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Determination of the distribution and concentration of some heavy metals between Male and Female fish sexes of *Bagrus bayad* (Macropterus) in River Rima Sokoto, Nigeria

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Abstract
The presence of heavy metals pollution in fresh water is known to disturb the balance of aquatic organisms and this has been noticed to manifest in the presence of irregularities in fish physiology as fish tend to contain some metals such as Pb, Cu, Zn, Cd and Cr which are responsible not only for the poor quality of water, but also for killing a number of organisms, human being inclusive. The knowledge of the level of contaminants in water bodies is of considerable importance because of its potential effect on fish and other top level predators that consume them, more especially humans. The study was carried out on the determination of the distribution and concentration of some heavy metals between Male and Female fish sexes of *Bagrus bayad* (Macropterus) in River Rima Sokoto Nigeria. It was forty (40) samples of *Bagrus bayad* specis that were obtained from River Rima in Sokoto for the study on monthly basis. The data collected was analyzed using SPSS 20.0 versions where T and F tests were adopted to check sex variability and mean monthly variation of the selected heavy metals. The result shows that bioaccumulation in relation to fish sex is not significant but with high concentration in female as 2.83 mg/l, while that of male is 2.41 mg/l. Awareness campaign, public enlighten programs and further research are highly recommended.

Keywords: Heavy metals, fish sexes, *Bagrus bayad*, River Rima

Introductions
The rapid development of agriculture and industrialization has resulted in the increase of heavy metals pollution in aquatic ecosystems, which are significantly hazardous for fish and human (Uluturhan and Kucuksezgin, 2007) [1]. Significant quantities of contaminant elements are discharged into rivers, which can be strongly accumulated and biomagnified along the water, sediment, and aquatic food chain, thus resulting in sub-lethal effects or death in fish populations (McGeer *et a1.,* 2000) [2].

Fish are commonly situated at the top of the aquatic food chain and normal metabolism of fish may accumulate large amounts of certain metals from food, water, and sediments. Commonly, fish is known to be nutritious with essential proteins, polyunsaturated fatty acids, and soluble vitamins (Gratwicke *et al.,* 2005) [3]. Nevertheless, levels of metals in fish are of interest due to their high potential to enter and accumulate in food chains (Jari, *et al.,* 2011) [4]. Even low concentrations of these elements could have damaging effects in humans and other animals, because there is no good mechanism for their elimination from the body (Chen, *et al.,* 2005) [5]. On the other hand, fish can be regarded as a good bio-indicator, because it is easily sampled and found in abundant population, with the potential to accumulate metals and has a long lifespan with an optimum size for analysis (Batvari, *et al.,* 2008) [6]. The presence of heavy metals pollution in freshwater is known to disturb the balance of aquatic organisms and this has been noticed to manifest in the presence of irregularities in fish physiology as fish tend to contain some metals such as Pb, Cu, Zn, Cd, and Cr which are responsible not only for the poor quality of water, but also for killing several organisms (Ayodele and Abubakar, 2001) [7].

The aquatic ecosystem is frequently the ultimate recipient of heavy metals pollution. Aquatic micro-fauna and micro-flora, which constitute fish food, can incorporate, and accumulate heavy metals into their living cell from their environment (Forstner and Wattman, 1981) [8].

The contamination of soil, water resources and biota by heavy metals is of major concern especially in many industrialized countries because of their toxicity, persistence, and accumulative nature (Schleunar and Maughan, 1999) [9]. Lead is a widespread environmental contaminant worldwide (Hoz-habri *et al.,* 2004) [10] and the accumulation of such trace element in aquatic organisms may lead to serious health problems through the food chain (Hoz-habri *et al.,* 2004) [10]. Consumption of fish contaminated with lead is the most likely route for human disease (Wang *et al.,* 2005) [11].

Therefore, there is need to investigate the heavy metals concentration levels of Zn, Pb Cu, Cd and Cr in water and in some commercially important fish species which impound river Rima of Sokoto state in northern Nigeria. This would enable information acquisition that relate to the safety or otherwise of the aquatic organisms exploited and consumed by the members of the immediate and distance communities that depend on the water body for drinking, irrigation, and fish protein supply.

The study is to determine the distribution and concentration levels of heavy metals in the muscle tissue of the male and female sexes of *B. bayad* fish in River Rima, Sokoto, Nigeria.

