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Full Length Research Article

COMPARATIVE STUDY OF HEAVY METALS IN WILD CATFISH (CLARIAS GARIEPINUS) FROM JABI LAKE AND CULTURED CATFISH FROM GWAGWALADA FISH MARKET ABUJA

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ABSTRACT
Pollution of heavy metals affect aquatic environments due to rise in natural processes and anthropogenic activities. The aim of the study was to analyse heavy metals in wild catfish from Jabi Lake and cultured catfish (*Clarias gariepinus*) from Gwagwalada fish market in Abuja. The specific objectives were to compare the presence of heavy metals (Cr, Cu, Fe, Pb, and Cd) in wild and cultured *Clarias gariepinus.* A total of 80 *Clarias gariepinus* were used for the study. Forty (40) fish from each group were purchased from Jabi Lake and Gwagwalada fish market respectively. The fish samples were prepared and digested using nitric acid and Sulphuric acid in a ratio of 3:1 for about 1 hour using a hot plate. The digested solution was taken to the fully automated PC-controlled double-beam iCE 300 Atomic Absorption Spectrophotometer for analysis. The result showed the presence of the five heavy metals. The mean levels of lead (Pb) and Cd in the cultured fish were (2.929 ±0.707) and Cd (0.1867 ±0.508) respectively. The result of the lake wild cat fish showed Pb > Fe > Cr > Cd > Cu while that of the catfish cultured in Gwagwalada market showed Pb > Fe > Cr > Cd > Cu. The study's finding showed that wild catfish had greater concentrations of heavy metals than cultured fish.

Keywords: Heavy metals, wild cat fish, cultured cat fish

INTRODUCTION
As the population continues to rise, the issue of heavy metal pollution in estuary environments is becoming more sensitive and significant. Urbanization and industrialization have led to heavy metal pollution, which has grown to be a significant environmental issue. Heavy metals have a significant negative impact on human health in addition to the aquatic ecology (Ahmad, *et al.*, 2024). Nigerian industries play a significant role in the country's economic growth and improvement of living standards. Because most metals are hazardous to living things, heavy metal pollution of aquatic environments has become an issue on a global scale. Fish have the highest trophic level in the environment. Humans have been using fish as a source of nutrition for more than 40,000 years (Eric *et al.,* 2018). As natural processes and human activity increase, aquatic ecosystems are increasingly susceptible to heavy metal contamination. Heavy metals can be hazardous at certain concentrations even though they may be necessary or non-essential nutrients. Because they are not biodegradable, heavy metals can accumulate, linger, and ascend aquatic food chains, endangering fish and posing health concerns to humans (Abalaka *et al.,* 2020). Fish is a widely available food product that is valued for its animal protein content and other vital components that humans, particularly those in developing nations, need to maintain a healthy body. According to reports, the African catfish (*Clarias garipienus*) is a suitable aquaculture species in Nigeria and other African nations. According to reports, Nigeria and other African nations can successfully raise the African catfish (*Clarias garipienus*) as an aquaculture species (Afolabi *et al.,* 2020).Fish are mostly raised in the wild in most parts of the world. Fish output from the wild could no longer satisfy the demands of the expanding population due to environmental deterioration, overfishing, and pollution, which is causing fish supplies to be depleted at an accelerating rate as the world's population expands. As a result, stakeholders in aquaculture have become more involved (Inyang-etoh *et al.,* 2024). Demand and consumption of fish have increased as a result of population growth and growing awareness of the excellent nutritional value of fish (Wogu and orji-georgewill, 2024). Because of their importance, fish are captured and raised in both wild and aquaculture settings (Onyidoh *et al.,* 2018). According to Adeshina *et al.* (2016), the African catfish, or *Clarias gariepinus*, is a significant and profitable fish species in Nigeria. The largest producer of farmed *Clarias gariepinus* is Nigeria. The fish's location in the food chain makes it vulnerable to concentrations of heavy metals, which subsequently trickle down to consumers. According to Abubakar and Adeshına (2019), the buildup of metals in fish is contingent upon their consumption and excretion from the body. In addition to the discharge of treated and untreated liquid wastes into water bodies, a number of sources, including rock and soil that are directly exposed to surface water, can introduce heavy metals into lakes and rivers. Environmental contamination is a result of hazardous industrial byproducts. Organic and inorganic pollutants are released into the environment in both dissolved and insoluble forms as industrial pollutants. Industrial water is converted to waste and contaminates groundwater, which leads to health issues. Fish that contain toxic metals may not have the same positive effects. Humans exposed to heavy metals may have heart problems, liver damage, renal failure, or possibly pass away. Sex, age, size, reproductive cycle, swimming pattern, feeding habit, and geographic location are all factors that can affect metal intake (Baworo *et al.,* 2018).The buildup of metals in fish, which results in their toxicity, may be influenced by additional variables such oxygen content, water temperature, pH, hardness, salinity, alkalinity, and dissolved organic carbon. While some heavy metals are necessary for life, others can become harmful at specific concentrations (Nwabunike, 2016). Dead fish are a clear indicator of extremely polluted water, yet sublethal contamination may merely produce ill fish (Authman *et al.,* 2015).The purpose of this study was to examine the levels of heavy metals in cultured catfish from Gwagwalada fish market in Abuja and wild catfish from Jabi Lake. Heavy metals are released and eroded into water bodies as a result of human activities such deforestation, urbanization, fuel

