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Trace metal concentration in freshwater fish organs of *Heterotis niloticus* from Alaro stream in Ibadan, Nigeria

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Abstract

Trace metal concentration in freshwater fish organs of *Heterotis niloticus* from Alaro stream in Ibadan was assessed. Trace metals analyzed were arsenic (As), selenium (Se), cadmium (Cd) and lead (Pb) due to their impacts on human health. Inductively coupled plasma-mass spectrometer (ICP-MS) was used for the analyses of the fish samples while the standard reference material (SRM) for quality assurance was bovine liver from the National Institute of Standards and Technology (NIST).Results show that the mean concentration of As, Se and Pb exceeded the World Health Organization guideline limits and other international standards, while only the muscle and gut did not exceed for Cd. The range of the As in the organs was 0.000-0.963ppm, while the mean concentration was 0.028-0.184ppm with the lowest in the bones and the highest in the gut. The range of the Se in the fish organs was 0.06-1.53ppm, while the highest mean concentration was 1.38ppm in the gills and the lowest was 0.11ppm in the fins. The range of Pb in the organs of *H.niloticus* was 0.00-14.12ppm, while the highest mean concentration was in the liver and the lowest was in the fins. The study shows that consumption of *H.niloticus* from Alaro stream is a health risk that must be avoided. It is recommended that a biomonitoring programme be established for regularly monitoring Alaro stream that is impacted by untreated industrial effluents.

1. Introduction

Bioconcentration of trace metals in aquatic organisms can pose a long lasting effect on the physiological functioning of the biota and ecosystem health [1]. This is because aquatic organisms have the ability to accumulate trace metals from the water column, plankton, suspended and bed sediments [2]. The concentration of toxic trace metals in the tissues of aquatic biota at hazardous levels is a problem of increasing public health concern to both animals and humans than are exposed to them through consumption. The excessive trace metal concentration in fish could lead to health consequences in man through the consumption of fish [3-6]. Among aquatic fauna, fish is the most susceptible to trace metal pollutants [7]. It is well known that fish are good indicators of chemical pollution and as a result they long been used to monitor metal pollution in the aquatic ecosystem. Since fishes are widely used to evaluate the health of aquatic ecosystems due to their ability to build up pollutants and in the food chain and are responsible for adverse effects and consequent death of humans that consume them, this study is necessary for public good. Therefore, in this study, the concentration of trace metals (arsenic, selenium, cadmium and lead) in fish (*Heterotis niloticus*) organs (muscle, liver, bone, gills, gut, fins,) were used to assess the food safety standards for public health using World Health Organization Guideline Criteria.

Table 1. *Industrial activities and their potential pollutants in Alaro stream from Oluyole industrial estate, Ibadan*

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

2. Materials and Methods

2.1. Study Area

The study area is located in the Alaro Stream Ecosystem in Oluyole Industrial Estate in Ibadan, Nigeria between latitude 7° 21″ N–7° 22′ and longitude 3° 50′ E–3° 52′ E. The stream is impacted by untreated industrial effluents that have been shown to contain trace metals. Table 1 shows the types of industries that discharge their untreated effluents in Alaro stream and their potential pollutants.

2.2. Sampling Sites

2.2.1. Sampling Site 1

This is located before Oke Alaro Bridge I just before it enters the industrial estate. This is the control site.

2.2.2. Sampling Site 2

Sampling site 2 is downstream of Oke Alaro bridge II.It is located about 500metres downstream of sampling station 1.It receives run-off water from Alaro settlements and parts of Oluyole residential area. There is a shopping arcade that discharges effluents into the gutter that drains into the stream at this point.

2.2.3. Sampling Site 3

This site receives effluents discharged from the carbonated beverages, crown cork factory and the confectionery and biscuit factories.

2.2.4. Sampling Site 4

This site receives effluents from an animal husbandry factory.

2.2.5. Sampling Site 5

This sampling site was located just before the meeting points of Ona River and Alaro stream behind the south east end of the meat processing factory. It represents the recovery site.

2.3. Fish Collection and Processing for Analyses

Fishes were collected from the sampling stations using cast nets with mesh sizes ranging between 30-50mm with varying dimensional sizes .These nets were left for about three minutes before retrieving with a drawing string to check for any entangled fish. Gill nets with mesh sizes of 30-50mm with 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. A total of 32 fish (*Heterotis niloticus*) were caught at various sampling sites in Alaro stream. Fish dissections were carried out using dissecting set to remove the gills, gut, liver, bone and muscle .These tissues were oven dried at 105^0C for 6hours .Each organ or pooled organs were pulverized separately by means of a porcelain mortar and pestle .The pulverized samples were kept in sample sachets and sealed prior to analyses.

