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Comparative Analysis Of Heavy Metals In Farm And River Bred Catfish (Clarias Gariepnus)

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ABSTRACT:
BACKGROUND: Catfish (*Clarias gariepinus*) is a major source of protein in Nigeria, which has some nutritional and health benefits. OBJECTIVE: The aim of this study is to compare heavy metal concentrations in farm and river bred catfish. Method: Total four catfishes (big and small); two each of farm bred and river bred were sourced from LASUSTECH Fish Farm and Bayeku River respectively. They were dissected; 1 g each of gill and flesh were removed from four fishes and analysed for iron (Fe), cadmium (Cd), chromium (Cr), nickel (Ni), copper (Cu), lead (Pb), and zinc (Zn) using standard analytical methods. Data were subjected to descriptive and inferential statistics using Statistical Package for Social Science (SPSS 22.0 version). The t – test was used to test, if there is a significant difference in the heavy metal concentration in big and small catfishes sourced from the farm and river. RESULTS: All the values of heavy metals (farm bred catfishes) above their corresponding Food and Agriculture Organisation (FAO) limits; with the Fe (75.70± 44.17 mg/kg) highest and Cd (0.001±0.0 mg/kg) lowest. There are significant differences in the values of Fe, Cr and Zn among four samples, except Cd, Ni, Cu and Pb. However, all the values of heavy metals (river bred catfishes) higher than their corresponding FAO limits; with the Fe (86.37 ±44.17 mg/kg) has the highest value, while Pb (0.54± 0.552 mg/kg) is the lowest. There are no significant differences in the values of Cd, Ni, Cu, and Pb among four samples. The Fe, Cr, Cu, Pb, and Cd contents (river bred) are higher than that of the farm bred, except Ni and Zn values. CONCLUSION: It can be concluded that farm bred catfish is less contaminated with Fe, Cd, Cr, Cu and Pb than the river bred.

Keywords: comparative, catfish, farm, heavy metals, river bred

INTRODUCTION

Fish is a source of protein worldwide; apart from the protein, it also contains fat and oil, which are suitable for nourishing the human body. Catfish (*Clarias gariepinus*) is highly consumed by low-income and high-income earners in Nigeria; it is served in various gatherings and homes as a source of protein. This is because it is widespread and can be found in any water in the neighborhood. Moreover, it is easier to raise; virtually every street in the Western part of Nigeria has one or two catfish farms. However, since they live in the water, which is constantly polluted by runoff from human activities like mining, agricultural activities, emptying of waste, washing, bathing, etc., These activities usually contain some degree of toxic pollutants like heavy metals that are embedded in the bodies of water. Hence, the fish consume these metals and food (M'Kandawire, 2017; Chen et al., 2015; Muradoglu et al., 2015). According to M'Kandawire (2017), cadmium concentration above 0.5 mg/kg in fish is hazardous and can be harmful to the consumer of such fish as well as affect the protein and carbohydrate metabolism in the fish.

Hazardous wastes are usually discharged into the aquatic system through anthropogenic sources and, in most cases, contain heavy metals such as lead, aluminum, cadmium, and arsenic is known to be very toxic or carcinogenic, even at deficient

concentrations to humans (Kabir et al., 2012). Metals in contaminated sediments accumulate in microorganisms, which enter the food chain and eventually affect human health (Ates et al., 2015). Heavy metals accumulate in different fish organs because of their affinity (Monirul Islam et al., 2017). Likewise, several researchers have reported heavy metal contamination in various fish organs: Musa (2021), Muradoglu et al. (2015), and Zhao et al., 2012., Joy et al. (2013) and Joseph et al. (2012) have reported the effects of these contaminants on some aquatic organisms. However, not all metals are toxic to humans; some metals, such as nickel, zinc, and chromium, are useful in human metabolic processes in small amounts (Sfakianakis et al., 2015). Fishes are a good yardstick to know whether heavy metals are present in water bodies or not because of their position in food chains (Sarker et al., 2016). As essential as fish is, it is widely consumed across all races. A river, stream, pond, or marine environment is the source of fish because most waste emptied or dumped into them eventually contaminates the water in which the fish live and consume them. Hence, the need to look inward to see the fish reared on the farm (a modern agricultural method) may mean they could be better off and free of the heavy metal load, detection, or deposit in them. Because of this, the study compared the number of heavy metals in the river and catfish (*Clarias gariepinus*) raised on farms.