emissions, agriculture, industry, and oil spills. Because of bio-magnification and the numerous negative health impacts they have on the general public, this is a major cause for concern. Thus, it's critical to keep an eye on or assess the buildup of heavy metals in catfish. The purpose of this study was to examine the levels of heavy metals in cultured catfish from Gwagwalada fish market in Abuja and wild catfish from Jabi Lake.

MATERIALS AND METHODS

The Study Area.

Jabi Lake is located in Abuja, Nigeria's Federal Capital Territory (FCT). The geographic coordinates of Jabi Lake are 7° 25' 27" East and 9° 3' 45" North, respectively. Jabi Lake is a destination for domestic and recreational activities, as well as tourists and fishermen. Jabi Lake is being serenaded by nature's ambience which provides an inexpensive way to have fun, picnics with families. Jabi Lake is in a very safe location surrounded with shopping malls and Jabi Lake Park. The location map is shown in Figure 1 below

Fig 1 Map showing the location of Jabi Lake (source: Apple map powered by tomtom)

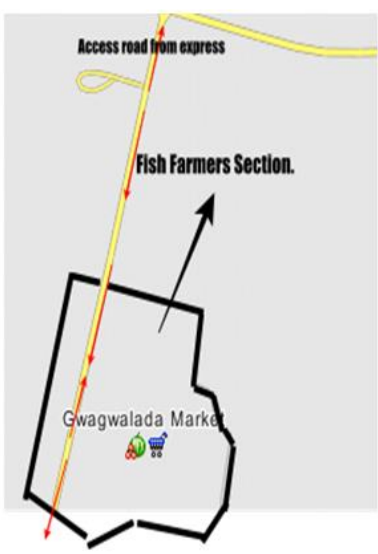

Fig 2 Map of Abuja Showing Gwagwalada and Market Position

Sample Collection

Fish Sampling

Forty live and fresh *Clarias gariepinus* catfish samples were collected from the fishermen at Jabi Lake by using plastic nets, and 40 *Clarias gariepinus* catfish samples were bought from Gwagwalada fish market. The cultured fish bought from Gwagwalada fish farm market were bought from designated sellers who buy directly from the fish farmers who harvest the fish from their earthed fish ponds. This is to prevent wild fish being bought as cultured fish. The freshly collected and bought fish were put in a container with adequate aeration and minimal water from the lake for wild catfish and water from the earthed ponds for the cultured catfish to keep them fresh, alive and active. In the lab, the head of *Clarias gariepinus* was cut off using a metal knife for the experiment. The removed head was washed with distilled water and HNO3 containing distilled water respectively. The components of the head (Brain, skin, and gills) were collected to form a single composite sample and placed in labelled plastic bags. Immediately the paper bags were put in frozen in icebox and stored in a fridge for further treatment. At due time, the representative samples were thoroughly homogenized and placed in a polyethylene bag.

Sample preparation and digestion

Fresh fish samples from fridge were crushed using a clean laboratory mortar and pestle and properly mixed to produce a homogenized sample. A 2 g of homogenized sample of each grounded fish, was weighed using analytical balance. The sample was transferred into a digestion flask into volume 12 mL of a mixture of Sulphuric acid (H_2SO_4) (35%, Riedel-de Haen) and Nitric acid (70%, Spectrosol) prepared in a 3:1 (v/v) ratio was added. The suspended mixture was digested for one hour, until a clear solution was obtained. The solution was then allowed to cool and then filtered through Whatman filter paper No.42. the resultant filtrate obtained was diluted to 50 mL in a volumetric flask with deionized water and get a side for later analysis of the heavy metals content using the iCE 300 Flame Atomic Absorption Spectrophotometer (Abubakar and Adeshına,2019)

