STUDIES ON CONCENTRATION OF HEAVY METALS IN TISSUES OF FISH SPECIES (*Clarias gariepinus* and *Oreochromis niloticus*) IN LOWER RIVER NIGER AT GEREGU AJAOKUTA, KOGI STATE, NIGERIA

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ABSTRACT
A study was conducted to assess of heavy metal concentrations in tissues (gills, viscera, and muscles) of Clarias gariepinus and Oreochromis niloticus from the Lower River Niger, Geregu Village. Sampling took place over three months (May-July) to evaluate spatial and temporal variations. Three sites along the River Niger at the location was marked for the samples collection and were designated as site A, B and C. The fish samples (muscle, gills and viscera) collected were digested and prepared for heavy metal analysis using Atomic Absorption Spectrophometer (AAS). Six heavy metals (lead, zinc, chromium, cadmium, iron, and nickel) were analyzed using AAS. The collected data were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS, version 20). Results showed lead was the most prevalent in gill tissues across both species. However, all heavy metal concentrations were below recommended guidelines set by World Health Organization (WHO). The study's findings suggest the Lower River Niger's aquatic ecosystem is relatively unpolluted with heavy metals, ensuring the fish are safe for human consumption.
Keywords: Heavy metal, Fish tissues, Lower River Niger

INTRODUCTION

The modern societies are faced with serious concerns about some global environmental challenges; developing countries in particular currently experience growing and complex pollution problems. The global environmental pollution, water pollution and waste management in particular, have attracted international public health attention. From the perspective of chemicals or hazardous substances, river water samples, sediments and some species of fish in Nigeria have been investigated (Unyimadu *et al*., 2019).

According to Vardi and Chenji (2020), fish are the best bio-indicator recognized for the assessment of heavy metals in the natural aquatic ecosystem. The global increase in fish consumption is attributable to the nutritional benefits of fish consumption (Adel *et al*., 2018). They serve as a good source of proteins, vitamins, omega-3-fatty acids, and essential minerals (Varol and Sünbül, 2020). Owing to the advancing industrialization and increasing population, the turnover of industrial waste and anthropogenic activities have heightened the contamination rate of the aquatic environment (Matouke and Abdullahi, 2020). Globally, aquatic environments are being polluted with toxicants and heavy metals. Studies have shown accumulation of heavy metals in different aquatic biodiversities such as prawn, crayfish, crabs, bivalve, and fish (Ali *et al*., 2020; Anandkumar *et al*., 2019). Consequently, there is a concomitant increase in the human health risk through consumption of fish contaminated with heavy metals (Liang *et al*., 2018).

MATERIALS AND METHODS

Study area

The study was conducted in lower River Niger at Geregu-Ajaokuta, Kogi State Nigeria. Geregu lies within Latitude N07˚31′ and N07˚38′ and Longitude 006˚33′E and 006˚43′E. The climate of the study area is tropical with dry season running from November to March while wet season run from April to October. The vegetation if guinea savannah with annual temperature ranges from 23ºC to 35ºC, while annual humidity ranges from 67 to 94%. The inhabitant are actively engaged in commerce, fishing, farming, mining, artisan industries and transportation (road and water transport).

Collection and preparation of fish samples

Fish samples were collected for the period of three (3) months from May to July. Fish using cast net, which was thrown at the study location by hired fishermen many times to catch the target fishes. Hooks and lines was also be used for the catch. Fish samples caught were transported to the laboratory in a thermo-flask with ice, kept at -5ºC. The tissue (gills, viscera and muscle) were removed using a stainless steel knife and were homogenized, weighed into separate beakers. Conc. HNO_3 and H_2O_2 was added into the beakers in ratios 3:1 and allowed to digest on a hot plate in a fume chamber at 120 °C for 20 minutes (Singh and Reddy 2021). The digested samples were allowed to cool at room temperature, filtered through Whatman filter papers and each solution made up to 25 ml mark with deionized water and analyzed for heavy metals concentration using AAS.

Statistical Analysis

Data generated from the study were subjected to analysis of Variance using SPSS computer software (version 11.0) to test for significant different between values of the variables (fish tissues). The value was represented as mean ± standard error and the significant mean was separated using New Duncan Multiple Range Test (NDMRT) at 5% level of significance.

RESULTS AND DISCUSSION

Heavy Metals in Fish Tissue for the month of May.

The mean heavy metal concentration and grand mean of tissues (gills, viscera and muscle) of *Clarias gariepinus* and *Oreochromis niloticus* are presented in Table1. The grand mean concentration of metals determined ranged from 0.02 – 72.54 mgkg^{-1}.

Table1: Heavy metals (mg/kg) concentration in fish tissue in the month of May.

