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Assessment of Heavy Metals (Ni, V, Se, Cu) in the Fish Species *Channa obscura* and *Lates niloticus* from Alaro Stream in Ibadan, Nigeria

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Abstract

A study was carried out on the assessment of heavy metals (Ni, V, Se, Cu) in fish species *Channa obscura* and *Lates niloticus* in Alaro Stream in Ibadan. The objective of the study was to appraise the heavy metal concentration in the organs of the two studied fish species and to compare it with safety standards of the World Health Organization (WHO). Pulverized organs of the fish were acid-digested for heavy metal analyses using Inductively Coupled Plasma Mass Spectrometer (ICP-MS). The mean concentration of Ni, Se and V in the fish species exceeded the WHO permissible limit guideline standard of 0.07, 0.04 and 0.02ppm respectively. In *C. obscura*, the highest mean Ni was 1.24ppm (gut), while the least was in the intestine (0.11ppm) in the order: intestine<muscle<gills<bone <fins <gut. The mean V in the two fish species was highest in the fins (6.50ppm) of *L.niloticus* while the least was 0.13ppm (muscle) of *C.obscura*. The highest mean Se concentration is the organs and tissues of the two fish species was in the intestine (11.80ppm) of *L.niloticus* while the least was in the gills (0.12ppm) of *C.obscura*. In *C.obscura,* mean Cu concentration was in the order: gills<gut<bone<liver< intestine<fins while in *L. niloticus*, it was liver<gills<bone<muscle<fins <gut<intestine. This study therefore shows that >75% of the mean heavy metal concentration in the organs and tissues of *C.obscura* and *L. niloticus* were above the World Health Organization's recommended safe limit and therefore not fit for human consumption.

1. Introduction

Aquatic pollution has arisen as a result of increasing urbanization and industrialization, and the relative laxity in enforcing environmental regulations in developing countries [3-4];. In addition, the occurrence of metals in the environment through processes such as weathering and volcanism [12] and the high affinitive absorption capacity of fin fish for trace metals [21, 10] can significantly increase the metal burden in aquatic ecosystems [2, 9]). Heavy metal contamination has been known to impact negatively on aquatic organisms [16]. Heavy metal concentrations in the organs and tissues of aquatic organism depicts the past as well as the current pollution load in the environment in which they live [18]. Heavy metals can be incorporated into food chains and transferred from one trophic level to the next through feeding to a concentration that might affect their physiological state [1, 8]. Of the highly toxic pollutants are the heavy metals which have drastic environmental health impacts on all organisms [19]. The concentration of heavy metals becomes toxic to the fish and higher consumers like man when its level exceeds the permissible level [11]. This threshold limit does not only varies from one heavy metal to another but also from one species to another [11]. The toxic effects of heavy metals become more conspicuous when various metabolic activities within the organism's internal environment fail to detoxify the pollutants [14]. Heavy metals exhibit different accumulation pattern in the organs and tissues of fish. The various exposure pathways of heavy metal accumulation in fish include ingestion of food, suspended particulate matter, sediments, metal ion exchange through gills and skin [14].

In this study, the appraisal of heavy metals (Nickel, Ni; Vanadium, V; Selenium, Se and Copper, Cu) in fish species *Channa obscura* and *Lates niloticus* in Alaro Stream in Ibadan, Nigeria will be assessed to elucidate the public health status in consuming them locally and internationally. The aim of the study is to assess the heavy metal concentration in the organs and tissues of *Channa obscura* and *Lates niloticus,* and to compare it with World Health Organization's (WHO) permissible limit guideline standards for human health and sustainable utilization of fishery resources.

2. Materials and Methods

2.1. Study Area

The Alaro Stream in Ibadan which forms part of the hydroecological system of the Oluyole Industrial Estate receives effluents from diverse sources of heavy metal pollution. It flows into Oluyole Area in a west, south east direction from its source at Agaloke near Apata in Ibadan. Oluyole Industrial Estate is geographically located between latitude 7° 21'N -7° 22'N and longitude 3° 50'-3° 52'E. Alaro Stream joins River Ona at the south east tip of a meat processing factory fence as its main tributary. The stream receives effluents from diverse industries, domestic and agricultural sources. Effluents from natural as well as anthropogenic sources are discharged into Alaro stream directly or indirectly through run-off, leachate or as seepage especially during the rainy season or as windblown materials during the dry season.

