PHYSICOCHEMICAL PARAMETERS AND COMPARISON FOR MEAN VALUES OF HEAVY METALS IN TWO DIFFERENT FISH SPECIES (*CLARIAS GARIEPINUS* AND *MORMYRUS RUME*) OF RIVER GIDIN DOROWA, WUKARI, NIGERIA

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ABSTRACT

Excess heavy metals accumulations are potentially harmful to fish and most organisms at some level of exposure and absorption. The study aim to evaluate the heavy metals concentrations in organs (gill, liver and muscles) of two different fish (Clarias gariepinus and Mormyrus rume) species of River Gidin Dorowa in Wukari Local government of Taraba State. Seventy two fish samples were purchased from alanding siteof the River and transported to the Department of Biology Science Laboratory on sampling days. Sampling of fish was carried out monthly for six (6) months. The results on physicochemical parameters of the River showed that for temperature higher mean value (34.23^{0}C) was recorded in February while lower mean value (17.85^{0}C) was recorded in October. For Dissolved Oxygen higher mean value (6.23mg/l) was recorded in February while the lower mean value (2.95mg/l) was recorded in October. Also, pH (0.00) andElectric conductivity value (0.00µs/m) were lower in the month of October during the study period. Valueof pH throughout the study range between (5.23) was the higher to (2.93) which was the lower. The highesttotal dissolve solid (TDS) mean value 86.50mg/l while the lower mean value was (28.75mg/l), recorded for November and October. The results of comparison of heavy metals mean value between the two fish species C. gariepinus and M. rume indicate that Zinc (Zns) concentration (1.6362mg/kg) was higher in M. rume than in C. gariepinus. Copper (Cu) value (0.0862mg/kg) was higher in C. gariepinus compare to M. rume.Lead (Pb) value (0.2505mg/kg) was higher in C. gariepinus than in M. rume. Cadmium (Cd) value (0.0065mg/kg) was lower in M. rume than in C. gariepinus (0.0081mg/kg) during the study. There is need for continuous monitoring and conservation of the fish and fisheries resources of River Gidin Dorowa waters and the heavy metals content therein cannot be overstress. Continuous monitoring of the pollution levels of the River Gidin Dorowa using fish species as bioindicators can provide adequate information necessary for its effective management.

KEYWORDS

Physicochemical Parameters, Heavy metals, *Clarias gariepinus*, *Mormyrus rume* and River Gidin Dorowa

1. INTRODUCTION

Pollution of the aquatic ecosystems with heavy metals has become a global concern due to the indestructible properties and adverse effects to aquatic organisms and humans alike [1]. “Heavy

metals" is a general term, which applies to the group of metals and metalloids with atomic density greater than 4 g/cm^3, or 5 times or more, greater than water [2]. Heavy metals, which especially accumulate in organs of fish, such as internal organs, kidneys, and spleen, can be transmitted to and accumulated in various organs of human body by their consumption [3];[4]. Heavy metals may occur in aquatic environments from natural processes and from discharges or leachates from several anthropogenic activities [5].

Many dangerous chemical elements such as heavy metals, if released into the environment, accumulate in the soil and sediments of water bodies. The lower aquatic organisms absorb and transfer them through the food chain to higher trophic levels, including fish. Potential of heavy metal ions to accumulate in seafood, including fish living in waters polluted with heavy metals, is rather high [6]. Contaminants can persist for many years in sediments where they hold potential of affecting human health, the environment and fish [7].

Fish has been recognized as an important food source for the human body. Fish provides essential fatty acids like Omega 3, proteins, vitamins, and minerals [8]. However, despite its nutritional value, consumption of fish contaminated with heavy metals brings many times a potential hazard concern for the human consumers. It has been reported that prolonged consumption of unsafe concentrations of heavy metals through foodstuff may lead to the chronic accumulations of the metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases [9]; [10], as heavy metals bioaccumulation. Bioaccumulation is the gradual build up over time of a chemical in a living organism. This occurs either because the chemical is taken up faster than it can be used or because the chemical cannot be broken down for use by the organism. The rate of bioaccumulation of heavy metals in aquatic organisms depends on the ability of the organisms to digest the metals and the concentration of such metal in the water body. Also, it has to do with the concentration of the heavy metal in the surrounding soil sediments as well as the feeding habits of the organism [11].

