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ASSESSMENT OF HEAVY METAL LEVELS IN FALSE UPSIDE-DOWN CATFISH (SYNODONDIS NIGRITA) AND SHADFLY (MAYFLY NYMPH) FROM KIRI RESERVOIR, ADAMAWA STATE.

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Abstract
Assessment of Heavy metal levels in false upside-down Catfish (*Synodondis nigrita*) and Shadfly (Mayfly nymph) was conducted in Kiri Reservoir, Adamawa state, Nigeria. False upside-down Catfish (S. nigrita) and Shadfly (Mayfly nymph) was sampled bi-weekly in triplicate for six (6) months. Cu, Cd, Pb, Fe, and Zn was determined using Atomic Absorption Spectrophotometer (AAS) and the values obtained were expressed in milligram per kilogram. Data obtained were subjected to descriptive analysis to establish means, standard errors and one way analysis of variance (ANOVA) was used to determine the mean significant at 0.05 of heavy metals in false upside-down Catfish (S. nigrita) and Shadfly (Mayfly nymph). All the heavy metals investigated were detected in false upside-down Catfish (S. nigrita) and Shadfly (Mayfly nymph). The sampling sites from the reservoir with the highest concentration of heavy metals are as presented below: In false upside-down Catfish (*Synodondis nigrita*) Pb (0.0032±0.27amg/kg), Cr (0.0045±1.00amg/kg), Cd (0.0036±1.00amg/kg), Zn (12.84±1.00amg/kg), and Cu (2.73±0.83amg/kg) while in Shadfly (Mayfly nymph) Pb (0.0023±0.07amg/kg) Cr (0.0025±0.22amg/kg), Cd (0.0026±0.06amg/kg), Zn (3.33±1.00a mg/kg) and Cu (0.30±1.00amg/kg). Pb, Cr, Cd, Zn and Cu investigated were not above the recommended permissible limits by NIS (2007) in false upside-down Catfish (S. nigrita) and Shadfly (Mayfly nymph. From the findings therefore, Kiri reservoir fish and mayfly investigated are not polluted with these heavy metals mentioned.

Keywords: Heavy metals, *Synodondis nigrita,* Mayfly, Kiri reservoir.

Introduction

Heavy metals are generally referred to as “naturally occurring metals having atomic number greater than 20 and an elemental density greater than 5 g/cm^3” (Ali *et al*., 2019). Heavy metals Heavy metals are becoming one of the most serious environmental problems due to their persistence, biological toxicity, non-degradability, and capability of entering the food chain. In addition, heavy metal pollutants have been found to react with some organic substances under certain conditions to convert them into more toxic metal-organic complex pollutants (Chowdhury *et al*., 2016). The rate of heavy metal enrichment in surface water has drastically increased in recent times due to increases in anthropogenic activities. Increased urbanization of industrialization could be the cause for an increased level of trace metals especially the heavy metals in our water ways (Njar and Al-Doush, 2012). If the cumulative concentrations or effects of heavy metals reach certain limits, destruction of cell metabolism will result, and the impacts of the heavy metals will become toxic (Salman *et al*., 2015). Pollution of heavy metals in aquatic ecosystem is growing at an alarming rate and has become an important worldwide problem (Arena *et al*., 2013;

Ikenakaa *et al*., 2013). High level of metals in the environment could be a hazard for functions of natural ecosystems and human health, due to their toxic effects, long persistence, bioaccumulative properties and biomagnification in the food chain (Conceicao *et al*., 2012). The investigation of distribution and pollution degree of heavy metals in coastal area has attracted more public concerns recently (Gao and Chen, 2012). To shorten the discharge of trace metals into aquatic system, a number of preventive actions are being applied, but existence of these metals in water system are even found nowadays. Due to the fact that biota has the ability to accumulate various chemicals, it has been extensively used to measure the effects of metals on aquatic organism as an essential indicator of water quality. (El-Moselhy *et al*., 2014). Theses metals can enter the aquatic environment via untreated wastewater, effluent discharges from mechanic work, boat making, metallurgy, pesticidal and fungicidal sprays, debris of corroded materials and petroleum exploration. When these potentially toxic elements gain entrance into the aquatic ecosystem, they undergo both physical and chemical changes and, in some cases, enter the food chain through bioaccumulation and biomagnification in some aquatic species (Anyanwu *et al*., 2023). Heavy metals mainly enter aquatic environments as a result of a variety of human activities which may include Agriculture, combustion, corroded underground pipes, industrial plants, sewage, smelting, and vehicles (Ali *et al*., 2019). However, fish are relatively situated at the top of the aquatic food chain; therefore, they can accumulate heavy metals from food, water and sediments (Zhao *et al*., 2012). Uptake of heavy metals by fish from the environment primarily occurs through gills, food, and skin and through water taken with food. Heavy metals are carried to the organ by carrier protein via blood path and can reach high concentration by bonding to metal binding proteins in these tissues. Zaghloul *et al*. (2020), Edward *et al*. (2016) also added that heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs of the fish.