2.2. Sampling Strategy and Processing

A total of sixty-one (61) fish comprising of *Channa obscura* (27) and *Lates niloticus* (34) were collected from Alaro Stream downstream of the industrial effluent outfall. Fish were collected using cast nets with mesh sizes ranging between 30-50mm with varying dimensions. The nets were cast and left for about three minutes before retrieving with a drawing string to check for any caught fish. Gill nets with mesh sizes of 30-50mm and varying dimension were tied to stakes with a lead weight on the stream bed and maintained vertically in water with the aid of floats overnight to allow fish attempting to swim through it to get caught.

Collected fish were identified while dissections were carried out using dissecting set to remove the gut (intestine), gills, fins, liver, bones and muscle. These organs and tissues were oven dried at 105°C for 6hours. Each organ or pooled organs were then pulverized separately by means of a porcelain mortar and pestle. The pulverized powdered samples were kept in Ziploc bags and sealed prior to analyses.

2.3. Acid Digestion of Fish Organs for Heavy Metal Analyses

Organ and tissue digestion was carried out by adding 2mL trace metal grade HNO_3 to 0.5g of each sample in Teflon digestion tubes which was heated at 105 ^{0}C for 1 hour in a heat block placed in a gas chamber. The resultant clear solution was then allowed to cool down, followed by addition of 1mL H_2O_2. After the simmering, it was boiled and left overnight to cool. The digested sample was diluted to the 10mL mark using MilliQ water. This was later transferred into test tubes rinsed with deionized water for Inductively Coupled Plasma Mass Spectrometer (ICP-MS) analyses.

The Standard Reference Materials (SRM) used was bovine liver obtained from the National Institute of Standards and Technology (NIST-1577) to assess heavy metal recovery by the ICP-MS and reproducibility. 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 to ions that are separated according to their mass/charge ratios by a quadrupole mass analyzer (MS). The inductively coupled plasma-mass spectrometry (ICP-MS) is a preferable facility for the analyses because it is precise, rapid, accurate, and extremely sensitive multimetal analyzer of biological sample materials.

3. Results and Discussion

Heavy metals in the Organs and Tissues of Fish

The mean Ni in the two fish species was highest in the fins (2.73ppm) and lowest in the bones (0.1ppm) of *L. niloticus* in the order; bone<intestine<muscle<liver<gills<gut<fins. In *C. obscura*, the highest mean Ni was 1.24ppm (gut), while the least was in the intestine (0.11ppm) in the order: intestine<muscle<gills<bone <fins <gut. All the mean Ni concentration in the organs and tissues of the two fish species were above the World Health Organization (WHO) permissible guideline limit standard of 0.07ppm [20].