Materials and Methods

Study Area

this study was carried out on fish sample obtained Kwalkwalawa landing site located in Dundaye district of wamakko local government area in Sokoto state, north western Nigeria. on latitude 13^0 07' 78'' N and longitude of 05' 12' 25'' E at 275m above sea level (Google, 2011) [12]. River Rima flows through Dundaye and Kwalkwalawa villages, east of Usmanu Danfodiyo main campus. The community is connected to Sokoto city by a bridge and both villages are landing site for fishermen who fish along the river. River Rima is stretch of Fadama covering about 500m of wetland where rice, onion, tomatoes, lettuce, maize, and sweet potatoes are cultivated (Abdulfattah, 2009) [13].

The climatic condition of the area is semi-arid with two distinct seasons. The rainy season last for 3-4 months from mid-May to mid-September and the dry season start from October to May (Abdulfattah, 2009) [13].

Experimental Fish Collection and Preparation

The fish used for the experiment was *Bagrus bayad (Macropterus)* commonly known as naked catfish. Ten (10) samples were randomly collected monthly, five (5) male and five (5) female for a period of four months (March to June 2016), giving a total of Forty samples. Fish samples were purchased monthly from the local fishermen at Kwalkwalawa landing site of River Rima. The fish samples were washed in flowing water to remove adhering dirt and transported to laboratory in an icebox for analysis.

Determination of heavy metals

Wet Digestion

The samples were digested by combining two digestion techniques *viz;*

Nitric acid digestion technique (APHA, 1997) [14].

Hydrofluoric-perchloric acid digestion technique (Allen *et al.*, 1984) [15].

The weight and length of the fish samples were measured, and two 2 grams of body tissue from each sample was weighed into the Microjeldahl flasks, and 8ml of 60% Nitric acid (NHO_3) and 2ml of 50% Perchloric acid ($HCLO_4$) was added to each sample. The digestion was carried out in a digestion box until clear solution was observed. After the digestion, the solution was filtered through a filter paper. And the clear solutions were made up to 50ml each in volumetric flask. From the solutions, 2m1 each of the solution were pipetted into another 50ml volumetric flask and made up to mark.

From the obtained solution, absorbance was read with atomic absorbance spectrophotometer (AAS) (LF2000) at different wavelengths.

Statistical analysis

The data obtained was analyzed for heavy metals concentration on fish tissue using one-way analysis of variance (ANOVA). The significant differences between means in tissues of fish species samples studied were determined using the Duncan's multiple range tests at the significance level of $p<0.05$. The analysis was carried out using IBM SPSS (version 23).

Results

Heavy metals concentration variability between two sexes

The heavy metals detected in the muscles of Bagrus bayad fish species from River Rima include cadmium (Cd), lead (Pb) copper (Cu), and zinc (Zn). The result obtained is presented in Table 3 and it indicated that sex of fish has no effect on heavy metals concentration, where the concentration of cadmium and lead ranged from 0.06±0.06 to 1.29±1.29ppm respectively. Lead had the highest concentration followed by copper with a concentration of 0.61±0.53ppm then followed by zinc with a concentration of 0.45±0.38ppm. Meanwhile cadmium had the lowest concentration in male fish, while in female fish, lead had the highest concentration with a value of 1.88±1.94ppm followed by 0.62±0.26ppm of copper and then zinc with a concentration of 0.25±0.24ppm, cadmium had the lowest percent with the concentration of 0.08±0.06ppm.

Table 1: Sex variability in heavy metals concentration

Species	Cadmium (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
Male	0.06±0.06	0.61±0.53	1.29±1.29	0.45±0.38
Female	0.08±0.06	0.62±0.26	1.88±1.94	0.25±0.24

Means without superscripts are not significant using DMRT at P<0.05

Mean Monthly Bio-accumulation Levels of the heavy metals over the Study Period

Results of mean heavy metals concentration of male and female *Bagrus bayad* from River Rima are presented in table 4.

