Journal of Food and Nutrition Sciences
2014; 2(6): 258-261
Published online November 20, 2014 (http://www.sciencepublishinggroup.com/j/jfns)
doi: 10.11648/j.jfns.20140206.13
ISSN: 2330-7285 (Print); ISSN: 2330-7293 (Online)

Toxic trace metal contamination (Arsenic, Cadmium and Lead) of *Sarotherodon melanotheron* (Ruppell, 1852) from Alaro stream in Ibadan

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To cite this article:
Emmanuel Tyokumbur, Tonye Okorie. Toxic Trace Metal Contamination (Arsenic, Cadmium and Lead) of *Sarotherodon melanotheron* (Ruppell, 1852) from Alaro Stream in Ibadan. *Journal of Food and Nutrition Sciences*. Vol. 2, No. 6, 2014, pp. 258-261.
doi: 10.11648/j.jfns.20140206.13

Abstract: Studies were carried out on the trace metal contamination of *Sarotherodon melanotheron* from Alaro stream in Ibadan, Nigeria. Fish were collected between January and December 2003 (Dry and rainy season).Muscle, liver, bone, gills, gut and fins were analyzed for arsenic (As), cadmium (Cd) and lead (Pb) 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 As, Cd and Pb in the fish organs was 0.000-0.154ppm, 0.000-0.302ppm and 0.00-4.03ppm respectively. Mean concentration of As in all the organs exceeded World Health Organization (WHO) standard while that of Cd concentration in the muscle, gut and fins were below and the liver and gills exceeded it. For Pb, apart from the fins (0.48ppm), 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.

Keywords: Trace Metals, Arsenic, Cadmium, Lead, *Sarotherodon melanotheron*

1. Introduction

Trace metals in the aquatic environment can be traced to both natural and anthropogenic sources (Tyokumbur and Okorie, 2014). Trace metals are classified as being 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). When these substances in the emissions and effluent discharged into the environment are in very minute amounts or in low concentrations and are toxic to plants and animals and have short residence time in the environment, they are described as 'contaminants' (Odiete,1999). Pollutants such as trace metals can be bioaccumulated by aquatic biota such as macrophytes, macroinvertebrates and fish. Aquatic organisms have been known to accumulate metals to concentrations many times higher than that which is present in the water (Akan *et al*, 2012). Some aquatic organisms accumulate trace metals from their surrounding water, sediments or food and it is important to recognize that this is a universal and often essential physiological process. Many organisms are able to regulate the concentrations of metals in their tissues and hence actively regulate their toxic effects by controlling absorption, excretion, and depuration rates or by detoxification either by changing the metal to a less toxic form or by storage at sites in the body where the metal does not have an adverse effect (Adedeji *et al*, 2011).

Fish as an important and affordable source of protein to man which could also concentrate trace metals from polluted waters like Alaro stream. Since there is no water quality treatment programme for effluents discharged from industries into the Alaro stream, it is important to monitor the levels of metals such as arsenic, lead and cadmium in the fish *Sarotheron melanotheron* in order to compare it with World Health Organization standards or guideline limits for public health purposes. In this study, *S. melanotheron* was chosen based on its food and economic value in Ibadan. The concentration of arsenic (As), cadmium (Cd) and lead (Pb) in the muscle, liver, bone, gills, gut (intestine) and fins of *S. melanotheron* will be assessed in order to unravel the food safety of this fish in Ibadan. The trace metals arsenic and

cadmium are carcinogens while lead is a neurotoxin (Akaahan *et al*, 2010; Sun *et al*, 2014).

2. Materials and Methods

2.1. Study Area

Alaro Stream is located within the hydro-ecological system of the Oluyole Industrial Estate in Ibadan, Nigeria that receives effluents from diverse sources of macro and trace 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. Figure 1 shows the map of the study area in Ibadan.

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, trace metals from oiling machine parts and organic wastes
ii. confectionery and biscuit	2	Organic wastes(solids and suspended),macro metals, pathogens, total suspended solids(TSS),biochemical oxygen demand (BOD),PH
iii. animal husbandry and meat processing	1	Organic wastes, macro and trace metals
Iron and fabrication		
i. steel	2	Trace metals, cyanide, fluorides, chromates, thiocyanates, naphthalenes
ii.metal foundry	2	Diverse trace metals
iii. crown corks	1	Metal filings, heavy and trace metals
Wood processing	1	Waste lignin, organic sulphur, mercury, magnesium, sulphide, terpenes, arsenates mercaptans, heavy and trace metals

