# The presence of some heavy metals in the water, sediments and *Sarotherodon galileaus* fish in Ilo-Idimu River, Ogun State, Nigeria

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**Abstract**

*The Ilo-Idimu river is situated in the heavily industrialised Ota Town, Ogun State, Nigeria, with industries empting their wastes or part of their wastes into the river. The community use the water of the river for domestic purposes such as cooking, drinking, bathing and washing. Iron (Fe) was the most abundant heavy metal amongst the four [Copper (Cu), Iron (Fe), Zinc (Zn) and Lead (Pb)] heavy metals tested for in the Ilo-Idimu River. Though, the levels of lead was more in the littoral midstream (Lit B) and benthic upstream and downstream (Bent A and C) 1.60, 1.40 and 1.30 mg/l respectively. The fish samples of Sarotherodon galileaus tested for the four heavy metals showed that lead (Pb) was present only in the gut of the fish. For the other heavy metals the trend are Cu > Zn > Fe in the scale, in the flesh of the fish Cu > Fe > Zn, while Fe > Cu > Zn in the gills and gut of the fish. The levels of the heavy metals tested in the water and fish samples were lower than the WHO standards therefore, there is no immediate threat to the biodiversity of the aquatic species in the river and to the health of the community using the water for various domestic uses.*

**Keywords:** Heavy metals, water, sediments, *Sarotherodon galileaus,* midstream, upstream and down stream

## Introduction

In heavy industrialised areas, effluents are discharged into streams and rivers. Apart from microbial pollution, there is a high possibility of releasing heavy metals into these water bodies. Heavy metals are any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations (Lenntech, 2009). Most of these metals are very poisonous and can have lethal effects on fish, other aquatic living resources and man, when they find their way into the food chain. Some of these metals get into streams and rivers through metal scrapes, dissolved metals and their salts, loose enamel, glasses, etc (Okonkwo and Eboatu 1999). Examples of some of these metals may include: Mercury, Cadmium, Chromium, Cobalt, Lead and Zinc. These metals are toxic and can cause specific health problems to man. For instance, Okonkwo and Eboatu (1999) observed that cadmium is linked with hypertension due to kidney malfunctioning. Also the epidemic of mercury poisoning in Japan was traced to the consumption of fish contaminated by high levels of mercury. This mercury founds its way into the bay through discharge from a factory that utilizes methyl mercury as a catalyst in plastic production (Okonkwo and Eboatu, 1999). Bacteria in water convert mercury to methyl mercury, a soluble compound that gets into the food chain.

Heavy metals are natural components of the earth's crust. They can neither be created nor destroyed. As trace elements, some of them (e.g. copper, selenium, and zinc) are essential to maintain the metabolism of the human body. Heavy metal poisoning could occur from drinking contaminated water (through Lead pipes etc), high ambient air concentration near emission source, or through industrial and consumer wastes which are being discharged into the streams and eventually flow into the rivers which are then absorbed either directly or through the food chain. Heavy metals are particularly dangerous because they tend to bioaccumulate in an organism over time (Lenntech, 2009).

Lead is a rare metal when compared to other elements like cerium, tungsten and vanadium (Welz and Sperling, 1999). Inorganic lead arising from a number of industrial and mining sources, such as petroleum and battery manufacturing industries, occurs in water in the +2 oxidation state. Lead from leaded gasoline used to be a major source of atmospheric and terrestrial lead, much of which eventually enters natural water system (Bhatia, 2002). Welz and Sperling (1999) observed that lead can enter the body by ingestion, inhalation, or reabsorption through the skin. Acute lead poisoning is nevertheless seldom due to the low reabsorption but a continuous assimilation of small quantity of lead is far more dangerous.

Zinc occurs at low concentration in freshwater due to the natural weathering of mineral deposits but pollution from anthropogenic sources may increase Zinc level to 150microgram per liter (Miller *et al*., 1992; Dallinger and Kautzky, 1985; Van Hattum*et al.*, 1991).Increased copper pollution has been attributed to geological weathering, atmospheric deposition, municipal and industrial sewage disposal, the discharge of mine tailings and fly ash, fertilizer production, algaecidae and molluscidal run off (Felt and Heath, 1984, Moore and Ramamoorthy, 1984).

Copper is an essential trace element for man and higher mammals and also for numerous plants. It is a constituent of cu protein with enzymes activity. The blood of marine molluscs and crabs contains the copper - containing haemoglobin rather than the iron - containing haemoglobin which is taken up from the sea water and act as a respiratory catalyst (Welz and Sperling, 1999).The increase in copper pollution can be attributed to geological weathering, atmospheric deposition, municipal and industrial sewage disposal, the discharge of mine tailings and fly ash (the major source of solid copper pollution), fertilizer production, algaecidae and molluscidal run off (Felt and Heath, 1984; Moore and Ramamoorthy, 1984).