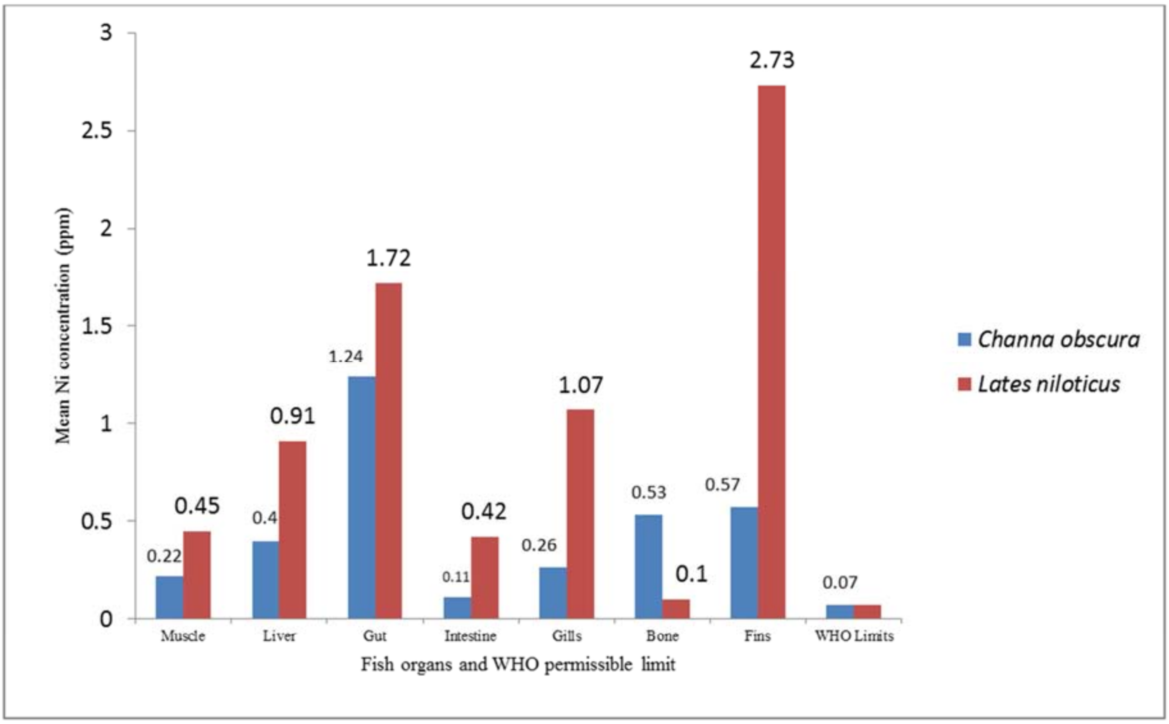

Figure 1. *Mean Ni concentration (ppm) in the organs and tissues of fish.*

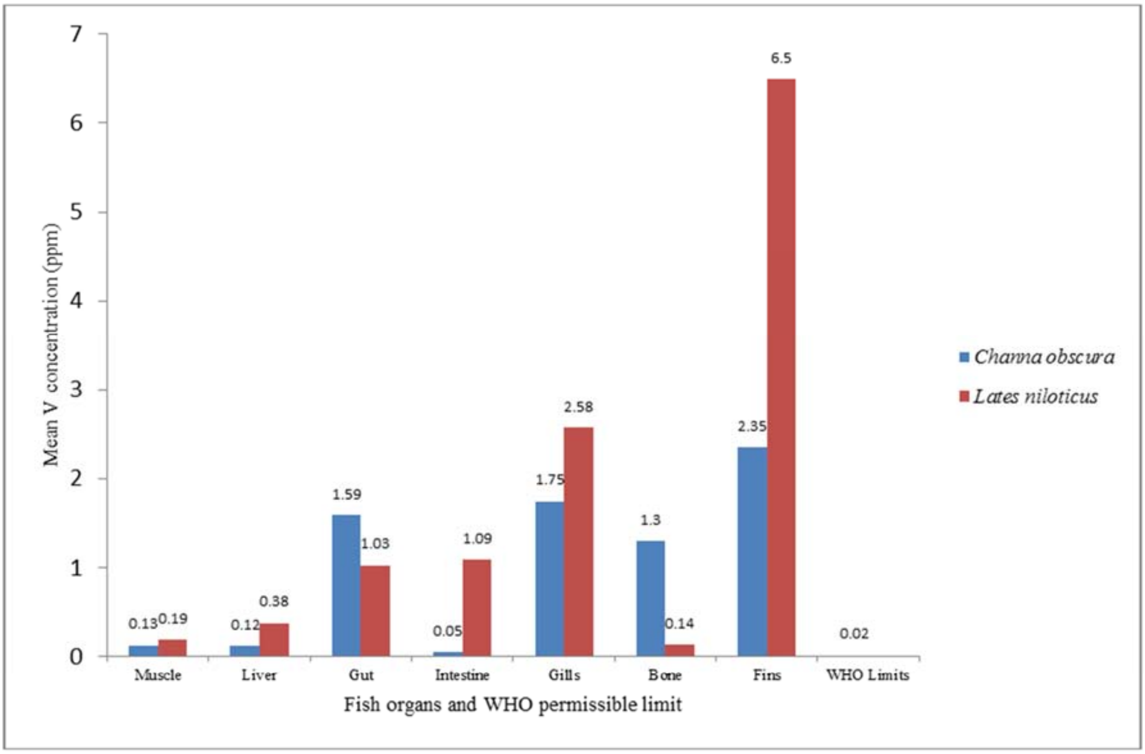

Figure 2. *Mean V concentration (ppm) in the organs and tissues of fish.*

The mean V in the two fish species was highest in the fins (6.50ppm) of *L.niloticus* while the least was 0.13ppm (muscle) of *C.obscura*. The highest value in *C. obscura* was in the fins (2.35ppm) while the least was 0.05ppm (intestine) in the order: intestine<liver<muscle<bone<gut<fins. The least mean V concentration in the organs of *L. niloticus* was recorded in the bone (0.14ppm) while the highest was in the fins (6.50ppm) in the order: bones<muscle<liver<gut<intestine<fins. All the mean V in the organs and tissues of the two fish species were above the WHO permissible limit guideline standard of 0.02ppm.