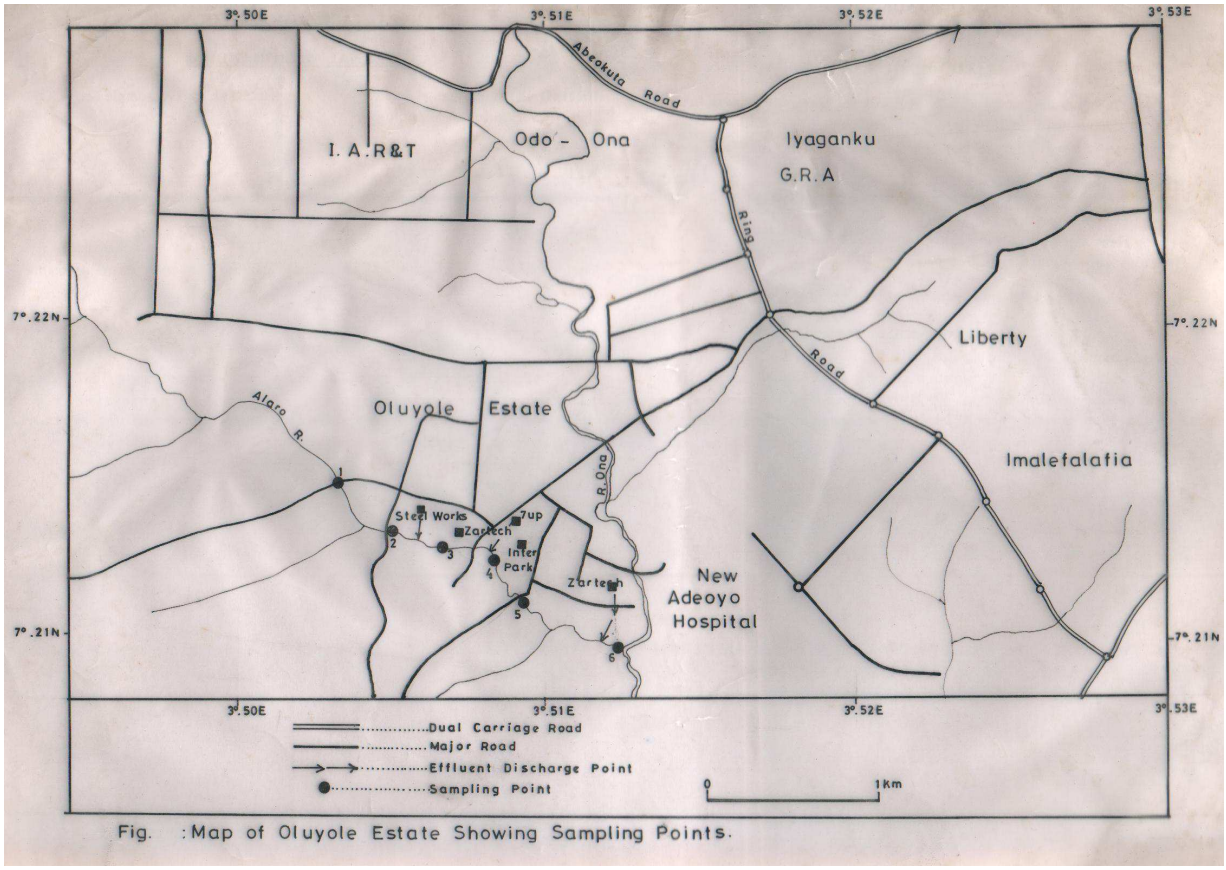

Figure 1. *Extract map of Oluyole Estate in Ibadan showing the study area*

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 Trace 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. These were then transferred into deionized water-rinsed test tubes for the for the inductively coupled plasma mass spectrometer (ICP-MS) analyses. Agilent 7700 ICP-MS was used for the analyses of the samples because it combines a high temperature ICP (inductively coupled plasma) source with a mass spectrometer which converts the atoms of the metals in the sample into ions that are separated according to their mass-charge ratios by a quadrupole mass analyzer (MS). The ICP-MS was preferred to other analytical facility because it is rapid, precise, accurate and extremely sensitive multimetal analytical facility for the determination of trace metals in biological samples. 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 85.9% (As), 88.3% (Cd) and 75.3% (Pb). The results were also corrected for errors using MilliQ water as the blank using the inductively coupled plasma-mass spectrometer (ICP-MS).

3.2. Fish Trace Metals in the Organs

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

The range of As in the fish organs was 0.000-0.154ppm, while the highest was in the gills and the lowest was in the muscle. World Health Organization (WHO) standard of 0.01ppm (10ug/l) for drinking water was exceeded in all the organs (WHO/FAO, 1989). The ability of different organs to store trace metals could be responsible for the differences in the levels of the mean concentration of As (Sun *et al*,2014).Bioavailability of As in Alaro stream and the fish organs is due to the preservatives used in wood processing that are discharged as effluents into the water as shown in table 1.