Fish	Tissue	Fe	Pb	Ni	Cr	Cd	Zn
Oreochromis	Gill	98.34^{a}±0.04	0.81^{b}±0.09	1.82^{a}±0.01	0.52^{a}±0.03	0.002±0.09	3.14^{b}±009
niloticus	Viscera	79.32^{b}±0.11	0.72^{b}±0.46	1.80^{a}±0.01	0.45^{b}±0.08	0.003±0.01	4.56^{a}±0.02
	Muscle	73.11^{c}±0.12	0.92^{a}±0.01	0.35^{b}±0.09	0.13^{c}±0.02	0.01±0.01	3.02^{b}±0.01
	GRA	83.59	0.82	1.32	0.37	0.02	3.57
	SEM	1.19	1.57	0.86	0.19	1.10	1.04
	WHO	100	2.0	8.97	3.0	0.6	40
Clarias	Gill	103.11^{a}±0.09	0.92^{a}±0.08	1.83^{a}±0.01	0.44^{a}±0.02	0.004±0.01	5.12^{a}±0.02
garieinus	Viscera	92.40^{b}±0.01	0.71^{b}±0.03	1.56^{b}±0.08	0.41^{a}±0.08	0.002±0.01	4.31^{b}±0.02
	Muscle	22.12^{c}±0.02	0.44^{c}±0.01	0.91^{c}±0.03	0.15^{b}±0.01	0.00	3.78^{c}±0.02
	GRA	72.54	0.69	1.43	0.33	0.02	4.40
	SEM	1.09	1.76	0.67	0.82	0.12	1.22
	WHO	100	2.0	8.97	3.0	0.6	40

The results are presented as mean± standard deviation. Result with different superscripts within the same column is significantly different at P < 0.05. Fe = Iron; Pb = Lead; Ni = Nickel; Cr = Chromium; Cd = Cadmium; Zn = Zinc

Heavy Metals in Fish Tissue for the month of June.

The mean concentration of heavy metal in the tissues (gills, viscera and muscle) of *Oreochromis niloticus* and *Clarias garipienus* in the month of June is presented in Table 2. The grand mean concentration for *Oreochromis niloticus* ranged from 0.002 to 82.04, while that of *Clarias gariepinus* ranged from 0.03 t0 71.42 mg/kg.

Table 2: Heavy metals (mg/kg) concentration in fish tissue in June.

Fish	Tissue	Fe	Pb	Ni	Cr	Cd	Zn
Oreochromis	Gill	96.41^{a}±0.02	0.72^{a}±0.02	1.73^{a}±0.08	0.61^{a}±0.01	0.003^{a}±0.00	3.12^{b}±0.04
niloticus	Viscera	81.41^{b}±0.09	0.44^{b}±0.04	1.83^{a}±0.02	0.52^{a}±0.01	0.002^{a}±0.01	5.22^{a}±0.01
	Muscle	68.31^{c}±0.01	0.70^{a}±0.02	0.51^{b}±0.03	0.09^{b}±0.12	0.001^{a}±0.03	2.98^{b}±0.03
	GRA	82.04	0.62	1.35	0.401	0.002	3.77
	SEM	1.45	0.78	0.45	0.55	0.11	0.13
	WHO	100	2.0	8.97	3.0	0.6	40
Clarias	Gill	98.60^{a}±0.02	0.82^{a}±0.09	1.91^{a}±0.04	0.51^{a}±0.02	0.005^{a}±0.01	5.61^{a}±0.02
garieinus	Viscera	92.11^{b}±0.06	0.74^{b}±0.02	1.62^{a}±0.02	0.42^{b}±0.03	0.003^{a}±0.01	3.89^{b}±0.02
	Muscle	23.57^{c}±0.03	0.52^{c}±0.09	0.81^{a}±0.02	0.11^{c}±0.01	0.001^{a}±0.00	2.92^{c}±0.01
	GRA	71.42	0.69	1.45	0.35	0.003	4.14
	SEM	1.01	0.44	0.54	0.19	1.10	0.45
	WHO	100	2.0	8.97	3.0	0.6	40

The results are presented as mean± standard deviation. Result with different superscripts within the same column is significantly different at P < 0.05. Fe = Iron; Pb = Lead; Ni = Nickel; Cr = Chromium; Cd = Cadmium; Zn = Zinc

Heavy Metals in Fish Tissue for the month of July.

The meanconcentration of heavy metals and grand mean in the tissues (gills, viscera and muscle) of *Oreochromis niloticus* and *Clarias garipienus* in the month of July is presented in Table 3. The grand mean concentration of metals for *Oreochromis niloticus* ranged from 0.001 to 80.30 and that of *Clarias gariepinus* ranged from 0.03 t0 71.80 mg/kg.

Table 3: Heavy metals (mg/kg) concentration in fish tissue in July.

