in the Black Volta of Northern Region in terms of Heavy metals in order to protect public health. Fish were selected based on weight and size. Three fish species which are commercially available were selected. The three fish species were bought from fishermen at the water body for four months. The concentration of metals (Zn, Pb, Fe, Mn, Cu and Cd) was determined using atomic absorption spectrometry.

1. Introduction

Heavy metal is a collective term which applies to a group of metals and metalloids with atomic density greater than 4g/cm^3 (Duruibe *et al.2007*). They are also known as trace elements because they occur in minute concentrations in biological systems (Duruibe *et al.2007*).

Depending upon their concentration they may exert beneficial or harmful effects on plant, animal and human life (Forstner and Witman, 1991).

Some of these metals are toxic to living organisms even at low concentrations, whereas others are biologically essential and become toxic at relatively high concentrations.

When ingested in excess amounts heavy metals combine with body's biomolecules, like proteins and enzymes to form stable biotoxic compounds, thereby mutilating their structures and hindering them from the bioreactions of their functions (Duruibe *et al.2007)* .

In the last decades, contamination of aquatic systems by heavy metals has become a global problem (Yalmaz, 2009). Heavy metals may enter aquatic systems from different sources:

Anthropogenic sources include; industrial or domestic wastewater, application of pesticides application of inorganic fertilizers, storm runoff, leaching from landfills, shipping and harbour activities while natural sources such as geological weathering of the earth crust, atmospheric deposition, volcanic activity, forest fires, geothermal activity and magma degassing are also potential sources (Yalmaz, 2009).

In natural aquatic ecosystems, metals occur in low concentrations. As they cannot be degraded, they are deposited, assimilated or incorporated in water, sediment and aquatic animals (Abdel-Baki *et al*.2011).

Pollutants enter fish through a number of routes: via skin, gills, oral consumption of water, food and non-food particles (Obasohan, 2008).

Once absorbed, pollutants are transported in the blood stream to either a storage point (i.e bone) or to the liver for transformation and/or storage (Mansour and Sidky, 2002).

Metals entering the aquatic ecosystem can be deposited in fish through the effects of bioconcentration, bioaccumulation via the food chain and becomes toxic when accumulation reaches a substantially high level (Huang, 2003).

Contaminated fish once consumed by humans causes health hazards.

The purpose of this study was to gather information and evaluate the status of fresh fish in terms of heavy metals in other to protect consumers and to compare the results with world health organization (WHO) standards of metals in fish for human consumption.

2. Materials and Method

2.1Fish Sampling

Three commercially available fish species – Tilapia *(Oroechromis niloticus*), Catfish (*Clarias gariepinus*) and River Sardine (*Brycinus nurse*) (plates 1,2 and 3) were bought from fishermen at the Black Volta from January to April 2014. The length and weight of fish were within the same range to avoid errors. The detailed information is listed in Table 1 below.

Table 1. Lists of Fish Species, Weight and Length Used In This Study

Scientific Name	Local Name	Common Name	TL (cm) Mean ±SD	BW (g) Mean ±SD
Oroechromis niloticus	Kafura	Tilapia	13.5±0.87	91.67 ± 6.19
Clarias gariepinus	Gogotse	Clarias	13.50±1.2	85.0± 10.80
Brycinus nurse	Peradu	River Sardine	12.25±0.83	46.67± 4.59

TL = Total Length, BW = Body Weight

2.2Sample Preparation

The scales of the fishes were removed, washed with tap water and the piece of flesh above the lateral line anterior to the dorsal fin was taken from each fish. The fish tissue were tied in clean plastic bags and kept in a deep freezer.

2.3 Digestion of samples

The AOAC (1990) method was modified and used for digestion of fish samples. About 1.0g of thawed fish muscles was weighed into Teflon tubes and 10ml of HNO_3 (69-70%) was slowly added to the Teflon tubes. The tubes were then tightly closed and placed into a block digester. The block digester was then heated to 40 ^{0}C for one hour and then increased to 140 ^{0}C for another three hours by which time all tissue samples dissolved in the acid. Samples were then allowed to cool at room temperature and 40ml of distilled water added and then filtered into clean containers.

2.4 Analysis of Digested samples

The analyses of heavy metals on digested samples (Pb, Mn, Cd, Cu, Fe and Zn) were performed in accordance with APHA-AWWA-WEF, 2001, using Shimadzu Atomic Absorption Spectrophotometer (AAS)-AA 6300 model.

All statistical calculations were performed with Microsoft Excel (2007).

3. Results and Discussion

The concentrations of heavy metals were determined in the muscles of *Oroechromis niloticus, Clarias gariepinus* and *Brycinus nurse* because of its importance for human consumption**.** The mean concentrations measured in the fishes during the study are presented in Tables 1. Almost all the fish samples collected from the water body contained detectable amounts of the metals studied except Cadmium and Copper which were below detection limit in all the samples. The metals were present in varying concentrations. Zinc (1.395) and Iron (0.956) were the metals with the highest concentration in muscle flesh of Tilapia while Cu and Cd were below the detection limits (Table 1).

Clarias showed varied concentration of the various metals with zinc and iron recording levels of 1.145 and 1.098 respectively. Cu and Cd were below the detection limits. The mean concentration of metals in muscle flesh of the River sardine also recorded the same trend of concentration with zinc (1.070) and iron (1.622) being the highest.

