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Heavy metal concentration (Copper, Manganese and Nickel) in the fish *Sarotherodon melanotheron* from Alaro stream in Ibadan

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Abstract
An assessment was carried out on the heavy metal concentration in the organs of the fish *Sarotherodon melanotheron* from Alaro stream in Ibadan. Fish were collected between January to December 2003 representing both the dry and rainy seasons. Muscle, liver, bone, gills, gut and fins were analyzed for copper (Cu), manganese (Mn) and nickel (Ni) using the inductively coupled plasma-mass spectrometer (ICP-MS).Quality assurance of the results was ensured through the use of bovine liver from the National Institute of Standards and Technology (NIST) as a standard reference material. The range of Cu, Mn and Ni in the fish organs was 4.24-77.79ppm, 13.8-96.5ppm and 0.04-0.92ppm respectively. Mean concentration of Mn in all the organs exceeded the FEPA (Federal Environmental Protection Agency) guideline limits set for it while that of Ni concentration in the muscle was below the WHO standard while all the other organs exceeded it. The heavy metal Cu, apart from the muscle, bone and gills, all the other organs exceeded the WHO recommended limit standard. The study shows that Alaro stream is polluted and fish (*S.melanotheron*) caught from it is unfit for human consumption due to public health consequences posed in the high concentration of the heavy metals Cu, Mn and Ni.

1. Introduction

Heavy metals in the human environment can be traced to both natural and anthropogenic sources (Tyokumbur and Okorie, 2014). Heavy metals are classified as 'light' or 'heavy' with densities less or greater than 5 g/cm. Natural and anthropogenic activities usually result in gaseous emissions and wastewater discharges into the environment (Olaifa *et al*, 2004). Substances in the emissions and effluent discharges in the environment can be in very minute amount or low concentration and may be toxic to plants and animals due to the presence of contaminants (Odiete, 1999). Contaminants such as heavy metals can be bioaccumulated by aquatic biota such as macrophytes, macroinvertebrates and fish. Aquatic organisms have been studied and shown to accumulate heavy metals to a magnitude of concentration many times higher than what is present in the water (Akan *et al*, 2012).Most aquatic organisms accumulate heavy metals from the surrounding water, sediments or food. Some organisms are able to regulate the concentrations of heavy metals in their tissues and hence actively control their toxic effects by regulating absorption, excretion, and depuration rates (Adedeji *et al*, 2011).

Fish is an important and affordable source of protein to man which could also concentrate heavy metals from polluted waters like Alaro stream. Since there is no water treatment programme for effluents discharged from industries and homes into the Alaro stream, it is important to monitor the levels of metals in the fish *Sarotherodon melanotheron* in order to compare it with World Health Organization standards or guideline limits. In this study, *S. melanotheron* was chosen based on its food and economic values in Ibadan. The concentration of copper (Cu), manganese (Mn) and nickel (Ni) in the fish organs of muscle, liver, bone, gills, gut (intestine) and fins will be assessed in order to ascertain the level of food safety in consuming this fish. Although the heavy metals Cu, Mn and Ni are required in the physiological functioning of the fish, they become harmful when they exceed the optimal set standards for them (Akaahan *et al*,2010;Sun *et al*,2014).

2. Materials and Methods

2.1. Study Area

Table 1. *Industrial activities and their potential pollutants in Alaro Stream*

Industry	Number of industries	Potential pollutants
Food processing		
i. carbonated beverages	2	Alkalis, phenols, suspended solids, detergents, fermented starches, pathogens, nitrates, heavy metals from oiling machine parts and organic wastes
ii. confectionery and biscuit	2	Organic wastes (solids and suspended), heavy metals, pathogens, total suspended solids (TSS), biochemical oxygen demand (BOD), PH
iii. animal husbandry and meat processing	1	Organic wastes, heavy metals
Iron and fabrication		
i. steel	2	Heavy metals, cyanide, fluorides, chromates, thiocyanates, naphthalenes
ii. metal foundry	2	Diverse heavy metals
iii. crown corks	1	Metal filings, heavy metals
Wood processing	1	Waste lignin, organic sulphur, mercury, magnesium, sulphide, terpenes, arsenates mercaptans, heavy metals