Fish	Tissue	Fe	Pb	Ni	Cr	Cd	Zn
Oreochromis	Gill	$89.34^{a}\pm0.11$	$0.75^{a}\pm0.01$	$1.68^{a}\pm0.13$	$0.64^{a}\pm0.02$	0.002 ± 0.00	$5.14^{a}\pm0.02$
niloticus	Viscera	$83.44^{b}\pm0.01$	$0.42^{b}\pm0.01$	$1.85^{a}\pm0.03$	$0.48^{b}\pm0.01$	0.003 ± 0.00	$4.33^{b}\pm0.0.3$
	Muscle	$68.11^{c}\pm0.02$	$0.62^{b}\pm0.01$	$0.43^{b}\pm0.04$	$0.08^{c}\pm0.00$	0.00	$2.19^{c}\pm0.03$
	GRA	80.30	0.59	1.32	0.40	0.001	3.88
	SEM	0.12	0.58	0.12	0.59	0.11	0.45
	WHO	100	2.0	8.97	3.0	0.6	40
Clarias	Gill	$97.66^{a}\pm0.08$	$0.84^{a}\pm0.02$	$1.91^{a}\pm0.08$	$0.53^{a}\pm0.11$	0.00	$2.42^{b}\pm0.08$
garieinus	Viscera	$93.11^{b}\pm0.02$	$0.72^{b}\pm0.11$	$1.74^{a}\pm0.01$	$0.50^{a}\pm0.02$	0.02 ± 0.00	$3.57^{a}\pm0.02$
	Muscle	$24.64\pm^{c}0.12$	$0.53^{c}\pm0.11$	$0.78^{b}\pm0.02$	$0.21^{b}\pm0.03$	0.08 ± 0.01	$2.82^{a}\pm0.08$
	GRA	71.80	0.69	1.47	0.41	0.03	2.93
	SEM	1.12	1.06	1.05	1.77	0.29	0.44
	WHO	100	2.0	8.97	3.0	0.6	40

The results are presented as mean± standard deviation. Result with different superscripts within the same column is significantly different at $P < 0.05$. Fe = Iron; Pb = Lead; Ni = Nickel; Cr = Chromium; Cd = Cadmium; Zn = Zinc

DISCUSSION

The trend in the accumulation of Lead (Pb) in the tissues of the studied fishes varied. The two studied species displayed a relative high concentration of Lead in their gills. Thus, the concentrations of heavy metal in gills reflect the concentration of trace metals in the waters where the fish lives (Shah *et al*., 2020). The average concentrations of Lead in the different tissues of the Catfish were higher than Tilapia fish. This may be due to difference of feeding habits of the two species. Catfish occur in shallow water with muddy bottom. They are mainly omnivorous, feeding on insect larvae, fish, molluscs, plankton organisms, seeds, worms and detritus which accumulate large amount of heavy metals (Parashar and Benerjee, 2020). Tilapia fish on the other hand feeds mainly on phytoplankton. Moreover, the concentrations of Lead in the tissues of the fishes were below the permissible limit of 2.0 mgkg1 set by regulatory bodies (WHO, 2019). This result is in agreement with earlier studies by Taslima *et al*. (2022) from the same water body. The higher level of Copper in the fish tissues relative to the other metals (Cadmium and Chromium) could be due to the fact that the metal is naturally abundant in Nigeria soil which is the main source of metals in the surrounding water of the fish sample (Hughes *et al*., 2019) in a related experiment observed similar trend of heavy metal accumulation in the tissues of three studied fish species. The trend in the accumulation of Cadmium and Chromium in the tissues of the studied fishes also varied, with relatively higher values in Catfish compared to the Tilapia fish. Cadmium and Chromium are toxic at very low concentration and have no known functions in biochemical processes (Mahapatra *et al*.,2022). The levels of Cadmium and Lead were however, below the concentrations recommended by regulatory bodies.

There was also variation in the concentration of heavy metal in the tissues fishes within the months of study. The result showed higher metal concentration of Fe, Pb, Ni and Zn in the month of May followed by month of June and the least month of July. This could be attributed to the fact that the month of May marked the early precipitation which could carry a lot of heavy metals through run off into the river and there was low volume of river water to cause dilution of the metal making the metal more concentrated in the early month of the wet season than the later months. This report agreed with the findings of Wangboje and Ikhuabe (2015) who recorded higher heavy metal content in fish and water from River Niger at Agenebode, Edo State, Nigeria, in the early months of rainy season.

The presence of the metals analyzed in the body parts of fish serves as an indicator for the extent of heavy metals pollution of the water body from where the two fish species were obtained (Ali *et al*., 2020). Also, the presence of most of the metals determined in the fish parts agreed with the results of the report of heavy metals in aquatic organisms from different water bodies (Lima *et al*., 2022).

CONCLUSION

This study examined the concentrations of Lead (Pb), Cadmium (Cd), Chromium (Cr) and Copper in the gills, viscera and muscles of fish samples from Lower River Niger at Geregu village and compared the results with the World Health Organization (WHO) allowable limits. The observed differences in metal concentrations in the two species of fish examined indicated difference in metal uptake. Although, the results obtained does not show any form of danger posed to consumers of the fish studied from this river but the possibility of deleterious effect after long period cannot be ruled out due to their bioaccumulative nature in human and aquatic environment.

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