Materials and Methods

Description of the study site

The Kiri Reservoir is in Shelleng Local Government Area of Adamawa State in the northeast of Nigeria, damming the Gongola River. The reservoir is 1.2 km long, 20 m high zoned embankment with an internal clay blanket. Kiri Reservoir is on coordinate's 9°40′47″N 12°00′51″E on the southern part of Adamawa State, Nigeria. With an average rainfall of 886mm.The dam was mainly completed in 1982. Kiri reservoir is the main source of water for irrigation, fishing, domestic and industrial purposes in that area. Waste from Agricultural activities, municipal sewage and waste water work as run off accumulated in the reservoir. Communities living within the reservoir depend on it as a sources of water for domestic use and fishes been caught are sold to the public within the surrounding town and beyond. Three sites were chosen along the reservoir as sampling sites, namely Site A, in which anthropogenic activities such as washing of clothes, decayed thatches used in roofing, fishing and other domestic waste. Site B Which serve as a dumping site for refuse such as domestic waste, animal dung, scraps of metals and cooking utensils as well as unused plastics materials. Site C was an opening for run off from Agricultural farm that may contain Agro-chemicals, pesticides, animals dung as well as domestic waste into the reservoir, and the three sampling sites were chosen to represent the water that drains into the reservoir in order to understand the influence of natural and human activities on the reservoir.

Sample collection and analysis

Sampling of Upside-down catfish (*Synodondis nigrita*)

Synodondis nigrita was purchased from fishermen at the three study sites, the fish samples were washed thoroughly and rinsed with deionized water to wash any contaminant present on the fish samples then packaged in a cooler containing ice Blocks and transported to the laboratory **Digestion of Upside-down catfish (*Synodondis nigrita*) and Shadfly (*Mayfly nymph*)**

The entire fish samples were dissected with sterile sharp knife and flesh/muscles sample was cut out. The fish samples and the mayfly samples were separately dried at 105 ˚C for 4hours and grind to a fine powder using an agate mortar and pestle. Acid digestion of fish mayfly samples followed standard methods (APHA, 2005). 2.0 g of ground fish and mayfly nymph samples were placed into a borosilicate beaker and 12 ml of Aqua regia (3:1 $HCL/NH0_3$ was added. The beaker was covered with watch glass and left for 16 hours at room temperature, the samples were heated for 2 hours on a hot plate at about 80 ˚C, after the first 15 hours of heating, the watch glasses were removed and small amount of 1% $HN0_3$ was periodically added to avoid drying of the samples. The sample was allowed to cool and then filtered through Whatman 41 filter papers. The sample were made up to the 100 ml. The filtrates then were used for metal determination by atomic absorption spectrophotometer(AAS) as reported by Pandiyan *et al*. (2020).

Determination of heavy metals in Upside-down catfish (*Synodondis nigrita*) and Shadfly (*Mayfly nymph*)

Determination of heavy metals Cu, Cd, Pb, Fe and Zn concentrations in fish and Mayfly was done directly on each final solution using Atomic Absorption Spectrophotometer (AAS, Model: VGP 210) equipped with an air acetylene flame (APHA, 2005). The levels of heavy metals was evaluated by comparing the statistical mean levels of the samples under study.

Results

Heavy metals in Upside-down catfish (*S. nigrita*)

The highest (0.0032 ± 0.27^{a} mg/l) Cadmium level was reported in Site A, while the lowest (0.0031 ± 0.72^{a} mg/l) was recorded at site B and C. Lead in fish was significantly different between sites (P<0.05). The highest (0.0045 ± 1.00^{a} mg/l) Chromium level was reported in Site B, while the lowest (0.0037 ± 1.00^{c} mg/l) was recorded at site C. The highest (0.0036 ± 1.00^{a} mg/l) Cadmium level was reported in Site B, while the lowest (0.0034 ± 0.32^{b} mg/l) was recorded at site A. Cadmium in fish are significantly different between sites (P<0.05). The highest (12.84 ± 1.00^{a} mg/l) Zinc level was reported in Site B, while the lowest (12.42 ± 1.00^{c} mg/l) was recorded at site C. Zinc in fish are not significantly different (P>0.05) between sites. The highest (12.84 ± 1.00^{a} mg/l) Copper level was reported in Site B, while the lowest (12.42 ± 1.00^{c} mg/l) was recorded at site C. Copper in fish are significantly different between sites and months (P<0.05).