METHOD VALIDATION FOR METAL ANALYSIS

Preparation of Stock Standard Solution

Working standard solutions of lead (Pb), iron (Fe), copper (Cu), chromium (Cr), and cadmium (Cd) were prepared from the stock standard solutions containing 1000 ppm of element in 2N nitric acid. Calibration and measurement of elements were done by using iCE 300 Flame Atomic Absorption Spectrophotometer. The calibration curves for each element were prepared individually by applying linear correlation using the least square method (Tegegne, 2015)

Instrumental Calibration

Calibration curves were prepared to determine the concentration of the heavy metals in the sample solutions. Intermediate standard solution (100 mg/L) of each metal was prepared from stock standard solutions containing 1000 mg/L of Cd, Cr, Pb, Cu, and Fe. Appropriate working standards were then prepared for each metal solution using serial dilutions of the intermediate solution using extraction solution. According to the instrument operation manual to attain its better sensitivity, the working standards were then aspirated one after the other into the flame atomic absorption spectrometer and its absorbance was recorded. Calibration curves were then plotted with different points for each metal standard solution using absorbance against concentrations (mg/L).

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Immediately after calibration using the standard solutions, the sample solutions were aspirated into the Flame Atomic Absorption Spectrophotometer instrument and direct reading of the metal concentrations were recorded

ANALYTICAL METHOD VALIDATION

Method Detection Limit
Three replicate blank samples were digested using the same procedures for fish digestion. Each blank was assayed for its metal contents (Cr, Cd, Fe and Pb) by Flame Atomic Absorption Spectrophotometer instrument. The Standard deviation (SD) of the three replicate blanks was calculated to determine the Method detection limit MDL. The Method detection limit (MDL) was then calculated according to equation indicated below:

(MDL = yB+3SD) (1). Where; yB= mean o the replicate blank SD= Standard deviation of the blank

Statistical Analyses
Results are presented as mean ± standard deviation; n equals 3, the number of replicate measurements. Results from the different markets were compared using one-way analysis of variance (One-Way ANOVA) at the 95% confidence level (α = .05). P ≤ .05 was considered to indicate significant difference.

RESULTS AND DISCUSSION

Table 1: Heavy metal concentrations (mean ± standard deviation) (ppm) in Wild and Cultured *Clarias gariepinus* from Jabi Lake and gwagwalada in Comparison with WHO Standards

Elements	Chromium (Cr) (ppm)	Copper (Cu) (ppm)	Iron (Fe) (ppm)	Lead (Pb) (ppm)	Cadmium (Cd) (ppm)
Wild Fish	0.518 ± 0.209[a]	0.215 ± 0.307[a]	1.824 ± 0.913[c]	3.414 ± 0.963[d]	0.291 ± 0.143[a]
Cultured Fish	0.238 ± 0.188[a]	0.110 ± 0.158[b]	1.211 ± 0.508[c]	1.211 ± 0.508[d]	0.186 ± 0.289[a]
WHO/FAO	3.0	1.0	5-43	0.2	2.0

Key: n= 40, Alphabets of different letters on the same row are significant. P<0.05, F = 315.45

From the data in Table 1 above, the chromium levels in cultured and wild *Clarias gariepinus* are below the WHO/FAO GUIDELINES (< 3.0). The levels of copper in wild and cultured catfish were found to be below WHO standards (<0.15). For Iron, the mean values for the wild (1.824 ± 0.913[c]) and cultured (1.211 ± 0.508[c]) fish are well below the WHO/FAO limits (5-43). The mean level of lead in wild *Clarias gariepinus* (3.414 ± 0.963[d]) is above the WHO standards (0.2) and the mean of the cultured catfish (1.211 ± 0.508[d]) is also above. The level of cadmium in both wild (0.291 ± 0.143[a]) and cultured (0.186 ± 0.289[a]) *C. gariepinus* is well below the safety limits of the World Health Organisation (WHO/FAO) (2.0). Overall, only one heavy metal exceeded the WHO guidelines namely Lead while Chromium, Copper, Iron and Cadmium were within the limits.

