



Analysis of Heavy Metals Presence in Three Fish Species from Swali Market, Yenagoa, Bayelsa State

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Abstract: Heavy metal concentrations were assessed in three fish species: *Citharinus citharus* (Moon fish), *Chrysichthys nigrodigitatus* (Silver catfish), and *Synodontis schall* (Nile squeaker/Mandi), purchased from Swali Market in Yenagoa in August 2024. The samples were examined using Atomic Absorption Spectrophotometry (AAS). Zinc (0.923 µg/ml) and lead (0.027 µg/ml) were the most concentrated in *C. citharus*, while cadmium (Cd), chromium (Cr), arsenic (As), and nickel (Ni) were insignificant ($p > 0.05$). Zinc (3.503 µg/ml) and lead (0.010 µg/ml) were the most abundant elements in *C. nigrodigitatus*, with no measurable levels of Cd, Cr, As, or Ni. Zinc concentration in *S. schall* was highest at 4.225 µg/ml, while Pb and other elements were undetectable. Overall, Cd, Cr, As, and Ni levels were below the World Health Organisation (WHO) permissible limits. However, the presence of lead, a highly hazardous metal even at low levels, causes concern. These findings underline the importance of regular monitoring of fish sold at Swali Market in order to protect public health from hazardous metal exposure through diet.

Keywords: Heavy metals, Fish safety, *Citharinus citharus*, *Chrysichthys nigrodigitatus*, and *Synodontis schall*

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Introduction

Environmental pollution has become a universal problem, and important pollutants are the heavy metals in the aquatic network because of their toxicity, accumulation and bio-magnification. Industrial and anthropogenic activities are the source of natural aquatic systems contamination of heavy metals. Heavy metals, being non-biodegradable, can be concentrated along the food chain, producing their toxic effects at points far away from the source of pollution. The heavy metals of concern are mainly Pb, Hg, Cd, Cr, Cu, Zn, manganese (Mn), nickel (Ni), silver (Ag), etc. The consumption of fish has increased concurrently with the growing concern about their nutritional and therapeutic benefits to humans around the world. In addition to its important source of protein, fish typically have rich contents of essential minerals, vitamins and unsaturated fatty acids (Rajeshkumar & Li, 2018, Chen *et al.*, 2022, Onu, 2024).

Available literature has shown bioaccumulation of heavy metal pollutants from the water in various tissues of aquatic organisms (Has-Schön *et al.*, 2006, Monroy *et al.*, 2014). Various species of fish can be bioindicators of contamination with heavy metals and other pollutants (Dural *et al.*, 2007). Feeding habits have a great influence on pollutant accumulation, especially regarding heavy metals in different fish species (Amundsen *et al.*, 1997, Merciai *et al.*, 2014, Lipy *et al.*, 2024). Additionally, in different fish species, heavy

metals can be deposited in various amounts in their tissues. There are five potential routes for a pollutant to enter fish: via food, non-food particles, gills, oral consumption of water, and the skin (Săvescu *et al.*, 2023). Distribution of these pollutants depends on fish tissue affinity to metals, degree of uptake and accumulation, as well as the ability to be excreted from the organisms. The major problem of concern with heavy metals is their long biological half-life in living organisms (Zrnčić *et al.*, 2013, Afrin *et al.*, 2015, Mitra *et al.*, 2022). Gills, liver and kidneys of fish accumulate heavy metals at higher concentrations, while muscles of fish contain lower quantities of heavy metals. Since it is known that fish present protein-based food all around the world. However, the toxic effects of heavy metal presence in their body can result in hazardous effects on human health (Abdel-Khalek, 2015, Rajeshkumar & Li, 2018). Non-essential heavy metals such as Cadmium (Cd), Mercury (Hg), and Lead (Pb) have no known essential role in living organisms; exhibit extreme toxicity even at very low(metal) exposure levels and have been regarded as the main threats to all forms of life, especially human health (Ahmed *et al.*, 2012, Atobatele & Olutona, 2015, Ben-Eledo, 2017).

The study area is an important source of supply to Bayelsa State. The primary goal of this study is to determine the presence of heavy metals, including Cr, Cd, Cu, As and Pb in the fish species of *Citharinus citharus* (Moon Fish), *Chrysichthys*

nigrodigitatus (Silver catfish) and *Synodontis schall* (Nile Squeaker/Mandi). As a research object, this could help us understand the enrichment behaviour of heavy metals in the fish being sold in the Swali Market in Yenagoa LGA.

