

Experimental Investigation of Some Heavy Metals in the Muscle Tissue of Cultured African Catfish (*Clarias gariepinus*)

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ABSTRACT

Oftentimes, the environmental scientist believes that heavy metal contamination of aquatic ecosystem is related only to fishes in aquatic environment. The present study was therefore undertaken to investigate the bioaccumulation of Manganese (Mn), Cobalt (Co), Mercury (Hg), Arsenic (As), Chromium (Cr) and Nickel (Ni) in the muscle tissue of Cultured African Catfish (*Clarias gariepinus*). A total of two (2) fish were used (male and female) weighing 390g and 310g. They were sacrificed and all the internal organs were removed and was oven dried at initial temperature of 105^oc and later adjust to 65^oc until a constant weight was obtained. The samples were ground and were digested with tri acid mixture (HNO₃: HCL: H₂SO₄). Digestion continued until the liquor become clear. The samples were analyzed using Dez Elmer Analyst 300 Atomic Spectroscopy (AAS). The result showed that Mn recorded 896.94±0.577mg/l; Co 78.10±0.577mg/l; and Ni, 78.725±0.578mg/l in feed 1 and Mn recorded 506.823±1.155mg/l; Co 32.499±0.577mg/l; Hg, 0.001±0.00001mg/l; As, 0.006±0.0000mg/l; Cr, 122.794±0.577mg/l. and Ni 56.180±0.578mg/l in feed 2. The result of the muscle tissue of male and female *C.gariepinus* shows the present of heavy metals at different concentration and the highest concentration was observed in female recorded Ni (44.200±0.5774mg/l) and the lowest observed in male recorded in Cr (-0.007±0.0001mg/l). There was a significant difference ($P>0.05$) among male and female *C.gariepinus*. This study has proved the availability of Mn, Co, Hg, As, Cr and Ni in the muscle tissue of *C.gariepinus* and also in the water and feeds used in culture the fish. This metal concentration observed in muscle tissue, feeds and water was beyond the maximum permissible limit by WHO/FAO and NOAA for human consumption contrary to most view that bioaccumulation of heavy metals is related to environmentally polluted water. Based on these findings, it is recommended that proper quality control analysis should be carried out in the cultured fish to determine its safety.

Keywords: Aquatic ecosystem, Bioaccumulation, Heavy Metals, African Catfish.

INTRODUCTION

Fish are widely consumed in many parts of the world by humans and polluted fish may endanger human health (Sen *et al.*, 2011). Metals are non-biodegradable and consider as major environmental pollutants causing cytotoxic, mutagenic and carcinogenic effects in animals (Staniskiene *et al.*, 2006). It is important to examine the toxic effects of metals on fish since they constitute an important link in food chain and their contamination by metal causes imbalances in aquatic system (Das *et al.*, 2017) now in commercial pond via the feed.

The presence of higher amount of heavy metals in any part of the body will induce changes in biochemical metabolisms, serum biochemical changes, histopathological changes and other induced stresses (Halla *et al.*, 2021).

Metal bioaccumulation is influenced by multiple routes of exposure (diet and solution) and geochemical effects on bioavailability (Bawuro *et al.*, 2018). As metals are not metabolized, bioaccumulation of metals and metalloids is of particular value as an exposure indicator.

Okwuosa, (2011) have shown that the cultured fishes are most patronised (most consumed) due to their availability and price friendliness. It is important to examine the toxic effects of metals on fish since they constitute an important link in food chain and their contamination by metal causes imbalances in aquatic system (Duruibe, *et al.*,2007) now in commercial pond via the feed. Catfish have become the most consumed fish food by man, adequate measures should be taken to avoid accumulating excess heavy metals such Manganese (Mn), Cobalt (Co), Mercury (Hg), Asernic (As), Chronium (Cr) and Nickel (Ni) in the muscle tissue of catfish which is the part of the fish mostly consumed.

MATERIALS AND METHODS

Three hundred (300) fingerlings of a month old were purchased and used for this study. They were evenly distributed in 16 aquaria of 10 liters for easy monitoring. They were sacrificed and oven dried initially at a temperature of 110^oc then 65^oc until a constant weight was obtained. The sample were grinded and 0.5g of each were collected and were digest with tri-acid mixture (HNO₃: HClO₄: H₂SO₄: 10: 4:1). Digestion was continued until the liquor becomes clear. The samples were analyzed using Atomic Absorption Spectrophotometer. The results were express in mg/l. Metal per dry weight (AAS). The heavy metal contaminations in the dried samples were estimated after acid digestion, following the standard method of APHA (2017).

STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was used to test for significance different in the levels of heavy metal in the different groups of fishes.