Alaro Stream is located within the hydro-ecological system of the Oluyole Industrial Estate in Ibadan, Nigeria that receives effluents from diverse sources of heavy metal pollution. The Alaro stream flows into Oluyole Estate in a west–south east direction from its source at Agaloke near Apata in Ibadan. It joins River Ona at the south east end of a meat processing factory as its main tributary. The stream receives effluents from diverse industries. Effluents from both natural and anthropogenic sources are discharged into Alaro stream directly or indirectly through run-off, leaching or seepage especially during the rainy season or as windblown materials during the dry season. The Oluyole industrial estate is located between latitude 7^o 21’N -7^o 22’N and longitude 3^o 50’-3^o 52’E. Table 1 shows the types of industries that discharge effluents into Alaro Stream and their potential pollutants.

2.2. Fish Collection and Identification

Fish were collected from the entire Alaro stream downstream of the industrial effluent outfall. Fish were collected using the following techniques: Cast nets with mesh sizes ranging between 30-50mm with varying dimensional sizes were used .These nets were left for about three minutes before retrieving with a drawing string to check for any entangled fish. In addition, gill nets with mesh sizes of 30-50mm and varying dimensions were tied to stakes with a lead weight on the stream bed and maintained vertically in water with the aid of floats overnight. 25 fishes were caught in the sampling of Alaro stream.

Fish collected were identified using the textbook by Moses,(1992).The dissections were carried out using dissecting set to remove the gills, fins, gut (intestine), liver, bones and muscle. These tissues were oven dried at 105^0C for 6hours .Each organ was pulverized separately by means of a porcelain mortar and pestle .The pulverized samples were kept in sample sachets and sealed prior to analyses.

2.3. Fish Organ Digestion for Heavy Metal Analyses

Tissue digestion was carried out by adding 2ml trace metal grade HNO_3 to 0.5g of each sample in Teflon digestion tubes which were heated at 105 ^{0}C for 1 hour in a heat block. The clear solution was then allowed to cool down, followed by addition of 1ml H_2O_2, after the simmering, boiled and left overnight. The digested sample was diluted to the 10ml mark using MilliQ water for inductively coupled plasma mass spectrometer (ICP-MS) analyses. Standard Reference Materials (SRM) comprising of bovine liver from the National Institute of Standards and Technology (NIST-1577) were used to obtain accurate values for fish tissue.

3. Results and Discussion

3.1. Standard Reference Materials and Quality Assurance

Percentage recoveries from the reference material were all above 70% with values of 91.73% (Cu), 92.9% (Mn) and 86.5% (Ni). The results were also corrected for errors using MilliQ water as the blank using the inductively coupled plasma-mass spectrometer (ICP-MS).

3.2. Heavy Metals in the Fish Organs

The results of the mean concentration of Cu in the organs of *S.melanotheron* are shown in figure 1.