The trend for the metal accumulation is Pb>Cu>Zn>Cd. The mean monthly concentrations for March, April, May and June show that cadmium (Cd) had the highest concentration in March with a concentration of 0.12±0.01ppm followed by April (0.09±0.05ppm) and then May with a concentration of (0.05±0.06ppm), while the lowest concentration fall in June 0.00ppm (Figure a). The concentrations for March, April and May are statistically similar ($p>0.05$), but in June it was highly significant with the least accumulation level (Table 4). Also, the Table 4 shows the mean monthly concentration of Zinc (Zn) which ranges from 0.51±0.38 to

0.02±0.10ppm. In March and April, the lowest concentration falls on May and June with percentage of 0.31±0.05 and 0.31±0.05ppm respectively. However, there was no significant difference (p>0.05) in the concentration among the four months (Figure b). In the same vein, Table 4; indicates that Copper of 0.64±0.19 and 0.94±0.69 in March and April respectively are statistically similar, meanwhile in March, May and June were also statistically similar (Figure C).

Lead monthly concentration in March and April (Table 4) obtain the following accumulation levels 1.4±0.69ppm and 2.44±2.35ppm but May June concentration were 2.08±2.22 and 0.42±0.23ppm respectively. Meaning, that March, April and May were statistically not significantly different but similarly the same. June and March shown no significant difference (P>0.05) Figure 1.

Table 2: Mean Monthly Bio-absorption Levels of heavy metals

Parameters	March	April	May	June
Cd (ppm)	0.12±0.01^{a}	0.09±0.05^{ab}	0.05±0.06^{b}	0.00±0.00^{c}
Zn (ppm)	0.02±0.10^{a}	0.51±0.38^{a}	0.31±0.05^{a}	0.31±0.05^{a}
Cu (ppm)	0.64±0.19^{ab}	0.94±0.69^{a}	0.58±0.05^{b}	0.31±0.09^{b}
Pb (ppm)	1.41±0.69^{ab}	3.44±2.35^{b}	2.08±2.22^{b}	0.42±0.23^{b}

Means with similar superscripts on the same row are not significantly different (p>0.05)

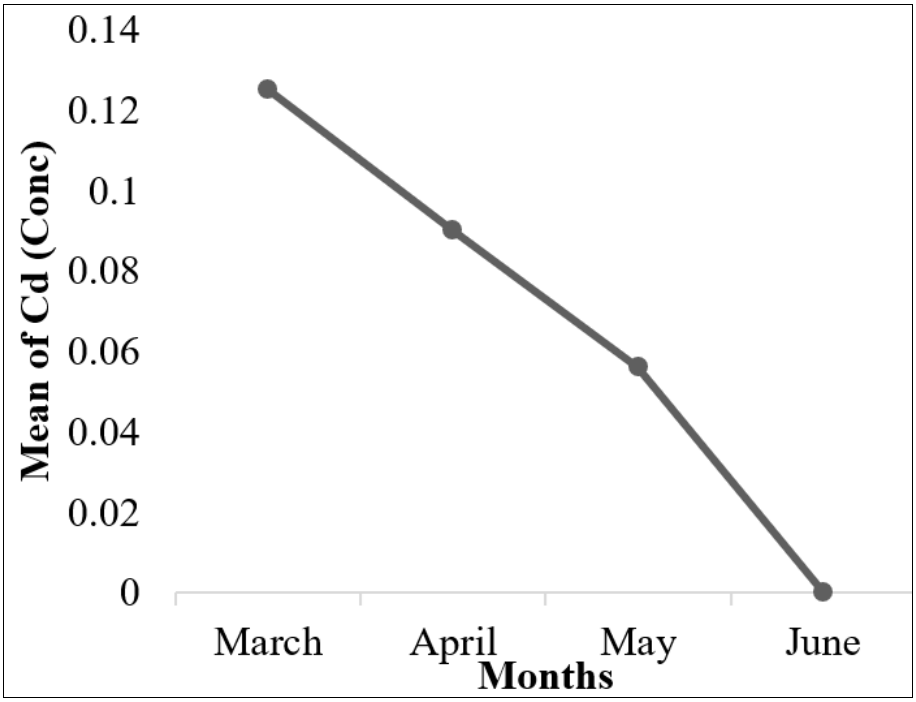

Fig 1: Mean Monthly Concentration of Cadmium (male and female) *Bagrus bayad* (March - June, 2016)