RESULT AND ANALYSIS

The result of Muscle tissue analyzed shows the availability of the studied heavy metals and its bioaccumulation over a period of three months that the investigation lasted according to standard method of APHA (2017). The result showed that Mn recorded 896.94±0.577mg/l; Co 78.10±0.577mg/l and Ni, 78.725±0.578mg/l in feed I and Mn recorded 506.823±1.155mg/l; Co 32.499±0.577mg/l; Hg, 0.001±0.00001mg/l; As, 0.006±0.0000mg/l; Cr, 122.794±0.577mg/l. and Ni 56.180±0.578mg/l in feed II as demonstrated in Figure 2. The result of the muscle tissue of male and female *C.garipepinus* shows the present of heavy metals at different concentration and the highest concentration was observed in female which recorded 44.200±0.5774mg/l of Ni and the lowest observed in male that recorded -0.007±0.0001mg/l Cr as demonstrated in Figure 3.

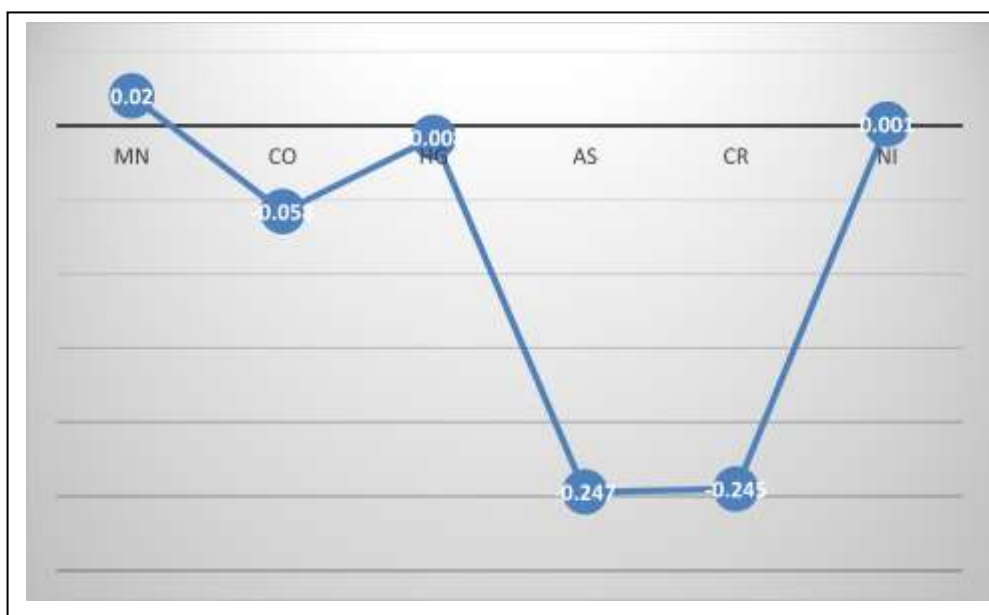


Figure 1: Line graph showing Concentration of Heavy Metals in Used Water

Water = Mn>Ni>Hg>Co>As>Cr

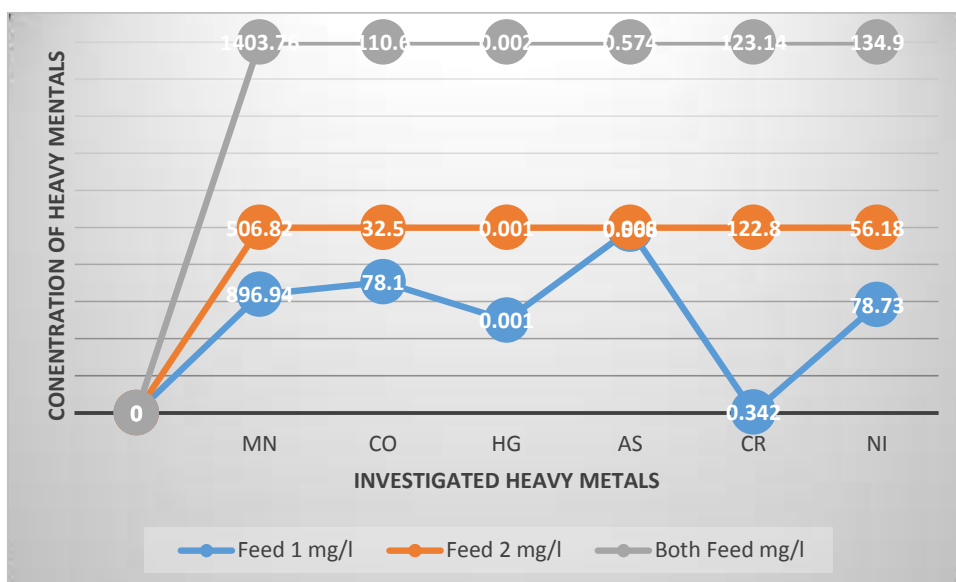


Figure 2: Line Graph showing the Concentration of Heavy Metals in the feed used to Culture the Catfish