Table 1: Mean levels of Heavy Metals (Mean ± SE) in false upside-down fish (*Synodondis nigrita*) from three different sites of Kiri reservoir, (May-November 2024).

Month (mg/kg)	Site A	Site B	Site C	WHO (2022)
Lead	0.0032 ± 0.27^{a}	0.0031 ± 0.72^{a}	0.0031 ± 0.72^{a}	0.02mg/l
Chromium	0.0042 ± 1.00^{c}	0.0045 ± 1.00^{a}	0.0037 ± 1.00^{c}	3mg/l
Cadmium	0.0034 ± 0.32^{b}	0.0036 ± 1.00^{a}	0.0035 ± 0.32^{b}	1.0mg/l
Zinc	12.62 ± 1.00^{b}	12.84 ± 1.00^{a}	12.42 ± 1.00^{c}	50-60mg/l
Copper	2.72 ± 0.83^{a}	2.73 ± 0.83^{a}	1.93 ± 1.00^{b}	1-2mg/l

abc means with the same superscript in the row are not significantly different (P<0.05).
SEM = Standard Error of Mean

Heavy metals in Shadfly (*Mayfly nymph*).

The highest (0.0023 ± 0.07^{a} mg/l) Lead level was reported in Site A, while the lowest (0.0021 ± 0.07^{a} mg/l) was recorded at site B. There was no significant differences (P<0.05) of lead across sites. The highest (0.0026 ± 0.06^{a} mg/l) Chromium level was reported in Site A, while the lowest (0.0024 ± 0.06^{a} mg/l) was recorded at site B. There was no significant differences (P<0.05) of lead across sites. The lowest (0.0026 ± 0.06^{a} mg/kg) cadmium was recorded from site B and C while the lowest (0.0024 ± 0.06^{a} mg/kg) value was recorded from site A. There was no significant difference (P>0.05) of cadmium between sites. The highest (3.33±1.00^{a} mg/l) Zinc level was reported in Site B, while the lowest (3.22±1.00^{c} mg/l) was recorded at site C. There was significant difference (P<0.05) of zinc in Mayfly larvae between sites. The highest (0.30±1.00^{a} mg/l) Copper level was reported in Site B, while the lowest (0.26 ±0.21^{b} mg/l) was recorded at site A. There was significant difference in copper between sites and months (P<0

Table 2: Mean levels of Heavy Metals (Mean ± SE) in Shadfly (Mayfly nymph) from three different Sites of Kiri reservoir, (May-November 2024).

Month (mg/kg)	Site A	Site B	Site C	WHO (2022)
Lead	0.0021±0.07^{a}	0.0023±0.07^{a}	0.0022±0.07^{a}	0.02mg/l
Chromium	0.0020±0.22^{c}	0.0025±0.22^{a}	0.0021±1.00^{b}	3mg/l
Cadmium	0.0026±0.06^{a}	0.0024±0.06^{a}	0.0024±0.06^{a}	1.0mg/l
Zinc	3.25±1.00^{b}	3.33±1.00^{a}	3.22±1.00^{c}	50-60mg/l
Copper	0.26 ±0.21^{b}	0.30±1.00^{a}	0.27±0.21^{b}	1-2mg/l

abc means with the same superscript in the row are not significantly different (P>0.05).
SEM = Standard Error of Mean

DISCUSSION

Heavy metals in Upside-down catfish (*S. nigrita*).

The slightly high level of lead in site A in this study may be due to run-off from nearby farms where fertilizers, agrochemicals and pesticides are added to agricultural lands which is then flushed into the reservoir. The value of Lead obtained in this study was within the range reported by Ogbuene *et al.* (2024) in *Oreochromis niloticus* from Anambra River, Nigeria but lower than that reported by Hussain *et al*. (2015) in *Liza abu* from Iran and Gungsat *et al*. (2018) in Tilapia muscles from river Dilimi of Jos Plateau State.

The highest lead value obtained in fish (*Synodontis nigrita*) was not above the recommended permissible limits of 0.2mg/kg value recommended by WHO (2022).

The chromium value recorded in this study was higher than that reported by Ogbuene *et al.* (2024) in *Oreochromis niloticus* from Anambra River, Nigeria but lower than that reported by Njinga *et al*. (2023) in *Tilapia brevimanus* from coastal water in South Western Nigeria and Abalaka *et al*. (2020) in *Clarias gariepinus* from Abuja Nigeria. The highest chromium value obtained in fish (*Synodontis nigrita*) was not above the recommended permissible limits of 3mg/kg value recommended by FEPA (2022) and WHO (2022).