Iron is the most important industrial metal. Physiologically iron is an essential trace element for animals and vegetable organisms. It is also an important micronutrient for plants which influences photosynthesis and formation of chlorophyll and carbohydrate (Welz and Sperling, 1999). Heavy metals bioaccumulate in animals as they rise up the food chain and more metals are accumulated in the animal muscle thereby resulting in biomagnifications further up the food chain (Nelson *et al*, 1989)

Occurrence of aquatic pollutants even very low sub lethal doses of certain heavy metals has been found to have extreme effects on the structure and/or functions of the immune system that could be almost as harmful as direct toxic doses (Saxenia *et al*, 2009). Pollution of water with heavy metals may adversely affect the immune system of fish leading to decreased production, increased susceptibility to diseases and mortality. For instance, mercury in fish naturally occurs in lakes and streams, but emissions from industrial and mining process and the burning of fossil fuels concentrate elemental mercury in the environment. Once in the environment, microorganisms within the lakes and streams or rivers convert the elemental mercury to the methyl mercury form. Methyl mercury binds tightly to protein in fish tissue and is concentrated in large fish, due to being high up in the food chain. Fish such as shark, sword fish, tuna, and king mackerel are high risk fish (Saxenia *et al*., 2009). Therefore the aim of this study is to note the occurrence and bioaccumulation of heavy metals in the water and fish (*Sarotherodon galileaus*) samples.

**Materials and methods**

Heavy metals were measured using atomic absorption spectrophotometer (AAS). Model number: Buck 210/211, Serial Number: 1245.

**Analysis of heavy metals on fish samples:**

10g of each sample was placed in conical flask; 5ml of phosphoric acid was added, heated on a heating mantle for about an hour, until heated to dryness; 100ml of distilled water was added and thoroughly shaken. It was then filtered into a 100ml standard flask and the filtrate was made up to mark with distilled water. Aliquot of each of the digested and prepared samples of gill, gut, skin and scale were analysed for Pb, Zn, Cu and Fe using Atomic Absorption Spectrophotometer (AAS) of model number Buck 210/1211 as stated above.

**Analysis of heavy metal in water samples**:

Water samples were collected with the aid of water sampler at the littoral and benthic zones of the experimental river, from each point/ Location (A, B, and C). The water was filter using 125mm whatman filter paper, cat no 1001125 (ashless) into 100ml standard flask (to mark). This was done to remove the particles and sediments so as to obtain a clear liquid. This prepared water samples were then analyzed for Pb, Zn, Cu, and Fe, using Atomic absorption spectrophotometer (AAS) of model number Buck 210/211as stated above.

Atomic absorption spectrophotometer (AAS) was used to analyze and determine the presence of heavy metals in the water body of Ilo River and in the tissue of *Sarotherodon galileaus*. Each of the digested and prepared samples of scale, flesh, gill and gut of *Sarotherodon galileaus* were analysed for Lead (Pb), Zinc (Zn), Copper (Cu) and Iron (Fe).

Water sampler was used to collect water at the littoral and benthic zones of the Ilo-Idimu River from three different locations (upstream (A), midstream (B), and downstream (C)). The water was then analyzed for Lead (Pb), Zinc (Zn), Copper (Cu) and Iron (Fe), using Atomic absorption spectrophotometer (AAS).

**Results**

Table 1 and Figure 1 shows the various levels of four heavy metals in the Ilo-Idimu River. The levels of iron (Fe) was more in the Ilo-Idimu River, however, the levels of lead was more in the littoral midstream (Lit B) and benthic upstream and downstream (Bent A and C) 1.60, 1.40 and 1.30 mg/l respectively. The levels of heavy metals in the fish samples of *Sarotherodon galileaus* shown in Table 2 indicated that lead (Pb) was present only in the water and gut of the fish. Cu >Zn >Fe in the scale, in the flesh of the fish Cu > Fe > Zn, while Fe > Cu > Zn in the gills and gut of the fish. The level of Iron was highest in the gill and gut of the fish while copper was more abundant in the scale and flesh. However, lead was only present in the gut of the fish (Figure 2).