Feed I = Mn>Ni>Co>Cr> As>Hg

Feed II = Mn> Cr>Ni>Co>As>Hg

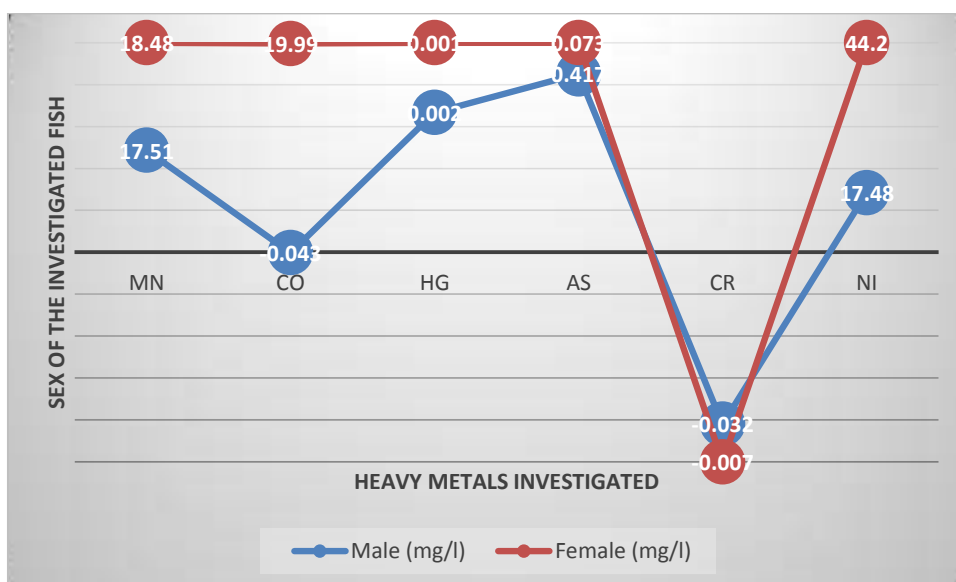


Figure 3: Line Graph showing the Concentration accumulated Heavy Metals in the Muscle Tissue of Cultured Catfish

Female = Ni>Co>Mn>As>Hg>Cr

Male= Mn>Ni>As>Co>Hg>Cr Ni

DISCUSSION

Fish have been considered good indicators for heavy metals contamination in aquatic systems. Fish are widely consumed in many parts of the world by humans and polluted fish may endanger human health (Zhang *et al.*, 2007). Heavy metal concentrations in fish muscle tissue can be surmised as one of the most considerable indicators for metal pollution levels in aquaculture. These metals are non-biodegradable and consider as major environmental pollutants causing cytotoxic, mutagenic and carcinogenic effects in animals (More *et al.*, 2003). In human, heavy metals

accumulation can cause blood and brain related diseases, and it can also affect the function of various body organs such as the liver and kidney.

There was a significant difference ($P>0.05$) among male and female *C.gariepinus*.

Heavy metals in water

According to Hidayati *et al.* (2020) maintaining an acceptable water quality is fundamental in aquaculture for maintaining the vitality and optimal growth of the cultured fish. The results of the heavy metals concentrations in the different water sources and fish ponds presented in Figure 1 were compared to USEPA permissible limits (USEPA 1988) for fish ponds water sources and found safe since they were all below the maximum.

Heavy metals in fed feed

The concentration of some of the investigated heavy metals in fed commercial feed were found beyond the recommended limit of NOAA (2009) hence not safe to feed the fish. In first feed, Mn was 896.94mg/l against the limit that is 400mg/l, Ni 78.73mg/l against 9.90 mg/l, while Co recorded 78.10 against 10.00mg/l. in the second feed, Mn was 506.86mg/l against 400mg/l limit, Cr 122.80mg/l against 7-13mg/l, Ni 56.18mg/l against 9.90mg/l while Co recorded 32.5mg/l against 10.00mg/l. this indicated that both commercial feed used were contaminated hence not safe for fish consumption that will translated to final fish consumers.

Heavy metals concentration in fish muscle tissue

The concentration of heavy metal in muscle tissue of *C. gariepinus* was found safe since they were not beyond the limit in both the female and male. However, Ni was found, beyond the limit in both while Co was in only female fishes. Co 19.99mg/l against 10.00mg/l Ni was 44.2mg/l against 9.90mg/l in female fish and 17.48mg/l against 9.90mg/l in male fish.

CONCLUSION AND RECOMMENDATION

This study has proved the availability of Mn, Co, Hg, As, Cr and Ni in the muscle tissue of *C.gariepinus* and also in the water and feeds used in the culturing of the fish. This metal concentration observed in muscle tissue, feeds and water was beyond the maximum permissible limit by FAO, FEPA and WHO for human consumption contrary to most view that bioaccumulation of heavy metals is related to environmentally polluted water. Based on these findings, it is recommended that proper quality control analysis should be carried out in the cultured fish to determine its safety before human consumption.

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