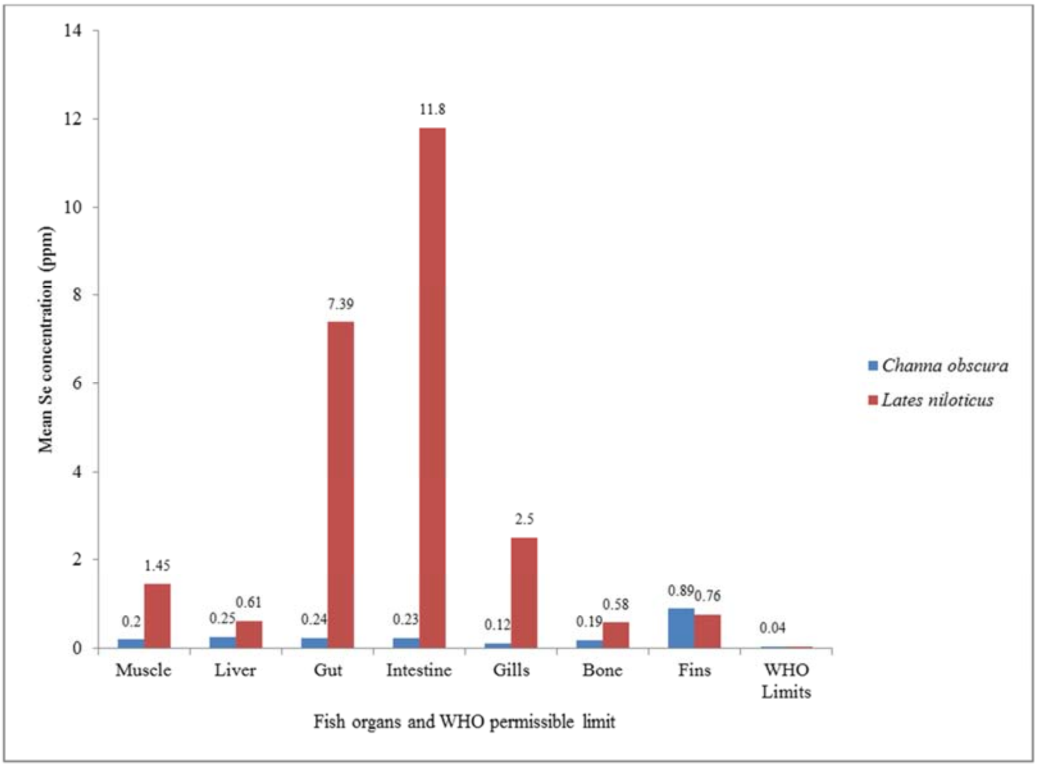

Figure 3. *Mean Se concentration (ppm) in the organs and tissues of fish.*

The highest mean Se concentration is the organs and tissues of the two fish species was in the intestine (11.80ppm) of *L.niloticus* while the least was in the gills (0.12ppm) of *C.obscura.* The highest mean value in *C.obscura* was recorded in the fins (0.89ppm) while the least was in the gills (0.12ppm) in the order: gills<muscle<intestine<gut<liver<fins. The least mean Se concentration in *L.niloticus* was in the bones (0.58ppm) while the highest was in the intestine (11.80ppm) in the order: bones<liver<fin<muscle<gut<intestine. All the organs and tissues of the two fish species studied had mean Se concentration above the WHO recommended permissible limit guideline standard of 0.04ppm [20].