2.4. Acid Digestion for Trace Metal Analyses

Pulverized organ digestion of fish 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 digestate 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) were used to obtain accurate values for fish tissue. The NIST number for the bovine liver was 1577.

3. Results and Discussion

3.1. Quality Assurance

Results of quality assurance from the National Institute of

Standards and Technology (NIST)'s standard reference materials (SRMs) of bovine liver indicating the percentage recoveries were As(85.9%),Se (76.0%),Cd (88.3%) and Pb(75.3%).All recoveries were above 70% ,thereby indicating a good analytic efficiency of the ICP-MS equipment.

3.2. Mean Trace Metal Concentration in the Fish Organs

Results of mean As concentration in the organs of *H.niloticus* and WHO guideline limits is given in figure 1.

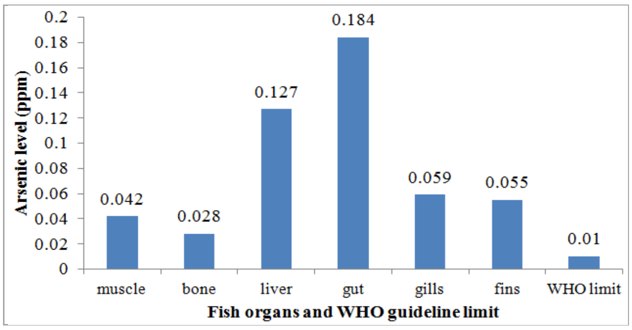

Figure 1. *Mean As concentration in the organs of H.niloticus and WHO guideline limits*

The range of the As in the organs was 0.000-0.963ppm, while the mean concentration was 0.028-0.184ppm with the lowest in the bones and the highest in the gut. All the mean organ concentrations exceeded the WHO guideline limit of 0.01ppm given for drinking water. Differences in the concentration of As in the organs can be attributed to physiological reasons such as ability to excrete or store the metalloid [8]. The high As in the organs of the fish species is due to geogenic and anthropogenic sources in the Alaro stream hydrology. Effluents from wood processing preservatives discharged into Alaro stream are a major source of arsenic as asserted in other collaborative studies by Sun [9] and Gress [10]. This study also corroborates high As concentration levels reported in Alaro stream by Tyokumbur and Okorie [11] in freshwater snails and Komolafe and colleagues [12] in the water where they become bioavailable to the fish species. Results of the mean Se concentration in the fish organs is shown in figure 2.

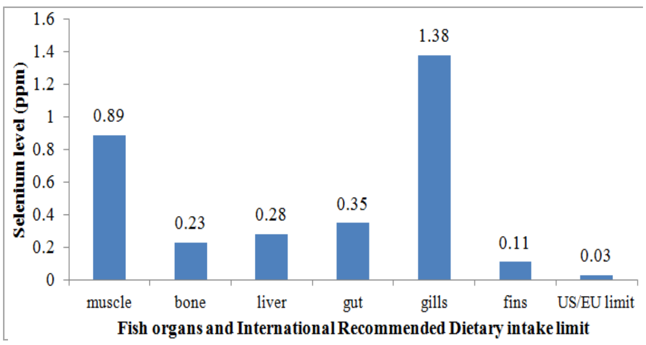

Figure 2. *Mean Se concentration in the organs of H.niloticus and US/EU recommended dietary intake*

The range of the Se in the fish organs was 0.06-1.53ppm, while the highest mean concentration was 1.38ppm in the gills and the lowest was 0.11ppm in the fins. All the mean organ concentration of Se exceeded the International dietary recommended intake of 30ug/d given by the US and European food agencies while 50-250ug/d is given for adults by the Chinese Nutrition Society [9].

Results of the mean Cd concentration in the fish organs is given in figure 3.

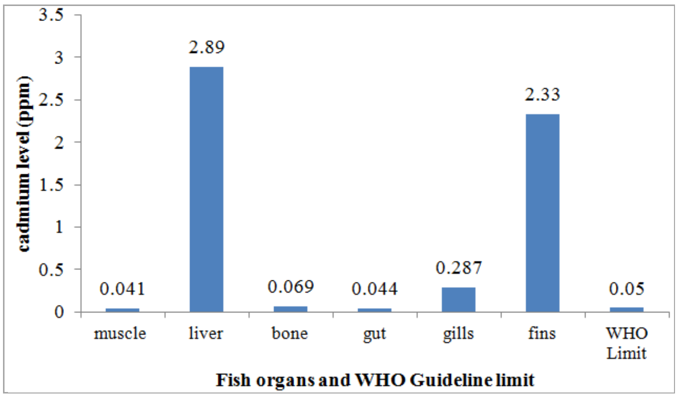

Figure 3. *Mean Cd concentration in the organs of H.niloticus and WHO guideline limits*

Cd range in the fish was 0.000-3.217ppm, while the highest mean concentration in the organs was 2.89ppm (liver) and the lowest was 0.041ppm (muscle).Liver, bone, gills and fins exceeded the WHO [13] guideline limits, while the muscle and gut were below. The high cadmium level in the fish organs can be due to the influx of electronic wastes into the aquatic ecosystem [14].