The cadmium value obtained was higher than that reported by Opaluwa *et al*. (2012) in fish muscles from Uke Stream, Nasarawa State and Adamu *et al*. (2023) in *Brycinus leuciscus* from Kiri reservoir, Shelleng LGA Adamawa State, Nigeria. The highest value of cadmium obtained in this study was not above the recommended permissible limit of 1.0mg/kg by FEPA (2022) and WHO (2022).

The highest value of zinc obtained was higher than that reported by Edward *et al*. (2017) in *Clarias gariepinus* muscles from upper Benue River, Adamawa State; but lower than that reported by Alam *et al*. (2023) in *Labeo rohita* from Bangladesh. The highest zinc value obtained in this study was not above the recommended permissible limit of 100mg/kg by FEPA (2022) and WHO (2022).

The value of copper in fish was higher than that reported Gungstat *et al* (2018) in catfish muscles from River Dilimi Plateau State and Edward *et al*. (2017) in *Clarias gariepinus* muscles from upper Benue River, Adamawa State and lower than that reported by Opaluwa *et al*. (2012) in fish muscles from Uke Stream, Nasarawa State Nigeria and Hussain *et al.* (2015) in Liza abu from Iran. The highest Copper value obtained in this study was not above the recommended permissible limit of 3mg/kg by FEPA (2022) and WHO (2022).

Heavy Metals in Shadfly (Mayfly nymph)

The high level of lead in site C in this study may be due to run-off from nearby farms where fertilizers and agrochemicals are added to agricultural lands which is then flushed into the reservoir. The value of Pb in mayfly obtained in this study was higher than that reported by Buzi *et al*. (2017) in macroinvertebrates (N Unerea) from Dadin Kowa Dam Gombe State, Nigeria but lower than that reported by Baruch-Garduza *et al.* (2022) in macro-invertebrates (Penaeus) in the Mexican Coast of the Gulf of Mexico. The highest lead Value observed in mayfly was not above the recommended permissible limits of 0.2mg/kg value recommended by FEPA (2022) and WHO (2022).

Chromium value observed in this research was higher than that reported by Oremo *et al*. (2019) in benthic macro-invertebrates (Baetidae and Gerridae) in River Isiukhun, Kenya and within the range reported by Chuba *et al*. (2011) in macro-invertebrates in a sub-basin in the South-East of Brazil but lower than that reported by Adeola and Opeyemi (2022) in Benthic macro-invertebrates (*Aeshna cyanea* Muller, 1764) from Oyo River sediments, Ilorin Kwara State, Nigeria. The value of Cd in mayfly was within the range reported by Buzi *et al*. (2017) in macro-invertebrates **(**Panta flavescens) from Dadin Kowa Dam Gombe State, Nigeria but lower than that reported by Baruch-Garduza *et al*. (2022) in macro-invertebrates (Penaeus) in the Mexican coast of the Gulf of Mexico and Shakirat *et al*. (2024) in macro-invertebrates (Dragonfly larvae) from River Owo, Agbara Ogun State, Nigeria. The highest cadmium Value observed in mayfly nymph was not above the recommended permissible limits of 1mg/kg value recommended by FEPA (2022) and WHO (2022).

The value of Zn in Mayfly observed was higher than that reported by Chuba *et al*. (2023) in damselfly larvae from sub-basin in te South-Eastern Brazil but lower than the report of Oremo *et al* .(2019) in macro-invertebrates (*Baetidae and Gerridae*) from River Isiukhu, Kenya. The highest Zinc Value observed in Mayfly nymph was not above the recommended permissible limits of 100mg/kg value recommended by FEPA (2022) and WHO (2022).

Cu value in Mayfly was higher than that reported by Shakirat *et al*. (2024) in macro-invertebrates (Dragonfly lavae) from River Owo, Agbara, Ogun State, Nigeria but lower than that reported by Adeola and Opeyemi 2022 in Benthic macro-invertebrates (*Aeshna cyanea* Muller, 1764) from Oyo River sediments Ilorin Kwara State, Nigeria. The monthly value of copper in Mayfly nymph was observed to be highest in May and lowest in August this could be attributed to dry season. The highest copper value observed in Mayfly nymph was not above the recommended permissible limits of 3mg/kg value recommended by FEPA (2022) and WHO (2022).

CONCLUSION

The study revealed that Lead, Chromium, Cadmium, Zinc and Copper investigated in Kiri Reservoir were not above the recommended permissible limits by NIS (2007) and WHO (2022), from the finding therefore, Kiri reservoir upside-down catfish (*Synodontis nigrita*) and Shadfly (Mayfly nymph) investigated are not polluted with these heavy metals mentioned.

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