The African Catfish (*Clarias gariepinus)* is one of the most widely consumed freshwater fish in Nigeria due to its large acceptability, Family Clariidae at present consists of 14 genera, which comprise 92 species distributed in Africa and South-East Asia. African catfish (*C. gariepinus* Burchell, 1822) is of great commercial importance both in fisheries and aquaculture.
C. gariepinus is a native species of Africa and has drawn attention of aquaculturists because of its biological attributes that include faster growth rate, resistance to diseases and possibility of high stocking density [12].

Mormyrus rume is an endemic fish species of sub-Saharan Africa. It is a species of little importance quantitatively in fisheries but still particularly appreciated for consumption. It is one of the species of Mormyridae's family which shows good growth in the natural environment and therefore has a good potential for aquaculture. *Mormyrus rume* has a high vulnerability around 63%. Hence it's necessary to point to studies for a sustainable management of this ichthyological resource in order to preserve the ecological balance of hydro systems [13].

2. MATERIALS AND METHODS

2.1. Study Area

The study carried out at River Gidin dorowa,Wukari L.G.A., Taraba State, Nigeria. Wukari L.G.A., comprises various towns include Bantaji, Gidin dorowa, kumutu and others with a population of 241,546, scattered over many small to large villages throughout the area as at 2006

census and a total land area of 4,308km^2 (1,663m^2). It is multi-ethic, include Tiv, Hausa-Fulani people as well as the original Jukun race. Wukari is located between Latitude 7^o 52" and 38^{o}4"N and a longitude of 9^{o}46 and 44^o 48"E. The vegetation in Gidin dorowa is mainly secondary forest, shrubs, re-growth and swamp. There are two seasons, April and October, raining season while the month of November to March are generally much drier than the remaining months. Its annual rainfall ranges from 130 cm to 266.30 cm/yr with temperature between 32°C and 36°C. The majority of the people are farmers and fishermen. See diagram of study area Figure 1.