Zinc concentration in all the samples were below the WHO (2003) allowable standard in fish for public consumption. The results suggest Zn concentration in surrounding biota are very low and are not interfering with normal metabolic processes of fish. The level of zinc accumulation should however be monitored since higher levels could lead to zinc toxicity which can occur in both acute and chronic forms. Acute adverse effects of high zinc intake include nausea, vomiting, loss of appetite, abdominal cramps, diarrhea, and headaches (Food and Nutrition Board, 2001).

Lead concentration in the samples of the three fish species exceeded the maximum permissible limits for fish by the WHO (0.01).

The higher concentration of Pb could be attributed to the use of fertilizers and pesticides along water bodies which are a source of the toxic metals (Rashed, 2001).T he chemicals find their way in to water bodies during rains.

Lead is known cause a wide spectrum of health problems, ranging from convulsions, coma, renal failure, and death at the high end to subtle effects on metabolism and intelligence at the low end of exposures (USATSDR, 1999). Fish from the Region is therefore a likely source of hazard to consumers especially if consumed over a long period of time.

Iron concentration in the three species ranged from 0.957 in Tilapia to 1.622 in the river sardines. These values are higher than the WHO limits (0.30) and so could lead to health effects especially over a period of time due to bioconcentration.

The higher concentration of Fe in the muscle could come from the sediments which is known to accumulate up to 99% of metals in an ecosystem (Odieke,1999) and a source of feed for fish.

Manganese in the samples ranged from 0.483 to 1.051 which also was below the standard set by the WHO (5.00) but the potential of bioconcentration still exist. The lower values indicate no immediate source of pollution to humans but levels above the recommended limits affects central nervous system, causes liver cirrhosis and a higher concentration of it produces a poisoning called Manganese Parkinson disease (Momtaz, 2002) .

Copper and cadmium concentrations in fish samples from the three water bodies were all below the detection limits. This reveals that water bodies are free from copper and cadmium pollution. It could also suggest Cu and Cd concentration in surrounding biota are very low and are not interfering with normal metabolic processes of fish.

The lower concentration of the two elements in the muscle flesh of the fish species is in agreement with Khail and Faragallah (2008) who reported that tissue is not an active organ in accumulation of some heavy metals.

Table 1. Showing mean concentration of heavy metal levels (Standard deviation) in muscle flesh of Tilapia, Clarias, River Sardine, and WHO limits.

	Mean Heavy metals concentration in mg/L					
Fish Spp	**Zn**	**Pb**	**Mn**	**Fe**	**Cd**	**Cu**
Tilapia	1.395(0.11)	0.194(0.19)	0.483(0.15)	0.957(1.08)	< 0.002	< 0.020
Clarias	1.145(1.32)	0.174(0.23)	1.051(0.89)	1.098(1.69)	< 0.002	< 0.020
River Sardine	1.070(0.56)	0.362(0.34)	0.546(0.322)	1.622(0.99)	< 0.002	< 0.020
WHO (2003)	5.00	0.01	0.50	0.30	0.01	2.25

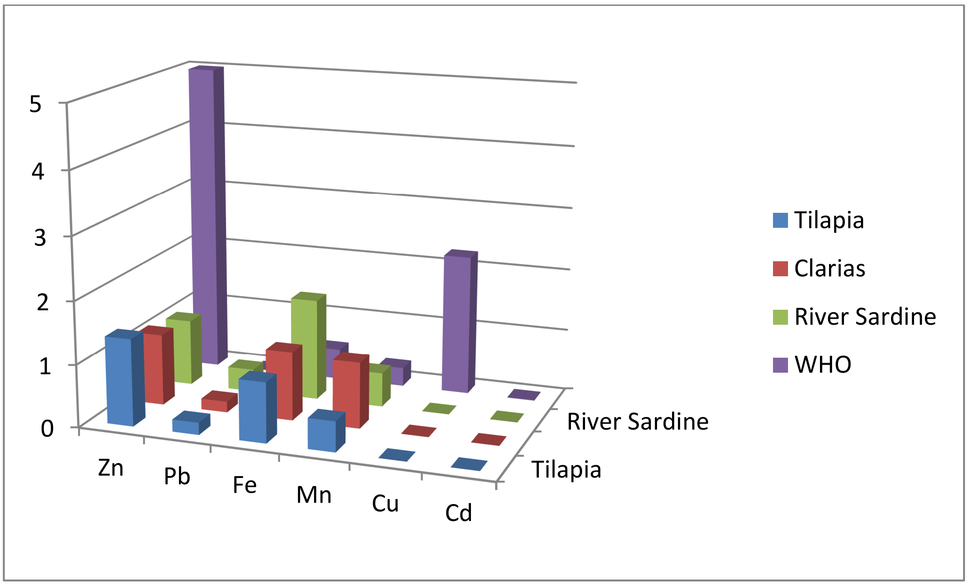

Fig. 1 showing mean concentration of heavy metals in the three fish species and the WHO limits.

Plate 1 *Clarias gariepinus*

Plate 2 *Brycinus nurse*

Plate 3.*Oroechromis niloticus*

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