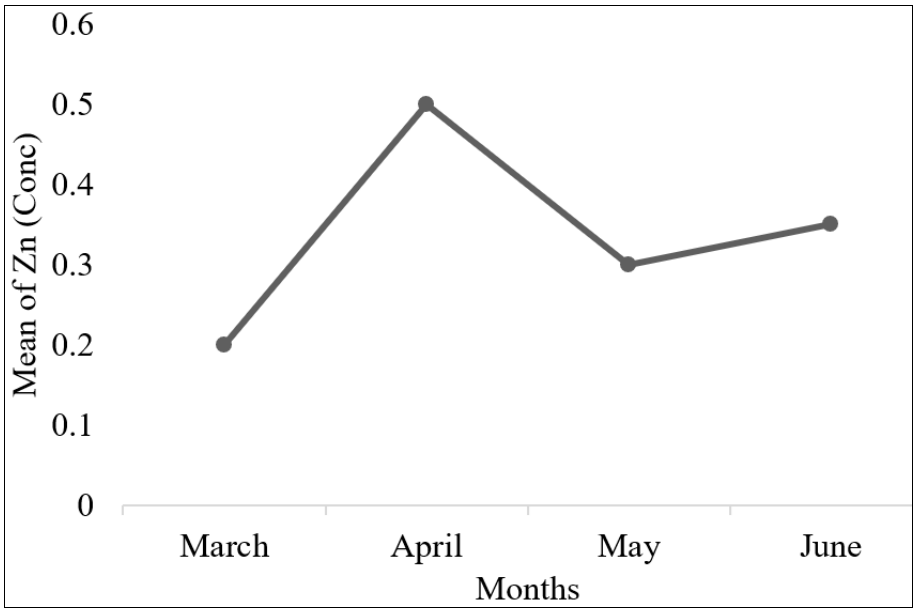

Fig 2: Mean Monthly Concentration of Zinc (male and female) *Bagrus bayad* (March - June, 2016)

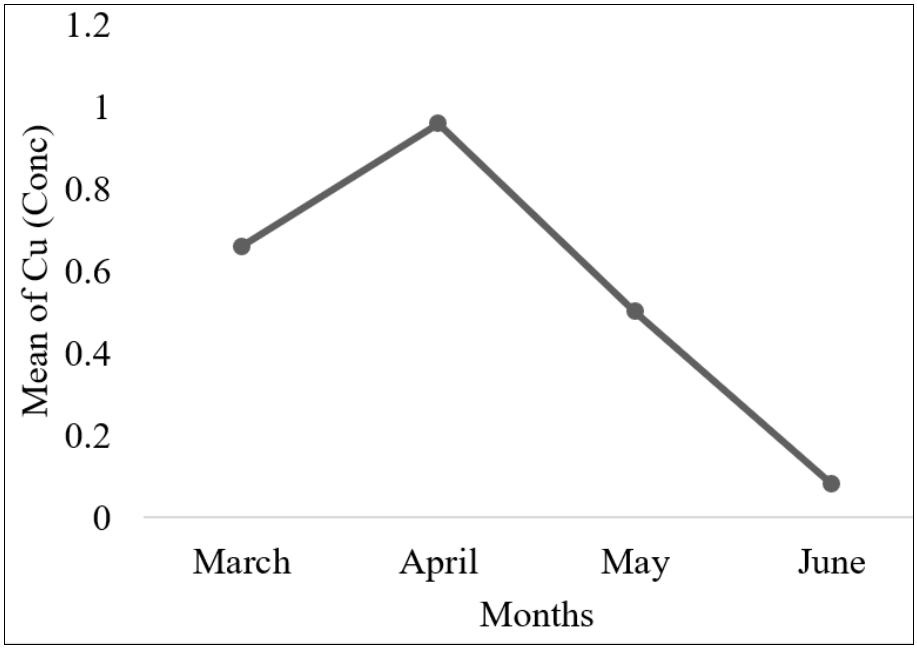

Fig 3: Mean Monthly Concentration of copper (male and female) *Bagrus bayad* (March - June, 2016)