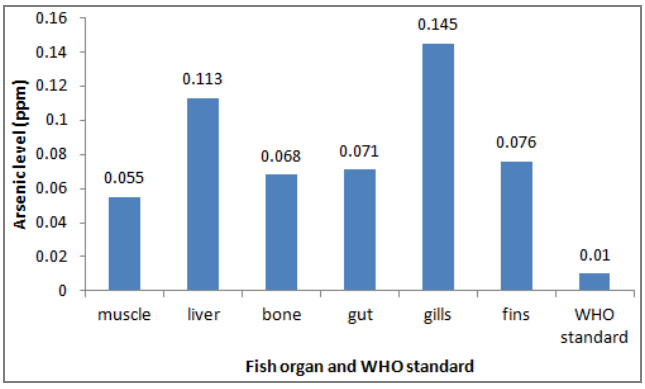

Figure 2. *Mean As in the organs of S.melanotheron and WHO standards.*

Results of mean concentration of Cd in the organs of *S.melanotheron* are shown in figure 2.

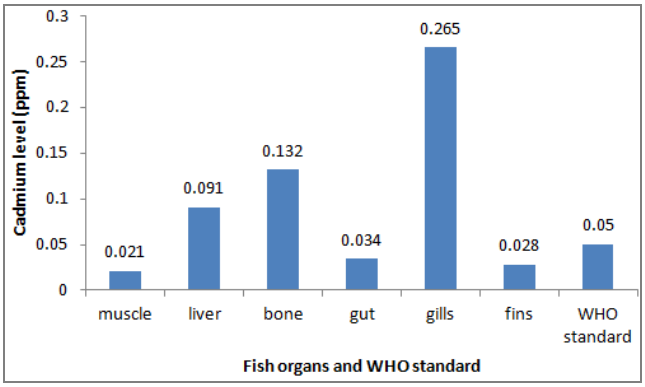

Figure 3. *Mean Cd in the organs of S.melanotheron and WHO standard*

The range of Cd in the organs of *S.melanotheron* was 0.000-0.302ppm, while the mean concentration was highest in the gills (0.265ppm) and lowest in the muscle (0.021ppm).The high mean concentration in the gills is due to its role as an exchange organ and interface with the water (Moses, 1992).Mean Cd concentration in the muscle, gut and fins were below WHO limit standard of 0.05ppm (WHO, 2008), while the liver and gills exceeded it. Results of mean concentration of Pb in the organs of *S.melanotheron* is shown in figure 3.

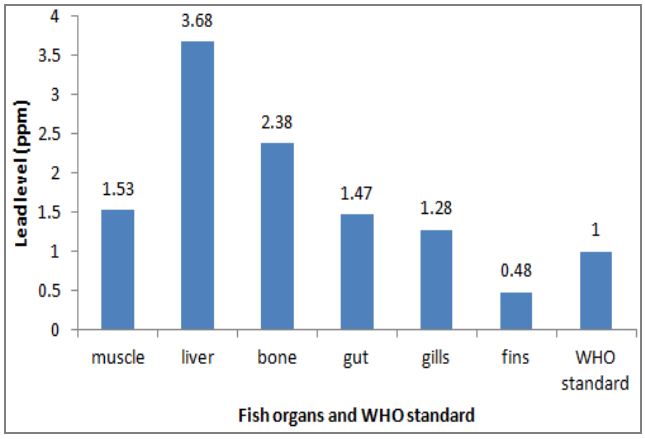

Figure 4. *Mean Pb in the organs of S.melanotheron and WHO standard*

The range of the concentration of Pb in the organs of *S.melanotheron* was 0.00-4.03ppm, while the high mean concentration was in the liver (3.68ppm) and the lowest was in the fins (0.48ppm).Apart from the fins (0.48ppm), all the other organs exceeded the WHO recommended limit standard of 1.00ppm (WHO/FAO (1989).The high Pb level in the organs of *S.melanotheron* is due to bioavailability of the trace metal in the aquatic ecosystem from leaded gasoline, 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 trace metals As, Cd and Pb in *S.melanotheron* from Alaro stream in Ibadan exceeded the World Health Organization (WHO) standard set for them in most of the organs data samples. This means that Alaro stream is polluted and fish such as *S.melanotheron* caught from the stream is unfit for human consumption due to the public health consequences.

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

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

[6] 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

[7] 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

[8] 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

[9] 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

[10] 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