**Table 1: Levels of Heavy Metals (mg/l) in the Water Body of Ilo-Idimu River**

| Water Sample | Cu | Fe | Zn | Pb |
|---|---|---|---|---|
| LitA | 0.32 | 0.81 | 0.25 | 0.50 |
| Lit B | 0.23 | 1.62 | 0.24 | 1.60 |
| Lit C | 0.24 | 0.97 | 0.21 | 0.40 |
| Bent A | 0.10 | 0.73 | 0.25 | 1.40 |
| Bent B | 0.34 | 1.71 | 0.25 | 0.50 |
| Bent C | 0.28 | 0.81 | 0.25 | 1.30 |

**Table 2: Levels of Heavy Metals (mg/kg) in *Sarotherodon galileaus***

| Samples | Cu | Fe | Zn | Pb |
|---|---|---|---|---|
| Scale | 1.48 | 0.68 | 0.91 | 0.00 |
| Flesh | 2.18 | 0.65 | 0.56 | 0.00 |
| Gill | 1.72 | 3.15 | 0.37 | 0.00 |
| Gut | 1.22 | 3.09 | 0.51 | 0.69 |

**Table 3: Regression analysis of Heavy Metals betweenthe water, gut, gills, scales and muscle of *Sarotherodon galileaus***

| Heavy Metal | Equation | $R^2$ | Sig. |
|---|---|---|---|
| Copper | $y = -0.342x + 2.396$ | 0.57 | ** |
| Iron | $y = 0.326x + 0.754$ | 0.16 | NS |
| Zinc | $y = -0.139x + 0.935$ | 0.76 | *** |
| Lead | $y = 0.259x - 0.449$ | 0.80 | *** |

**Significant at $P<0.05$ *** Significant at $P<0.01$

## Discussion

The levels of heavy metals were higher in the fish than in the water of Ilo River. The high levels of copper could be due to the fact that some species of plants have ability to bioaccumulate and bioconcentrate heavy metals, making the level higher in the plants than in the soil where the plants grows (Atayese *et al*, 2008) and this can also be applicable to aquatic plants (on which Tilapia feeds, being an herbivorous fish) especially in the shallow part of the water. This could also account for the high levels