Materials and Methods

Sampling Location/Study: Swali market is the main market in Bayelsa State. The market is situated in Yenagoa, the capital of Bayelsa State. Yenagoa became the state Capital when Bayelsa state was created in 1996. Yenagoa is geographically located between latitude 4° 47' 15" and 5°11' 55" North and longitude. 6°07'35" and 6°24'00" Eastings (Sridhar *et al.*, 2011, Ndiwari, 2013). The LGA has an area of 706 km². Yenagoa Local Government Area is bounded by Mbiama communities of Rivers State on the north and east, Kolokuma/Opokuma LGA on the north west, Ogbia LGA on the south east and Southern Ijaw on the South West (Sridhar *et al.*, 2011, Ndiwari, 2013). Yenagoa Local Government Area is located on the banks of Ekole Creek, being one of the major river courses making up the Niger Delta's rivers (Koinyan, 2013). The climate of Yenagoa LGA is an equatorial type of climate (Iyorakpo, 2015). Rainfall occurs generally almost every month of the year. The mean monthly temperature is 25 °C to 31°C. The hottest months are December to April. Relative humidity is high throughout the year and decreases slightly during the dry season.

Sample collection: The three live fish samples were randomly purchased at Swali Market in Yenagoa Local Government Area and were immediately transported to the laboratory for analysis.

Preparation of Fish Samples: Before the analysis of the heavy metals' concentration, the fish were properly rinsed in distilled water to remove dirt and debris from the skin and gills.

Digestion of Fish Samples: 10g of each fish was weighed and dried in the hot air oven at 105 °C. The weight of the fish parts was periodically measured at 2-hour intervals until a constant

weight (dry weight) was achieved. The dried samples were ground using a clean mortar and pestle. After grinding, they were put into a furnace to be further dried at a temperature of 5500°C to remove further moisture. This was done for 4 hours. Thereafter, the samples were digested. The samples were digested with a mixture of HNO₃, HClO₃ and H₂SO₄. These chemicals were mixed in a ratio of 10:4:1. The samples were placed in a tri-acid mixture were heated on a hot plate at 1000 °C until the medium became clear. Thereafter, the samples were filtered with Whatman filter paper and were diluted to 25ml with distilled water. The heavy metals Lead (Pb), Cadmium (Cd), Chromium (Cr), Zinc (Zn), Nickel (Ni) and Arsenic (As) concentrations in the samples were evaluated using Varian Spectra A100 Atomic Absorption Spectroscopy (AAS) using a prepared standard solution.

Sample A *Citharinus citharus* (Moon Fish): *Citharinus citharus* (Moon Fish) is of the family *Citharinidae*. The fish is found in African countries such as Gambia, Senegal, Niger, Volta, Ouémé and Chad basins, the Niger Delta, and Bayelsa State. It is a freshwater-based fish. Distinguishing features and morphology of the fish are: Dorsal soft rays (total): 17-21; Anal soft rays: 26 - 31. Diagnosis: body depth 1.8-2.7x and head length 3.0-4.1x SL; caudal peduncle 0.7-1.4x long than deep; short snout, slightly prominent; snout 0.7-1.6x eye diameter; eye diameter 3.7-6.1x head length; adipose-fin base shorter than distance separating it from rayed dorsal fin (ratio adipose base/distance to rayed dorsal is 0.5-0.8); pectoral fins 0.5-1.1x head length; cycloid scales; scale formula 22.5-25.5/77-92/22.5-25.5; 77-92 scales in longitudinal line; 17.5-20.5 scales between lateral line and pelvic fin; 17-21 dorsal fin branched rays; 26-30 anal fin branched rays (Gosse & Paugy, 2003). It reproduces ovoiparously. The fish is Detritus, Omnivorous. It has high commercial value and can be used in the aquarium.



Figure 1. *Citharinus citharus* (Moon Fish)

Sample B Silver Catfish, (*Chrysichthys nigrodigitatus*): The silver catfish, *C. nigrodigitatus* (Lacepède, 1803), is among the dominant African commercial fishes of high economic value and widely serves as food for human consumption in West Africa (Leveque, 1997). *Chrysichthys nigrodigitatus* is a prominent member of the *claroteids*. This catfish belongs to the genus *Chrysichthys*, family *Claroteidae*, *Siluriformes* order and *Ostariophysi* superorder. Synonyms are *Pimelodus nigrodigitatus*, *Arius acutivelus*, *Chrysichthys furcatus*, *Chrysichthys buettikoferi* and *Chrysichthys cameronensis* (Leveque, 1997). In the tropical estuary of Nigeria, the species forages on a variety of benthic food resources. The species also inhabits saltwater areas in Nigeria. In Bayelsa State, *C. nigrodigitatus* is one of the most common fish caught by fishermen, sold and consumed by the inhabitants of the State.