2.0 MATERIALS AND METHODS

2.1 Study Area

Bayeku River is an extension of the Atlantic Ocean, passing through Lekki Beach and to the Bayeku River. Bayeku is an outskirt of Ikorodu towns located in the North - East of Lagos state, Nigeria, and shares the boundary with Ogun State, on the coordinates 6.380˚N and 3.549˚E. Figure 1 shows the location of the Bayeku River. The major occupation of the inhabitants of Bayeku is fishing. Two samples of catfish (*clarias gariepinus*) each were collected from the Bayeku River and Lagos State University of Science and Technology (LASUSTECH) Fish Farm at Ikorodu; on 4 November, 2021. LASUSTECH is situated on Latitude 6.595 ℕ and Longitude 3.337 ℈. The two fishes were put inside buckets with small water from their respective habitats and transported to the laboratory for analysis. Figure 2 shows a fish pond from LASUSTECH Fish farm

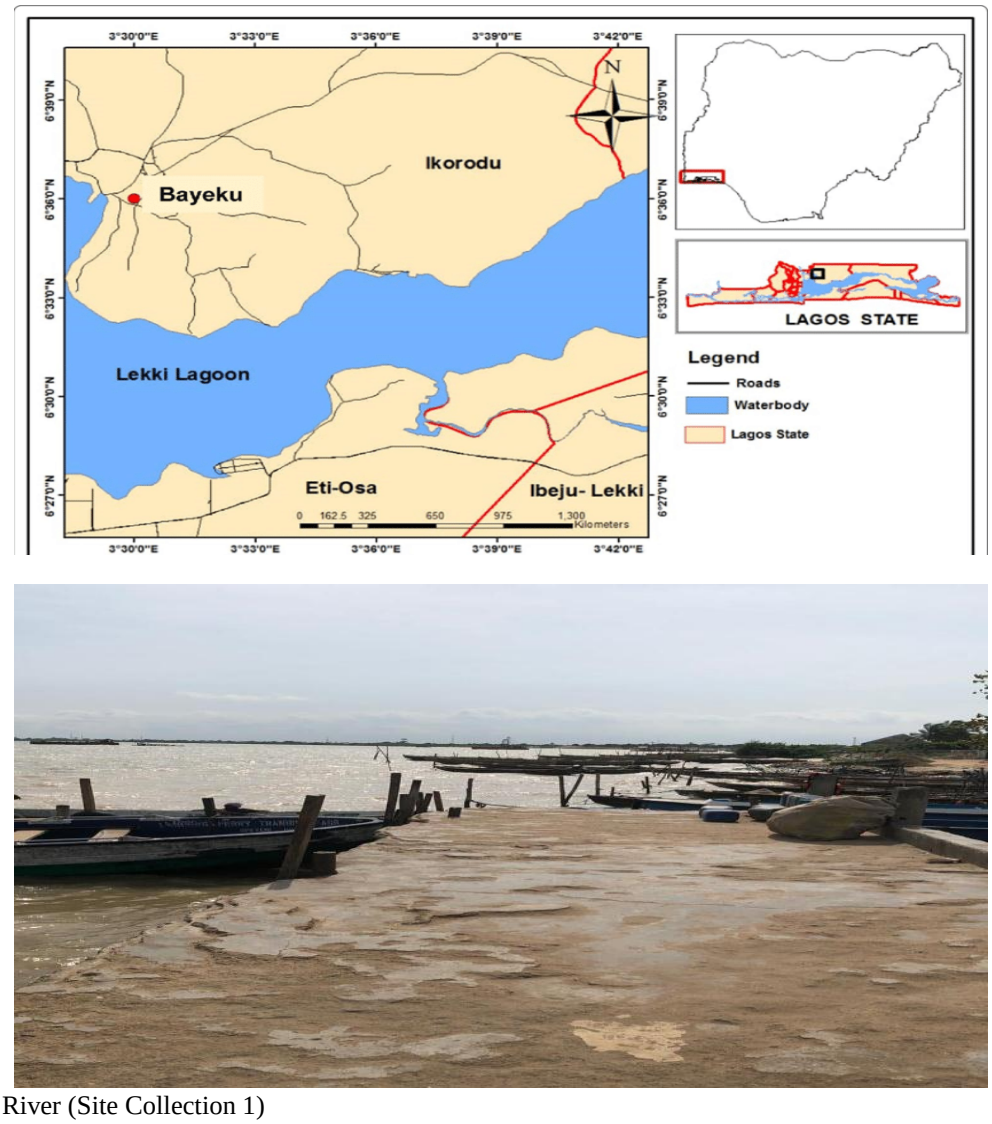

Figure 1: Bayeku River (Site Collection 1)
red dot = Bayeku village; blue colour = extension of Lekki beach to the Bayeku river