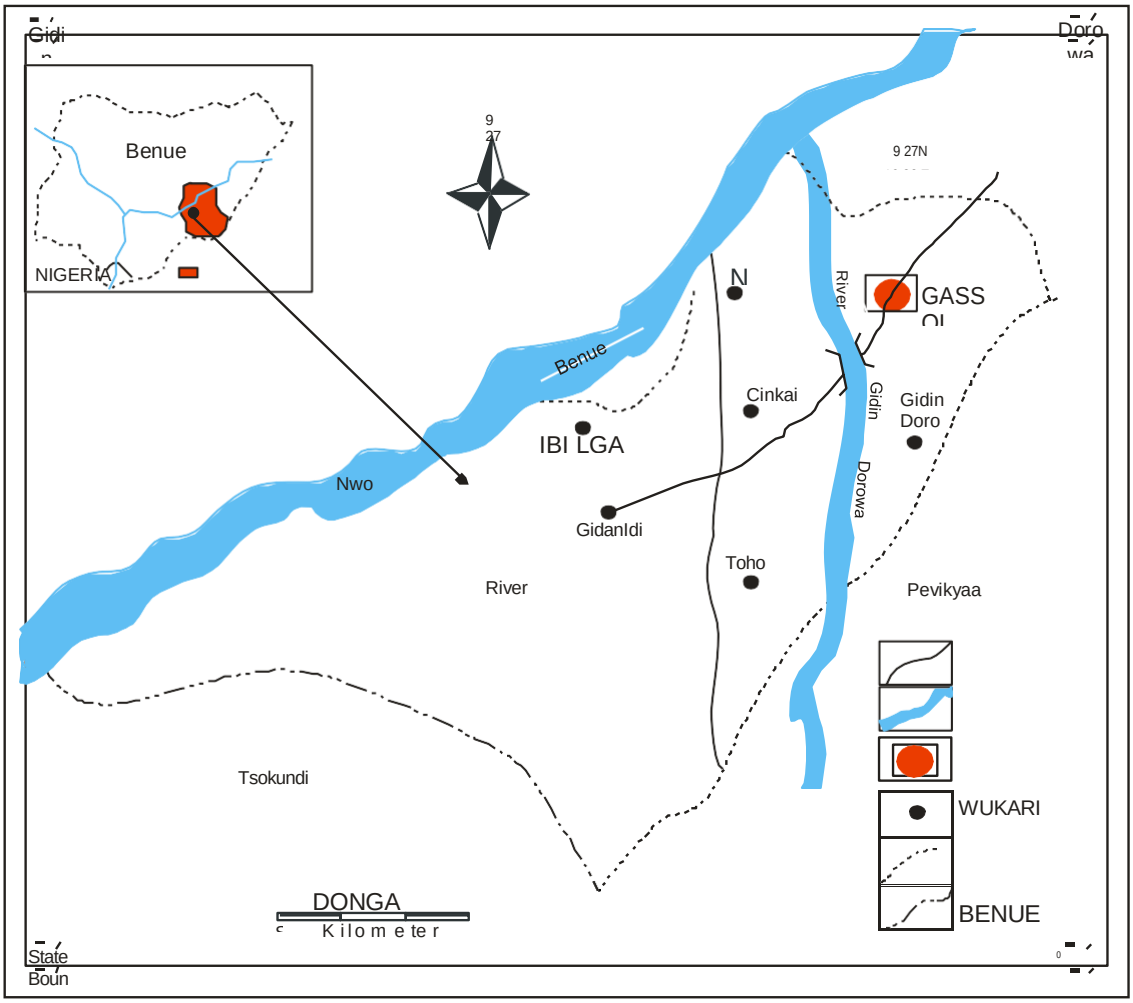

Figure 1: Map of Wukari LGA showing Gidin Dorowa (Study Area)
Source: Ministry of Lands and Survey, Jaklingo, Taraba State

2.2. Experimental Design

The Research was conducted as a factorial experiment in Completely Randomized Design (CRD) with 2 (Species) × 4 (Metals) × 6 (Months) × 3 (Sources) replicated thrice.

2.3. Collection of Fish Samples

Fish samples were purchased at the landing site and transported to the Department of Biology Science Laboratory on sampling days from the sampling location. Sampling of fish was carried out monthly for six (6) months. Fish samples obtained were identified using keys and monograph in the laboratory. The fish samples were placed in labeled clean polyethylene bags and stored in a

deep freezer. The Fish was then allowed to thaw at room temperature prior to the dissection at (27^0C) and their parts (gills, liver and muscles) were procured by dissection using a stainless steel dissection kit. These organs was oven dried at 80^0C for 48hours, milled separately using porcelain mortar and pestle, placed in labeled polyethylene packs and stored at -10^0C prior to digestion and analysis.

2.4. Digestion of Fish Samples for Heavy Metal Analysis

Fish organs (gill, liver and muscles) were treated separately. Each organ was digested using the Organic Extraction method described by [14]. 1g of each milled sample was placed in 50ml Kjeldhal flask. 10ml of nitric acid, 2ml per chloric acid and 2mlsulpuric acid (5:1:1) ratio was added to the sample in the flask. Contents of the flask were treated with moderate heat under a hood. Digestion was terminated at the appearance of white fumes. An aliquot of the digest were diluted with 10ml distilled water and further boiled for a few minutes and allowed to cool. This was subsequently filtered into 50ml volumetric flask and made up to mark. Blank samples were prepared using the same quantity of mixed acids.

2.5. Determination of Physicochemical Parameters

The following physicochemical parameters were analyzed in the field.

2.5.1. Temperature (^{0}C)

Temperature was measured using Digital thermometer on site of sample collection. The thermometer was immersed in the water sample and allowed to stabilize for two (2) minutes and the reading was taken from the screen. The temperature test was carried out for several times and the average value for water temperature was recorded.

2.5.2. Dissolved Oxygen (Mg/L)

Dissolved oxygen was measured on site of sample collection using Digital Dissolve Oxygen Meter. (407510A model).

2.5.3. pH

pH was measured using portable pH meter (PHS-550 Model) on site of sample collection. pH meter was immersed in the water sample and allowed to stabilize for two (2) minutes and the reading was taken and recorded.

2.5.4. Electrical Conductivity (µs/M)

Electrical Conductivity was measured with the help of EC meter which measures the resistance offered by the water between two platinized electrodes (DDS-307 model).

2.5.5. Total Dissolved Solids (TDS) (Mg/L)

Total dissolve solid was filtering through 1 micro meter pores. The procedure was carried out by heating the sample at 130^0C in the oven till drying of evaporated dish. TDS: Combo meter HANNA 9532 model instrument was used.

2.6. Analysis of Heavy Metals

The following heavy metals were analyzed in the fish organs Zinc (Zn), Lead (Pb), Copper (Cu), Cadmium (Cd), Mercury (Hg) and Arsenic (As) at Central Laboratory and Biological Laboratory Federal University Wukari, Taraba state. Heavy metals analyses were carried out with an Atomic Absorption Spectrophotometer. Blanks, standards and specimen digests were aspirated into the AAS using air-acetylene flame as oxidant.