Results of the mean Pb concentration in the fish organs are shown in figure 4.

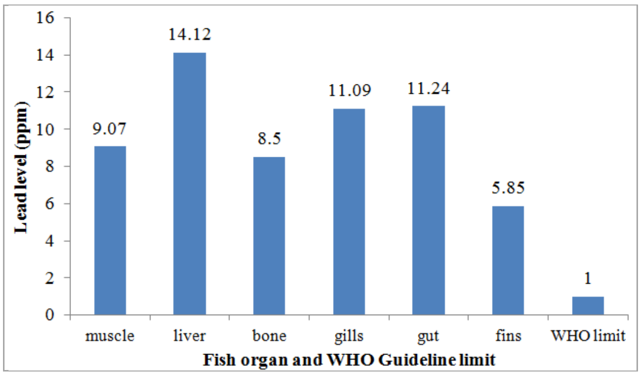

Figure 4. *Mean Pb concentration in the organs of H.niloticus and WHO guideline limits*

The range of Pb in the organs of *H.niloticus* was 0.00-14.12ppm, while the highest mean concentration was in the liver and the lowest was in the fins. The liver had high levels of Pb due to its capacity to store contaminants and to detoxify them. All the mean Pb concentration in the organs exceeded the World Health Organization Guideline limit of 1ppm [15].This study compare favorably with findings from Akan and colleagues [5] that showed high bioaccumulation of heavy metals in fish from a similar ecological zone in

Nigeria. The high Pb levels could be due to the use of leaded gasoline in automobile engines that eventually finds its way into the aquatic ecosystem and is taken up from the food chain and water by the fish [14].

4. Conclusion

This study shows that the fish *H.niloticus* bioconcentrated high levels of As, Se, Cd and Pb in the organs which exceeded set guideline limits of World Health Organization and other international standards thereby making the fish unfit for human consumption. Since As, Se and Cd are carcinogens and Pb is a neurotoxin that impacts on human health, there is the need for a biomonitoring programme to regularly screen fish caught from Alaro stream.

References

[1] Godwin,T.H; Young,A.R; Holmes,M.G.R; Old,G.H; Hewitt; Leeks,G.J.L; Packman,J.C and Smith,B.P.G (2003).The Temporal and Spatial Variability of Sediment Transport and Yields within the Bradford Beck Catchment, West Yorkshire. *Science of The Total Environment.* 14(16): 475-494.

[2] Raju, K.V; Somashekar, R.K and Prakash, K.L. (2013).Metal Concentration in Fresh Water Fish Organs. *Open Journal of Metal*. 3:23-28

[3] Kargin, F. (1998).Metal Concentration in Tissues of The Fresh Water Fish *Capoeta barroisi* from the Seyhan River (Turkey).*Bulletin Environmental Contamination and Toxicology.*60 (5): 822-828.

[4] Ashraf, W. (2001).Accumulation of Heavy Metals in Kidney and Heart Tissues of *Epinephelus microdon* Fish from the Arabian Gulf. *Environmental Monitoring and Assessment.* 101(1-3): 311-316.

[5] 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

[6] Krishna, P.V; Jyothirmayi, V and Rao, K.M. (2014). Human health risk assessment of heavy metal accumulation through fish consumption from Machilipatnam Coast, Andhra Pradesh, India. *Int. Res. J. Public Environ. Health.* 5:121-125

[7] Nwaedozie, T.M. (1998). The determination of heavy metal pollution in some samples of River Kaduna. *J. Chem. Soc. Nigeria*. 21-23.

[8] Nagabhushanam, R., Kodarkar, M.S and Sarojini, R. (1999). *Textbook of Animal Physiology*.2ndEdition. IBH Publishing Co.PVT.Ltd.India.

[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] Gress, J.K; Less, J.T., Dong X and Ma, L.Q (2014). Assessment of children's exposure to arsenic from CCA-wood staircases at apartment complexes in Florida. *Science of the Total Environment.* (2014):440–446

[11] 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.* 2(1): 51-65

[12] Komolafe, J.I, Okorie, T, and Tyokumbur, E. (2014): Physico-chemical quality of water, sediments, effluents and biota in Alaro stream and a pond in Ibadan. *Advances in Bioscience and Bioengineering*.2 (1):16-37

[13] 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

[14] Don-Pedro, K.N. (2009).*Man and the Environmental Crisis*. Cheers Book Series, University of Lagos Press, Akoka, Lagos, Nigeria.

[15] 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.World Health Organization.