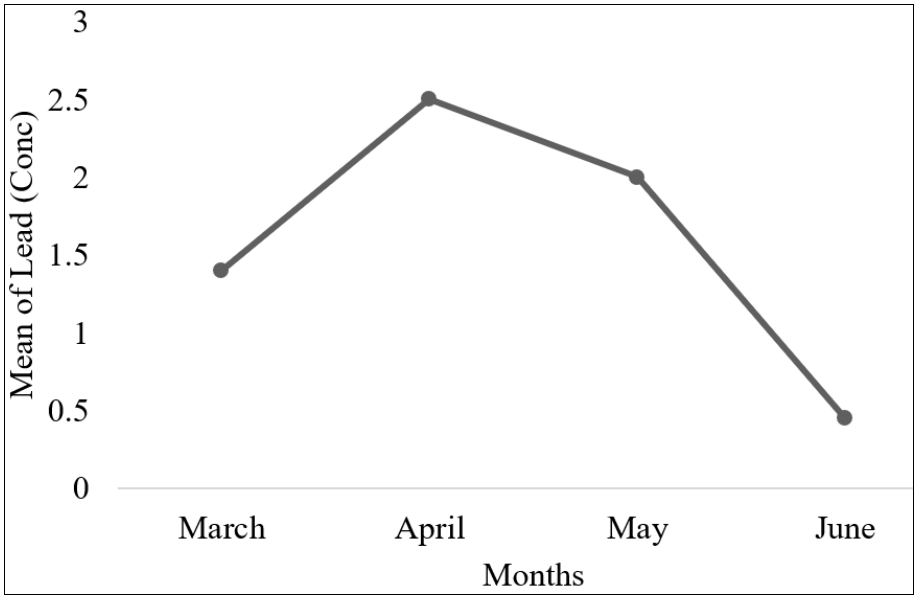

Fig 4: Mean Monthly Concentration of Lead (male and female) *Bagrus bayad* (March - June, 2016)

Discussion

Effect of Sex on Heavy Metal Concentration

According to many research, such as Andres *et al.* (2000) [16]; Canli and Atli (2003) [17]; Farkas *et al*. (2003) [18], many factors, including feeding habitats, fish size, age, physiological condition, spawning status or migration, can affect bioaccumulation of heavy metals on fish. Hence the result obtained in this study is contrary to earlier statement, that sex has no significant effect on heavy metals concentration in fishes, particularly *Bagrus bayad* species

Bioaccumulation Levels of Heavy Metals in *Bagrus bayad*

The concentration of lead observed in this study was higher than the value obtained by FAO/WHO (1989) [19]; Wyse *et al.* (2003) [20]; TFC (2002) [21]; EC (2006) [22] and Cheung *et al*. (2008) [23] recommended limits except for Range of International Standards (Yamazaki *et al.,* 1996) [24] who reported lower mean concentration (ppm) of 0.219±0.011. The values obtained in this study were also similar to the findings of Daoud *et al*. (2007) [25].

The Cadmium values in the muscle of fish species in this study were similar to the values obtained for *C. carpio, L. cephalus, T. tincaand S. lucioperca* respectively in Beyehir Lake by Altindag and Yigit (2005) [26], Zn is an essential trace element for both animals and humans. Zn is an essential component of many enzymes participating in the synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids as well as in the metabolism of other micronutrients (WHO, 1998) [27]. Zn also showed a protective effect against the Cd and Pb toxicity (Malik *et al.,* 2010) [28]. Zn concentration in this study disagrees with the findings of (Murugan *et al.,* 2008) [29] who reported higher concentration of Zn in the gills of *Labeo dyocheilus, Wallago attu and* in the liver of *C. punctatus.* Although zinc is an essential element, at high concentrations, it can be

toxic to fish, cause mortality, growth retardation and reproductive impairment (Sorenson, 1991) [30]. Zinc can interact with other elements and producing antagonistic, additive, or synergistic effects (Malik *et al*., 2010) [28].
Copper (Cu) is an essential part of several enzymes and is necessary for the synthesis of hemoglobin, but higher intakes of Cu can cause adverse health problems (Malik *et al*., 2010) [28]. Average Cu content in this study is below the tolerable limit as recommended by WHO (1971) [31].

Conclusion

The results obtained in this study shows that bioaccumulation in relation to fish sex is not significant, but with higher concentration in female (2.83 mg/l as grand mean total) and that of male (2.41mg/l as grand total). Meanwhile, the mean monthly concentration is within the maximum permissible limit published by WHO (1985) and FEPA (2003).

Recommendation

The research should be conducted during the training season to find out whether the year and location have effect on the concentrations of these metals in the fish muscle. Enlightment campaign should be made to alert the public through various media, traditional councils at the grassroots concerning the impending dangers of indiscriminate oils, slaughter, Agricultural activities, domestic dump and effluent discharges from neighboring villages around the water body either directly or indirectly. Further research should also be carried out to cover some other visceral tissues or organs aside muscles.

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