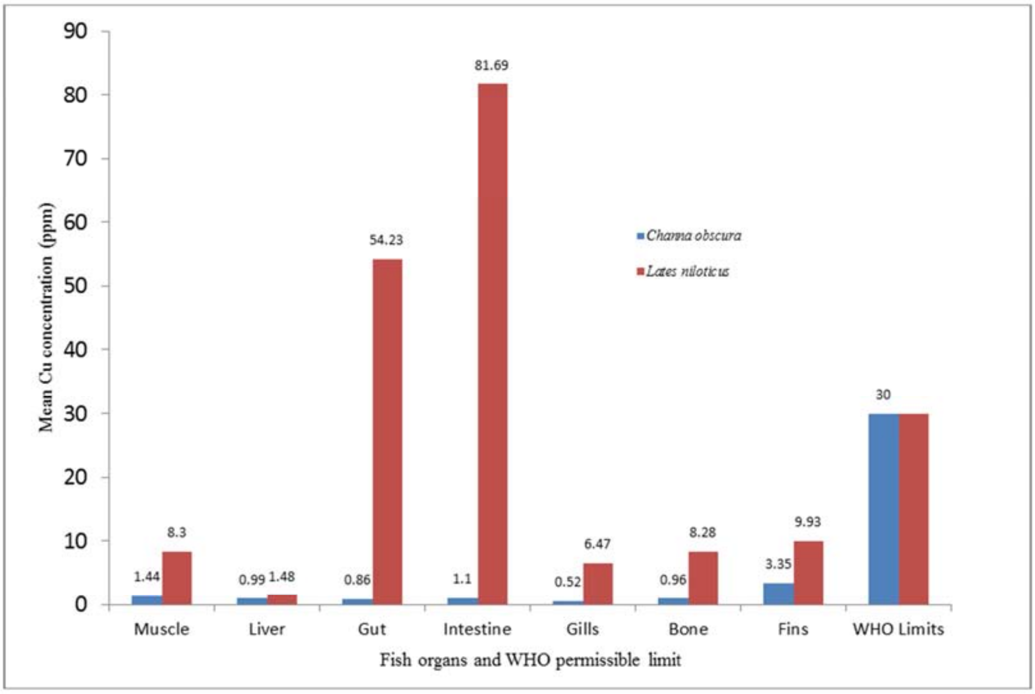

Figure 4. *Mean Cu concentration (ppm) in the organs and tissues of fish.*

With the exception of the gut (54.23ppm) and intestine (81.69ppm) of *L. niloticus*, all the other organs had mean Cu concentration below the World Health Organization (WHO) limit of 30ppm. In *C.obscura,* mean Cu concentration was in the order: gills<gut<bone<liver<intestine<fins while in *L. niloticus*, it was liver<gills<bone<muscle<fins<gut<intestine.

The high mean concentration of Ni, V and Se which exceeded the World Health Organization's (WHO) permissible limit guideline standards shows that the fish is not fit for human consumption. However the muscles (flesh) of both fish are safe to consume when Cu is the heavy metal under consideration. It is important to note that all the heavy metals Ni, V, Se and Cu all have well known cellular physiological functions, their continued consumption in excess of the limit guideline would pose potential health threats to humans who are on top of the food chain [15, 5, 7]. The high mean heavy metal concentration is the organs and fish of *C. obscura* and *L. niloticus* in the study supports earlier findings by Ikem *et al* [6] that found elevated trace elements in water, fish and sediment from Tuskegee Lake, Southeastern USA; studies by Raja *et al* [17] on heavy metals concentration in four commercially valuable marine edible fish species from Parangipettai Coast, South East Coast of India and Nayaka *et al* [13] assertion on impact of heavy metals on water, fish (*Cyprinus carpio*) in Tumkur, India. This study therefore shows that >75% of the mean heavy metal concentration in the organs and tissues of *C.obscura* and *L. niloticus* were above the World Health Organization's recommended safe limit and therefore not fit for human consumption.

4. Conclusion

This study shows that >75% of the mean heavy metal concentration in the organs and tissues of *C.obscura* and *L. niloticus* were above the World Health Organization's recommended safe limit and therefore not fit for human consumption from this ecosystem.

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