Figure 2: LASUSTECH Fish Pond (Site Collection 2)

2.3 Sample Collection

Two sizes of fish (big and small) were collected from the river—likewise, two from the LASUSTECH Fish Farm. Any fish weighing more than 1000 g was labeled as large, while anything weighing less than 1000 g was labeled as small. However, both the large and small were dissected, and the gills and flesh of each were extracted and analyzed for heavy metals such as iron (Fe), cadmium (Cd), chromium (Cr), nickel (Ni), copper (Cu), lead (Pb), and zinc (Zn).

2.4 Preparation and Digestion of Samples

The four fishes were dissected; flesh and gills were taken out of each**.** The flesh and gills of each fish were cut into pieces. However, one gram (1 g) of flesh and gill from big and small fish, for both river and farm, was taken and put inside the eight crucibles separately; then the eight crucibles were transferred into the oven at 450 C for 5 hours until the samples (both flesh and gill of the four fish) turned into ashes. The ashes of both the flesh and gill of the fish were digested separately using the combination of 5 cm^3 of hydrochloric acid and nitric acid (25 % v/v). After digestion, the ashes were filtered and 5 g of dry weight of each filtrate was put inside a different beaker, and thereafter, 5 mL of HNO_3 and 5 mL of H_2SO_4 were added to each and aspirated into an Atomic Absorption Spectrophotometer. The concentration of heavy metals considered (Cd, Cu, Ni, Fe, Pb, Cr, and Zn) in the digested samples was determined using an Atomic Absorption Spectrophotometer (Model AA-6650) after calibrating the equipment with different standard concentrations. The mean and standard deviation of the flesh and giblets (big and small fish) from the river were calculated. The same was calculated from the two fish (big and small) from the farm.

2.5 Statistical Analysis

Data obtained for farm and river fishes were subjected to the statistical tool (mean, standard deviation, one sample t-test) using Statistical Package for Social Science (SPSS 22.0 version). The values were compared with Food and Agriculture Organisation (FAO) Standard (2004).

3.0 RESULTS

The heavy metal concentration in farm-bred catfish (Table 1) illustrates that Fe has the highest concentration of heavy metal with a mean value of 75.70± 44.17 mg/kg and which is higher than 0.03 mg/kg of the Food and Agriculture Organisation (FAO) limit in the fish. There is a significant difference (0.02) among the four samples; two big fishes (gill and flesh) and two small fishes (gill and flesh form). Cd with the lowest mean value of 0.001±0.0 and lower than 1.5 mg/kg of FAO limit. The $P > 0.05$; hence there are no significant differences (0.92) among the Cd values of each sample. In addition, Cr (18.13 ± 13.04), Ni (27.51±26.88), Cu (3.95 ± 4.57), Zn (52.01 ± 31.29) and Pb (0.38 ± 0.28 mg/kg) content in farm-bred catfishes are higher than FAO limit of 1.0, 0.6, 1.3, 2.5, and 0.03 g respectively. Furthermore, with the *P value* of Cr (0.03), Ni (0.07), Cu (0.09), Zn (0.02) and Pb (0.04); there are significant differences among the values of fishes (gill and flesh) in the Cr, Zn and Pb; but there are no significant differences in the values of Ni and Cu in fishes. Heavy metal concentration in freshwater-bred catfish (Table 2) shows that Fe has the highest concentration (86.37 ±44.17 mg/kg) and is higher than the 0.03 mg/kg of the Food and Agriculture Organisation (FAO) limit. There are significant differences (0.01) among the four samples. Pb has the lowest mean value of 0.54± 0.55 mg/kg and is higher than the 0.03 mg/kg of FAO limit. $P > 0.05$; hence, there are no significant differences (1.949) among the Pb values of each sample. The mean value of Cr (23.56 ± 13.04), Ni (6.72 ± 12.51), Cu (8.49 ±9.05), Zn (42.22 ± 22.69) and Cd (5.59 ± 7.83 mg/kg) content in the river bred catfishes are higher than FAO limit of 1.0, 0.6, 1.3, 2.5, and 1.5 mg/kg respectively. However, with *P value*

of Cr (0.01), Ni (0.18), Cu (0.08), Zn (0.02) and Cd (0.92); there are significant differences among the values of the river bred fishes in Cr and Zn; but there are no significant differences in the values (gill and flesh) in Ni, Cu, and Cd.