Figure 2. *Chrysichthys nigrodigitatus*, (Silver catfish)

Sample C *Synodontis schall* (Nile Squeaker or Mandi): *S. schall* (Bloch & Schneider, 1801) (Nile Fish). While Cd, Cr, As and Ni have negative values.

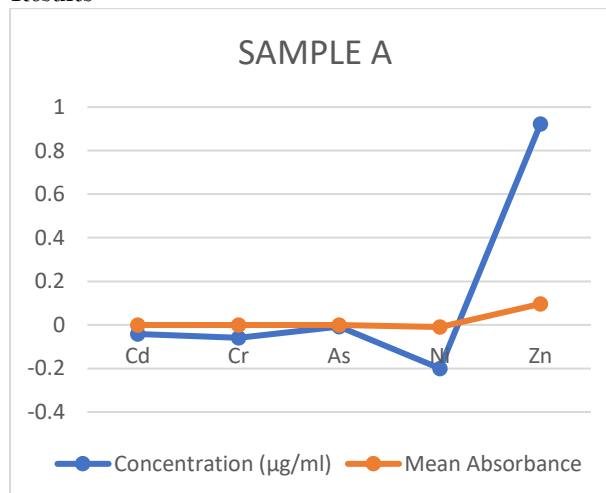


Figure 4. Graph showing the concentration of heavy metals in *Citharinus citherus* (Moon Fish)

In Figure 4, the results show that the concentration of Zn (0.923 µg/ml) and Pb (0.027µg/ml) were the highest in *C. citherus* (Moon

Squeaker or Mandi) is of the family *Mochokidae*. This species is patchily distributed from Senegal to Ethiopia, and along the entire length of the Nile and other parts of North Africa. In West Africa, this species is known from basins of the Chad, Niger, Benue, Senegal, Gambia and Volta, Niger Delta and Bayelsa State (Orose *et al.*, 2021). The species is a bottom feeder; it feeds on chironomid larvae, plant remains, mud, insect larvae, molluscs and detritus. In Bayelsa State, it is found in both fresh and saltwater areas.



Figure 3. *Synodontis schall* (Nile Squeaker or Mandi)

Statistical Analyses

Data were given as mean ± SD for each of the measured variables. All statistical analyses were performed using SPSS version 21.0. The one-sample Kolmogorov–Smirnov (K–S) test was used to assess the data normality. All the concentration values for the five heavy metals in the tissues of fish species were normally distributed at the 95% confidence level. A one-way ANOVA test was used to assess significant differences in the fish tissues. The data are presented in graphical form.

Fish). While Cd, Cr, As and Ni have negative values.

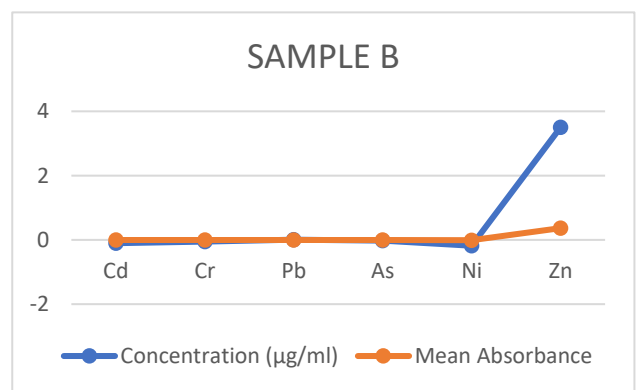


Figure 5. Graph showing the concentration of heavy metals in *Chrysichthys nigrodigitatus* (Silver catfish)