2.7. Data Analysis

Generated data were subjected to one way analysis of variance (ANOVA) using statistical package for scientists and engineers (SPSS) 9.0 Edition (2012) for windows to determine the significant difference between physicochemical parameters, heavy metals and the locations at 5% level of probability. Significant means were separated using New Duncan Multiple Range Test [15].

3. RESULTS

The results of the investigation for comparison of heavy metal levels in fish organs of two commercially important fish species *Clarias gariepinus* and *Mormyrus rume* from River Gidin Dorowa are presented below in Tables 2. The mean values of physicochemical parameters measured during the study presented in Table 1.

3.1. Physicochemical Parameters from River Gidin Dorowa

The mean monthly values recorded for the physicochemical parameters from the river waters in Table 1. Showed that for temperature mean higher value (34.23^0C) was recorded in February while lower mean value (17.85^0C) was recorded in October. The dissolved oxygen higher mean value (6.23mg/l) was recorded in February while the lower mean value (2.95mg/l) was recorded in October. Also pH (0.00) and electric conductivity value (0.00µs/m) were lower in the month of October during the study period. The mean values of pH throughout the study range between (5.23) which was the higher to (2.93) was the lower. The higher total dissolve solid (TDS) mean value (86.50mg/l) while the lower value was (28.75mg/l), recorded for November and October (See Table 1. below).

Table 1: Monthly Mean Values of Physicochemical Parameters during the Study Period

MONTHS	TEMP.	D.O.	pH	E.C	TDS
SEPTEMBER	25.1 ± 0.24 [a]	4.15 ± 0.43 [a]	2.93 ± 0.06 [a]	8.00 ± 0.71 [a]	67.50 ± 4.50 [a]
OCTOBER	17.85 ± 5.97 [a]	2.95 ± 1.19 [a]	0.00 ± 0.00 [b]	0.00 ± 0.00 [b]	28.75 ± 1.25 [b]
NOVEMBER	25.90 ± 0.21 [a]	13.30 ± 7.58 [a]	5.23± 0.78 [a]	0.16 ± 0.05 [b]	86.50 ± 3.52 [c]
DECEMBER	32.43 ± 0.25 [b]	4.73 ± 0.45 [a]	4.80 ± 1.37 [a]	0.03 ± 0.00 [b]	30.25 ± 3.42 [b]
JANUARY	32.83 ± 0.48 [b]	5.63 ± 0.81 [a]	4.55 ± 0.03 [a]	0.08 ± 0.01 [b]	57.75 ± 2.79 [a]
FEBUARY	34.23 ± 0.52 [b]	6.23 ± 0.84 [a]	4.95 ± 0.12 [a]	0.09 ± 0.01 [b]	59.75 ± 2.79 [a]

KEY: TEMP= Temperature, D.O= Dissolved oxygen, E.C= Electrical conductivity, TDS= Total dissolved oxygen

Values are presented as mean ± S.E.M. Values with different superscript across the columns indicates a level of significance at ($p<0.05$).

3.2. Heavy Metals Mean Values Between the Two Fish Species *Clarias gariepinus* and *Mormyrus rume* during the Study.

The results of comparison of heavy metals mean values between the two fish species *Clarias gariepinus* and *Mormyrus rume* during the study period are presented in Table 2. The results showed that between the species heavy metals concentrations were higher in the liver followed by the gill and lower in the muscles. The heavy metals concentration were higher in *Clarias gariepinus* compare to the organs of *M. rume*. However Zinc (Zn) concentration (1.6362mg/kg) was higher in *M. rume* than in *C. gariepinus*. Copper (Cu) mean value (0.0862mg/kg) was higher in *C. gariepinus* compare to *M. rume*. Lead (Pb) mean value (0.2505mg/kg) was higher in *C. gariepinus* than in *M. rume*. Cadmium (Cd) mean value (0.0065mg/kg) was lower in *M. rume* than in the organs of *C. gariepinus* (0.0081mg/kg) during the study period.