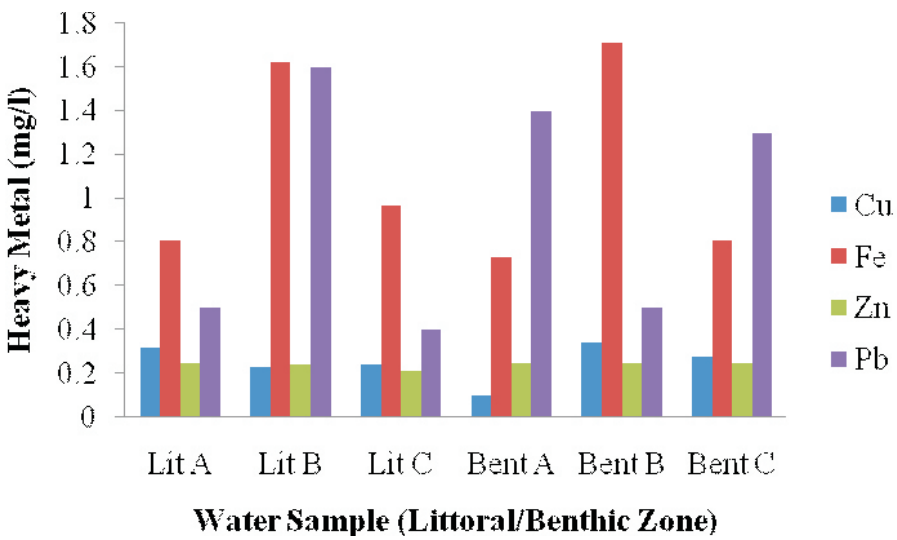



**Figure 1: Levels of Heavy Metals in Ilo-Idimu River**

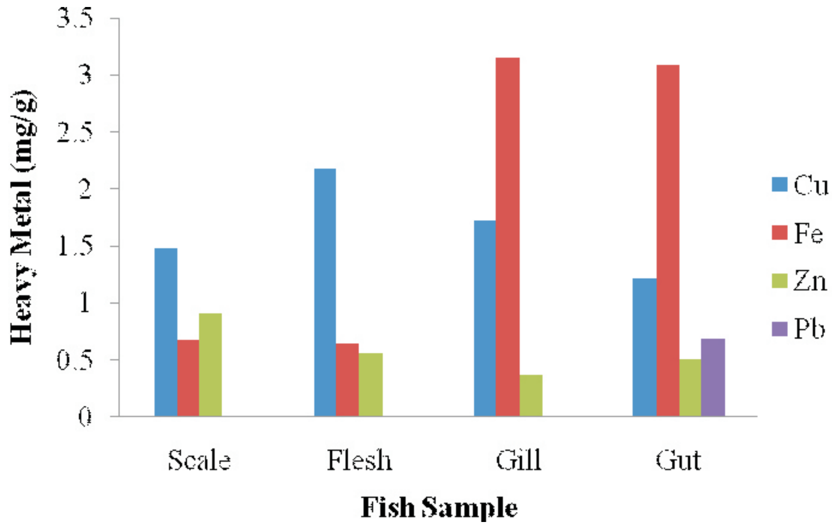
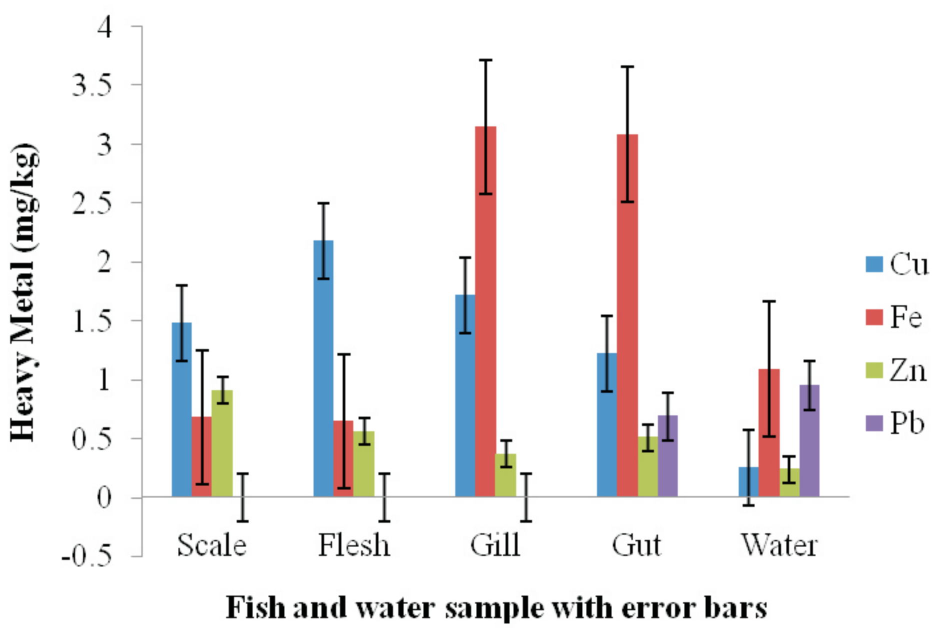



**Figure 2: Levels of Heavy Metals in the Fish Samples of *Sarotherodon galileaus***



of iron in the gut and gills of *Sarotherodon galileaus.* Toxic metals could therefore be transferred from one organism to the other (especially from plants to animals) through the food chain (Ma *et al*., 2007).

The WHO standard for lead is 0.01mg/l for water and 1.5mg/g for fish. Lead (Pb) was present only in the gut of the fish (0.69mg/g) and below the WHO standard. The water body of Ilo-Idimu River contains lead that is above the WHO safe standard level for consumption at both the littoral and benthic zones. Copper (Cu) levels were more than the levels of Zinc and Iron in the scale and flesh of the fish. However, the level of Iron was more in the flesh of the fish than Zinc and more in the gills than copper and Zinc. The level of Iron was highest in the gill and gut of the fish while copper was more abundant in the Scale and flesh. The WHO standard for Zinc in fish is 150mg/g and the highest level of Zinc was 0.91 mg/g which is way below the WHO standard. With respect to Zinc, the water was not polluted at the littoral and benthic zones when compared with the WHO standard of 3.0 mg/l. In a similar study carried out by Taweel *et al*. (2013) who assessed the levels of five heavy metals in the muscle of tilapia fish, they observed that tilapia fish is the safest fish to consume in terms of heavy metal concentration.

The fishes and water investigated did not contain heavy metals at a lethal or heavy concentration more than the World Health Organization (WHO) standard, with the exception of lead. Hence, one may conclude that the level of heavy metals in the samples analysed could not constitute a health hazard to the community that was dependent on it for domestic uses. On this basis it could be said tilapia fish from Ilo-Idimu River may be considered safe for human consumption. This corroborates Taweel *et al*. (2013) findings. However, the water is not safe for consumption due to lead poisoning. There is therefore, the need to continually monitor the water of Ilo-Idimu River in Ota, Ogun State.

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