In Figure 5, the results show that the concentration of Zn (3.503 µg/ml) and Pb (0.010 µg/ml) were the highest in *Chrysichthys*

nigrodigitatus (Silver catfish). While Cd, Cr, As and Ni have negative values

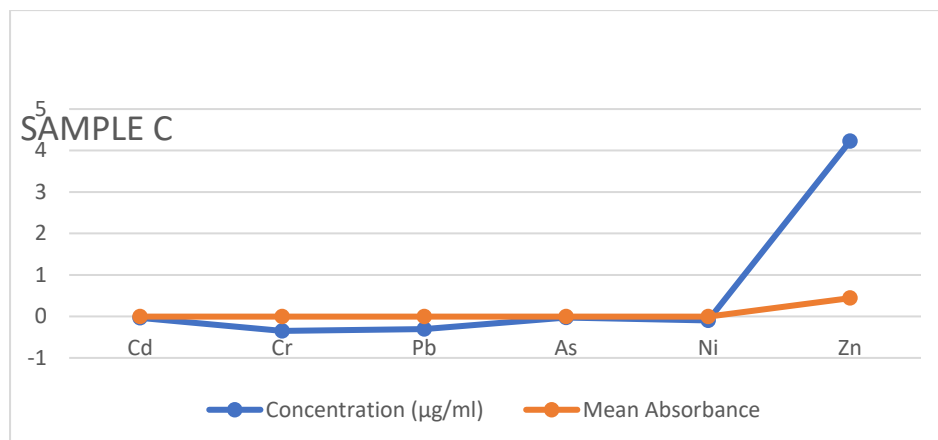


Figure 6. Graph showing the concentration of heavy metals in *Synodontis clarias*

In Figure 6, the result shows that the concentration of Zn (4.225 µg/ml) is the highest in the *Synodontis schall*. While Cd, Cr, As, Ni, Pb and Zn have negative values.

Discussion

The results show that the concentration of Zn (0.923 µg/ml) and Pb (0.027 µg/ml) were the highest in *Citharinus citharus*. While Cd, Cr, As and Ni have negative values. In Figure 2, the result indicates that the concentration of Zn (3.503 µg/ml) and Pb (0.010 µg/ml) were the highest in *C. nigrodigitatus*. Cd, Cr, As and Ni have negative values. In Figure 3, the concentration of Zn (4.225 µg/ml) was found to be the highest in the *S. schall*. Whereas Cd, Cr, As, Ni and Pb are negative. The concentrations of Cd, Cr, As, and Ni are negative in the three fish tissues. The accumulation of Cd, Cr, As and Ni in fish tissues is shown in several studies (Has-Schön *et al.*, 2006, Jarić *et al.*, 2011, Castro-Gonzalez & Mendez-Armenta, 2008). Pb is known to cause serious health effects, including toxicity to haematopoietic, renal, nervous and skeletal systems. Even low-level exposure to Pb present in air, water, and food plays an important role in causing toxicity (Castro-Gonzalez & Mendez-Armenta, 2008, Wani *et al.*, 2021, Tešić *et al.*, 2014, Afshan *et al.*, 2014). The level of concentration of Cd, Cr, As, and Ni in the fish analysed was found to be below the WHO permissible limit. The heavy metal concentrations were variously distributed in the fish tissues. The Pb content in the three fish species was the highest heavy metal observed in this study. However, the values were lower than the WHO required concentration in fish. The three fish species, *C. nigrodigitatus*, *C. citharus* and *S. schall* are known to feed on plankton and algae, and it could be one

of the reasons for their higher lead bioaccumulation. The variation in the accumulation of heavy metals in different fish species is attributed to several feeding habits. Considering the results, it is necessary to monitor the presence of heavy metals in the fish sold in the Swali market, ensuring that the fish are within the permissible limits of heavy metal pollutants and are safe for human consumption now and in the future.

Conclusion

The findings of this study reveal that heavy metal concentrations in the fish species purchased from Swali Market, Yenagoa, were within internationally allowed limits, suggesting that their ingestion may not pose acute health hazards. However, fish continues to be a vital source of protein for the diet, and because of the possibility of bioaccumulation, even trace amounts of non-essential substances should be taken seriously. According to earlier studies, fish exposed to contaminated waters can build up dangerous amounts of heavy metals, making them unfit for human consumption (Obasohan *et al.*, 2006, Briffa & Blundell, 2020). Therefore, it is advised to conduct continuous biomonitoring of fish and their aquatic habitats in order to identify any early indications of pollution. Maintaining the existing low level of contamination is essential to protecting aquatic biodiversity and preventing future threats to human health. Aquatic biota from where these fish are obtained to avoid pollution in the near future to avert deleterious effects to humans.

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