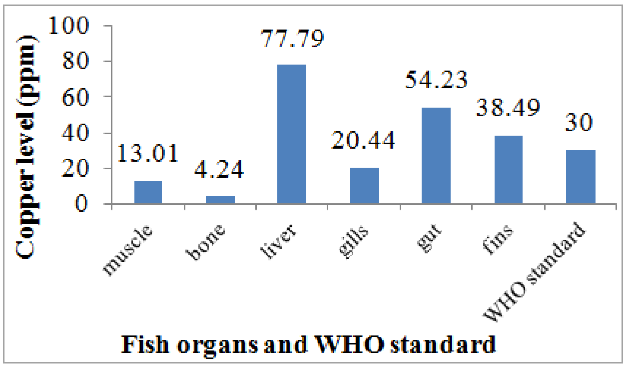

Figure 1. *Mean Cu in the organs of S.melanotheron and WHO standards.*

The range of Cu in the fish organs was 4.24-77.79ppm, while the highest was in the liver and the lowest was in the bone. World Health Organization (WHO) standard of 30ppm for drinking water was exceeded in all the liver, gut and fins of the fish (WHO/FAO, 1989; WHO, 2004). The potential of the different fish organs to store trace metals could be responsible for the differences in the levels of the mean concentration of Cu. Bioavailability of Cu in Alaro stream and the fish organs is due to its presence in the discharged effluents into the water as shown in table 1. Copper is also present in electrical wiring, pipes, valves, fittings, coins, cooking utensils and building materials. Its presence in munitions, alloys (brass, bronze) and coatings makes it bioavailable as a contaminant. Copper compounds are used as fungicides, algaecides, insecticides and wood preservatives and in electroplating, dye manufacture, engraving, lithography, petroleum products and pyrotechnics that can easily be part of effluents in Alaro stream in Ibadan. Copper compounds are also added to fertilizers and animal feeds as a nutrient to support plant and animal growth, which in this case there is the presence of an animal husbandry industry in the catchment hydrology of Alaro stream (Landner and Lindestrom, 1999; ATSDR, 2002).

Results of mean concentration of Mn in the organs of *S.melanotheron* during the study is shown in figure 2.

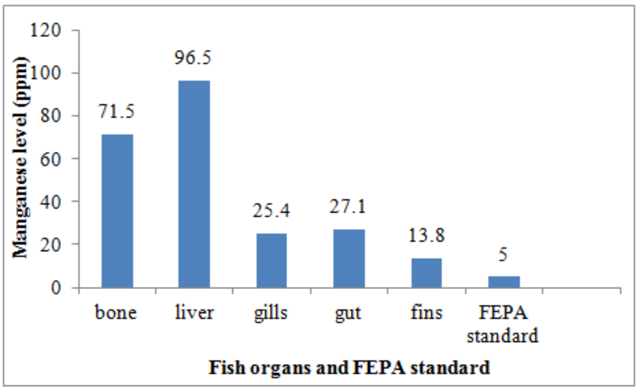

Figure 2. *Mean Mn in the organs of S.melanotheron and FEPA standard*

The range of Mn in the organs of *S.melanotheron* was 13.8-96.5ppm, while the highest mean concentration was in the liver (96.5ppm) and lowest was in the fins (13.8ppm).The high mean concentration in the liver is due to its role as a detoxification and storage organ. (Moses, 1992).Mean Mn concentration in all the organs exceeded the FEPA (Federal Environmental Protection Agency, FEPA (1991) limit standard of 5ppm. while the liver and gills exceeded it.

Results of mean concentration of Ni in the organs of *S.melanotheron* is shown in figure 3.

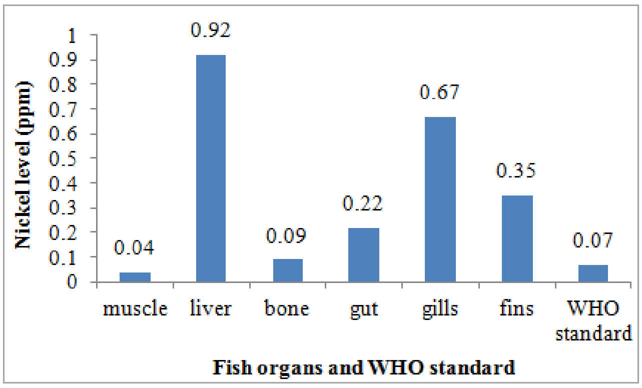

Figure 3. *Mean Ni in the organs of S.melanotheron and WHO standard*

The range of the concentration of Ni in the organs of the fish *S.melanotheron* was 0.04-0.92ppm, while the high mean concentration was in the liver (0.92ppm) and the lowest was in the muscle (0.04ppm).Apart from the muscle (0.04ppm), all the other organs exceeded the WHO recommended limit standard of 0.07ppm (WHO/FAO,1989; WHO,2005).The high Ni level in the organs of *S.melanotheron* is due to bioavailability of the heavy metal in the aquatic ecosystem from industrial effluents and geogenic sources as reviewed by Odiete (1999) and Akaahan *et al*,2010) and Akan *et al*,(2012).