Table 2: Comparison of Heavy Metals Mean Value concentrations (mg/kg)between *C. gariepinus* and *M. rume*(n=6)

Fish species	Cd	Pb	Zn	Cu
MR	0.0065 ± 0.0007^{a}	0.2334 ± 0.0222^{a}	1.6362 ± 0.0927^{a}	0.0695 ± 0.0097^{b}
CG	0.0081 ± 0.0070^{a}	0.2505 ± 0.0303^{a}	1.5639 ± 0.0928^{b}	0.0862 ± 0.0127^{a}

KEY: MR= *Mormyrus rume,* CG= *Clarias gariepinus*

Values are presented as mean ± S.E.M. values with the same superscript across the column indicates no level of significance at ($P<0.05$)

4. DISCUSSION

4.1. Physicochemical Parameters from River Gidin Dorowa

The mean monthly values recorded for the physicochemical parameters from the water for this study showed that for temperature higher value (34.23^{0}C) was recorded in December while lower mean value (17.85^{0}C) was recorded in October (Table 1). The water temperature were within the optimum range (23-32mg/l) ideal for fish survival and growth throughout the study period as recommended by Federal Ministry for Environment [16]. Spawning activity can decrease rapidly at temperatures below 21^{0}C or above 30^{0}C, the water must be 24^{0}C – 30^{0}C for successful hatching [17].

Environmental temperature has been found to influence breeding and reproductive behavior in fish hence it plays major role overtime. [18]. For dissolved oxygen higher mean value (6.23mg/l) while the lower mean value (2.95mg/l) was recorded in October. The dissolve oxygen range throughout the study period was within the optimum range (6- 8mg/l) recommended by the federal ministry for environment [16] best for fish survival. In many cases,

lack of sufficient dissolved oxygen limits the growth and reproductive performance of fish and encourages heavy metal adsorption to sediment.

Also pH (0.00) and Electric Conductivity mean value (0.00µs/m) were lowest in the month of October during the study period. The mean value of pH throughout the study range between (5.23) which was the higher to (2.93) was the lower, water pH was also within safe range recommended by [16] throughout the study period. Fish can live in waters having a range of 5 to 10 which is the desirable pH range for fish survival. The pH of water is influence by the amount of carbon dioxide present (Aquaculture Network Information Centre [19]. The highest Total Dissolves Solid (TDS) mean value (86.50mg/l) while the lowest value was (28.75mg/l) recorded for November and October. Total Dissolve Solid mean values was within safe limit throughout the study period. High values of Total Dissolved Solids tend to affect heavy metal availability, since this will also affect the level of sedimentation in the river water [20].

4.2. Heavy Metals Concentrations in Two Commercial Fish Species *Mormyrus rume* and *Clarias gariepinus* from River Gidin Dorowa

The result showed that between the species heavy metals concentrations were highest in the liver followed by the gill and lowest in the muscles. However, metals mean values showed significant difference ($P< 0.05$) among the two species and were higher in the organs of *C. gariepinus* compare to the organs of *M. rume*. The Zinc (Zn) concentration (1.6362mg/kg) was higher in *M. rume* than in *C. gariepinus*. Copper (Cu) mean value (0.0862mg/kg) was higher in *C. gariepinus* compare to *M .rume.* Lead (Pb) mean value (0.2505mg/kg) was higher in *C. gariepinus.* Cadmium (Cd) mean value (0.0081)higher in *M. rume*than in *C. gariepinus*(0.0065).[20; 21] Reported a similar mean value from their findings. Fish is a main food source which we all consume as protein source. It stores nutrients including heavy metals which the fish ingest through organs like the gills, and stores in the liver and muscle, that is why the whole fish or its part are used as bioindicators of heavy metals contamination in general [22].
Results obtained from this study showed that there was significant difference ($P< 0.05$) of heavy metals concentration between organs of *C. gariepinus and M. rume.* However values reported in this study were lower compare to values report by [23]in the Myonematic tissues of selected finfish species from a freshwater ecosystem in south western Nigeria and within range [24] safe limit. The lower value report in this study for Cd, Cu, Pb, could be due to differences in the species, sizes, ages, and sampling periods [25].

5. CONCLUSION

The results from this study revealed the mean values of heavy metals levels (Zn, Cd, Pb, Cu) in the two commercially important species *C. gariepinus* and *M. rume* of River Gidin Dorowa, Taraba State. The levels of Cd, Pb, Zn and Cu in the two fish species studied were below the WHO and FAO recommended limits in fish and fishery products. Cadmium (Cd) mean values were generally Low throughout the study period in both species. Though Zn, Pb, Cd and Cu Values were within the safe limits recommended by WHO/FAO for fish and fisheries products. *C. gariepinus* has more heavy metal concentration compare to *M. rume*. It is imperative that the public should be aware of long-term exposure of humans to heavy metals could lead to immune system dysfunction. Nevertheless the need for continuous monitoring and conservation of the fish and fisheries resources of River Gidin Dorowa waters and the heavy metals content therein cannotbe overstress.

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