Table 1: Heavy Metal Concentration in Farm-Bred Catfish (N=4)

Heavy metal (mg/kg)	Mean ± Std	T - stat	P - value	FAO Standard (mg/kg)
Iron (Fe)	75.70± 44.17	3.43	0.02	0.03
Chromium (Cr)	18.13 ± 13.04	2.78	0.03	1.0
Nickel (Ni)	27.51±26.88	2.05	0.07	0.6
Copper (Cu)	3.95 ± 4.57	1.73	0.09	1.3
Zinc (Zn)	52.01 ± 31.29	3.32	0.02	2.5
Lead (Pb)	0.38 ± 0.28	2.66	0.04	0.03
Cadmium (Cd)	0.001±0.0	0	0.922	1.52

std = standard deviation

Table 2: Heavy Metal Concentration in River bred Catfish (N=4)

Heavy metal (mg/kg)	Mean ± Std	T - stat	P - value	FAO Standard (mg/kg)
Iron (Fe)	86.37 ± 44.17	4.568	0.0098	0.03
Chromium (Cr)	23.5625 ± 13.04	-0.834	0.0121	1.0
Nickel (Ni)	6.723 ± 12.51	1.0747	0.1806	0.6
Copper (Cu)	8.4875 ±9.05	1.866	0.0794	1.3
Zinc (Zn)	42.22 ± 22.69	3.7216	0.01688	2.5
Lead (Pb)	0.54 ± 0.55	1.949	0.07318	0.03
Cadmium (Cd)	5.59025 ± 7.83	0	0.922	1.52

std = standard deviation

DISCUSSION

Fe, Cr, Cu, Pb, and Cd contents of the river-bred catfish are significantly higher than those of the farm bred except Ni and Zn (M'Kandawire, 2017; Skakianakis et al., 2015). This revelation implies that there could be continuous deposition of these heavy metals by catfish in the river over a while and with their present values already surpassing the FAO limit (Chen et al., 2015; Muradoglu et al., 2015). However, these heavy metals can affect the existence of the catfish in the river or be passed to the food chain and accumulate in higher animals that feed on them (Monirul Islam et al., 2017; Sarker et al., 2016). Furthermore, heavy metals discovered in farm-bred catfish could result from unintentional human error, such as improper feed preparation and handling of farm-feeding equipment. Thus, farm-bred fish is better for consumption than freshwater fish. However, the information obtained in this study will help inform people about which products to buy and eat to reduce the risks of bad products.

4.0 CONCLUSION

Data from this study showed that the concentrations of lead, iron, copper, nickel, cadmium, zinc, and chromium of all fish samples investigated in the Bayeku River were higher than the concentrations of heavy metals found in the fish from the LASUSTECH fish pond, except for Ni and Zn. However, both exceeded the Food and Agriculture Organization (FAO) limits. Furthermore, the government of Nigeria should encourage local farmers of these catfishes to improve their feeds and use modern technology to avoid contamination from farmers due to feed preparation and tool handling.

Recommendation

i. Heavy metal levels of the fish must be monitored periodically concerning consumers' health by National Agency for Food and Drug Administration and Control (NAFDAC) in Nigeria.
ii. There should be regular monitoring of the aquatic ecosystem by a relevant government agency.
iii. Industries should be cautioned by the concerned authority to treat their waste before empty to the water bodies to reduce the aquatic pollution
iv. Agricultural activities should also be monitored and distanced away from water bodies to prevent the leaching or runoff of heavy metals from agricultural waste and chemicals e.g., fertilizer, insecticide, herbicide etc., into the water bodies.
v. Production of fish feed should be monitored and regulated to avoid unnecessary unwholesome and contamination.

Competing Interests

There is no conflict of interest as far as this study is concerned. I am the sole author of the work.

Ethics Committee Approval

No ethical approval is needed for the fish and the type used.

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