Table 2. Concentration of Heavy Metal of Wild and Cultured *Clarias gariepinus* from Jabi Lake and Gwagwalada

Elements	Cultured Fish	Wild Fish
Chromium (Cr)(ppm)	0.238 ± 0.188[a]	0.518 ± 0.209[b]
Copper (Cu) (ppm)	0.110 + 0.158[a]	0.215 ± 0.307[b]
Iron (Fe) (ppm)	1.211 ± 0.508[a]	1.824 ± 0.913[b]
Lead (Pb) (ppm)	2.929 ± 0.707[a]	3.414 ± 0.963[b]
Cadmium (Cd) (ppm)	0.1867 ± 0.2897[a]	0.2919 ± 0.143[b]

n =40,
Cr t = -5.83, DF = 77, P< 1.1910
Cu t = 1.91, DF = 78, P>0.058
Fe t = -3.72, DF = 78, P>3.78 x 1O^{-10}
Pb t = 2.623, DF = 76, P>0.0105
Cd t = 2.057, DF = 78, P>0.0429

Table 2 compares the heavy metals of study levels in wild *Clarias gariepinus* from Jabi Lake with cultured *Clarias gariepinus* from Gwagwalada fish market using the ANOVA statistical method of data analysis to establish if the metals are more present in the wild or the cultured catfish. The level of chromium in the cultured catfish is 0.238 ± 0.188which is lower than the mean chromium level in the wild catfish 0.518 ± 0.209. The level of copper was present in a higher concentration in wild catfish at 0.215 ± 0.307.than in the cultured catfish at 0.110 ± 0.158.Iron level in the cultured cat fish is lower than the mean iron present in the cultured fish samples when compared with the wild which had a value of 1.824 ± 0.913. In Lead (Pb), the mean level in the cultured fish (2.929 ± 0.707) is lower than in wild catfish (3.414 ± 0.963).Cadmium is Higher in the wild catfish with a value of 0.291± 0.143 than in the cultured whose mean is 0.1867 ± 0.2897.Except in copper whose mean level was higher in the cultured catfish samples, all the heavy metals of study were present in the wild catfish samples in greater amount. All the mean values for the various metals were statistically significant (P>0.05) except for Chromium (P< 1.191).

The five heavy metals of study namely; Chromium, Copper, Iron and Cadmium (Cr, Cu, Fe, Pb and Cd), were present in higher concentrations in the wild *Clarias gariepinus* from Jabi Lake than

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the cultured *Clarias gariepinus* from Gwagwalada. These findings correlate with the work of Zhang *et al.* (2018) carried out in Honghu City, China, where heavy metals (As, Cd, Cr, Cu, Pb and Zn) were found to have a higher concentration in the wild captured fish than in the cultured. The mean values of the five metals in this study were compared with the WHO guidelines, only lead was found to have exceeded the WHO limits in Both Cultured and wild *Clarias gariepinus*, hence pose health risks due to bioaccumulation. The result of this study disagree with the findings of Ullah *et al.* (2016) who reported lead to be within the permissible limits. Lead has been found to be capable of causing several health defects, such as: Disruption of the biosynthesis of haemoglobin and anaemia, high blood pressure, kidney damage, miscarriages, declined fertility in men, disruption of nervous systems, brain damage, diminished learning abilities of children (Lenntech, 2018).

The significant increase of lead may be due to the influx of agricultural wastes, domestic or municipal and most significantly industrial wastes drainage from the neighbouring environment (Tiimub and Afua, 2013). The result obtained may account for the surrounding of the lake which harbours numerous residential areas (estates and other settlements), markets for food and other items, mini industries, car parks with mechanic workshops, fun parks and recreation sites, a big multipurpose supper market/mall (Jabi Lake Mall) and cattle graze on its banks because of the green grasses and shrubs. Given that Abuja and Jabi particularly are known for poor and faulty drainage systems, it is only realistic to say that residues from these various activities are eroded into Jabi Lake and organic matter can be degraded into releasing soluble metals into water bodies by oxidation .Since the fish live and feed in the water they are susceptible to continuously absorb and accumulate these heavy metals .On the other hand, the presence of metals in cultured fish sold at Gwagwalada market were also contaminated with heavy metals although at a concentration lower than permissible level. The presence of the metal in cultured fish may be due to poor water quality used in ponds for rearing. This result was in agreement with previous findings. (Zhang, 2018).

Conclusion

This study analyzed and determined the various levels of the heavy metals in wild and cultured *Clarias gariepinus* from Jabi Lake and Gwagwalada fish market. The present study showed that the five heavy metals were present in both wild and cultured *Clarias gariepinus*. Heavy metals concentration were higher in wild catfish compared to cultured fish, and lead (Pb) level was above the WHO/FAO guidelines (0.2 ppm).

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