4. Conclusion

The study shows that mean concentration of the heavy metals Cu, Mn and Ni in *S.melanotheron* from Alaro stream in Ibadan exceeded the World Health Organization (WHO) standard set for them in most of the organs. This shows that Alaro stream is polluted and fish (*S.melanotheron*) caught from the stream is unfit for human consumption due to the public health consequences posed by its consumption.

References

[1] Adedeji, O.B, Adeyemo, O.K and Oyedele, M.O (2011).Heavy metals in snail and water samples from Alaro River in Oluyole Industrial Area of Ibadan Southwestern Nigeria. *Journal of Applied Sciences in Environmental Sanitation* 6 (2): 115-121

[2] Akaahan, J; Oluma, H.O.A and Sha'Ato, R (2010). Physico-chemical and Bacteriological Quality of Water from Shallow Wells in Two Rural Communities in Benue State, Nigeria. *Pak. J. Anal. Environ. Chem.* (11)1:73-78

[3] Akan, J.C; Mohmoud, S; Yikala, B.S and Ogugbuaja, V.O (2012). Bioaccumulation of Some Heavy Metals in Fish Samples from River Benue in Vinikilang, Adamawa State, Nigeria. *American Journal of Analytical Chemistry* 3, 727-736.

[4] ATSDR (2002) Toxicological profile for copper (draft for public comment). Atlanta, GA, US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry

[5] Landner L, Lindestrom L (1999) Copper in society and in the environment. Vasteras, Swedish. Environmental Research Group (MFG) (SCDA S-721 88).

[6] Moses B.S (1992). *Introduction to Tropical Fisheries*. Ibadan University Press; 1992

[7] Odiete, W.O. (1999). *Environmental Physiology of Animals and Pollution*. First Edition. Diversified Resources Limited. Lagos.

[8] Olaifa, F.E; Olaifa, A.K; Adelaja, A.A and Owolabi, A.G (2004).Heavy metal contamination of *Clarias gariepinus* from a lake and fish farm in Ibadan, Nigeria. *African Journal of Biomedical Research*, Vol. 7 (2004); 145 - 148

[9] Sun, H.J; Rathinasabapathi, B; Wua, B; Luoa, J; Pu, L.P and Ma, L.Q (2014). Arsenic and selenium toxicity and their interactive effects in humans. *Environment International* 69 ; 148–158

[10] Tyokumbur, E.T and Okorie**.** T.G. (2014). Bioconcentration of trace metals in the freshwater snail *Melanoides tuberculata* (Mollusca: Thiaridae) from Alaro stream ecosystem of South West Nigeria. *Advances in Bioscience and Bioengineering.*Vol.2.No.1. 51-65

[11] WHO (2008). Cadmium. In: Guidelines for drinking-water quality. 3rd edition incorporating 1st and 2nd addenda. Volume 1. Recommendations. Geneva, World Health Organization, pp. 317–319

[12] WHO/FAO (1989). Evaluation of certain food additives and contaminants. Thirty third Report of the joint FAO/WHO expert committee on food additives. WHO technical report series (Geneva).776, 26–27

[13] WHO (2004).Copper in drinking water. Background document for development of WHO Guidelines for Drinking-water Quality. World Health Organization.31pp.

[14] WHO (2005). Nickel in drinking water. Background document for development of WHO Guidelines for Drinking-water Quality. World Health Organization.30pp.