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SPECTROPHOTOMETRIC DETERMINATION OF SOME HEAVY METALS IN SOME SELECTED FISH SPECIES COLLECTED FROM RIVER TELLA, GASSOL, TARABA STATE

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ABSTRACT

The concentrations of heavy metals (Cu, Zn, Cr, Cd and Pb) were measured in the tissues of some selected fish species (Clarias gariepinus, Oreochromis niloticus and Synodontis gambiense) from Tella River, and also the condition factor of these fish species inhabiting the river was evaluated. The concentrations of these metals in the fish sample were determined by Atomic Absorption Spectrophometry (AAS). The result show that among the five element analyzed only two (Cu and Zn) were detected in all the samples collected; Pb was detected in small amount in the months of November, December and January. Cr and Cd were below detection limit. The mean value of metal concentration of Cu in C. gariepinus, O. niloticus and S. gambiense is 0.159, 0.285 and 0.194 mgkg-1 respectively. Similarly the mean value of metal concentration of Zn in C. gariepinus, O. niloticus and S. gambiense is 0.248, 0.303 and 0.260 mgkg-1 respectively. From the obtained, the concentration of heavy metal was found to be slightly higher in the months of November and lowest in the months of February and March. The mean concentrations of heavy metals in tissues of the fish were different among species; this indicated that different species from the same area contained different levels of heavy metals in their tissues. The result also revealed that the concentration of metals among the species as compared with the international permissible limit were within the acceptable limit. The results of the ANOVA pointed that there is no significant difference in the concentration of heavy metals in fish flesh of the various fish species at (P-value < 0.05). It was also

observed that the fish species recorded varying condition factors, some samples shows slight increases in K – value while others within the normal range. Most of the fish species sampled in this present study had condition factors ≥ 1, and were within the normal recommended ranges. It was also stated from previous study that condition factor greater or equal to one is good, indicating a good level of feeding, and proper environmental condition.

***Keywords**: Heavy Metals, River Tella, Fish Species, Condition Factor, AAS.*

INTRODUCTION

A heavy metal is a member of a loosely defined subset of element that exhibits metallic properties. It's mainly includes the d-block transition metals, some metalloids, lanthanide and actinides. Many different definitions have been proposed, some based on density, colour, some based on atomic number or atomic weight and some on chemical properties or toxicity [6]. Certain heavy metals are nutritionally essential for healthy life when present in small quantities and are refer to as the trace elements (e.g. iron, copper, manganese and zinc). While some heavy metals are toxic or poisonous to the body (e.g. lead, mercury, cadmium, Chromium and Arsenic) [3]. These elements enter into water through weathering, industrial activities, and disposal of sewage by human activities and through agricultural activities. Heavy metals are also used in industrial application such as in the manufacture of pesticides, fertilizers, electroplated metal parts, textile dyes, steel etc. [10]. Increasing human influences through heavy metal pollution have over the years led to the depletion of our aquatic biodiversity. As a result, several important endemic fish species have become threatened. Realizing this, concern for the assessment of heavy metals in fish species of most water bodies have increasingly been gaining ground throughout the world [11], [15]. Fish accumulate toxic metals directly from water and diet, and contaminant residues may ultimately reach concentrations hundreds and thousands of times above those measured in the water, sediment and food. These metals are known to be environmentally stable, non-degradable and induce toxic effect. Heavy metals are normal constituents of aquatic environment that

occur as a result of pollution principally due to discharge of untreated wastes and agricultural activities into the rivers [17], [10].

Bioaccumulation of heavy metals in the tissues of aquatic organisms has been identified as an indirect measure of abundance and availability of metals in the aquatic environment, and for this reason, monitoring fish tissues contamination serves an important function as an early warning for sediment contamination or related water quality problems [15]. This will enable relevant authorities to take necessary action or measures to protect the general public health and the environment [23, 25]. Heavy metals are persistent environmental contaminants that are very harmful because of their potentials to accumulate in different body parts. Most are extremely toxic because of their solubility in water, and even at lower concentrations they may have damaging effects because of the lack of good mechanisms for eliminating them [1]. Prolonged intake of heavy metals through foodstuffs may lead to chronic accumulation in the kidney and liver of humans and animals causing disruptions of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases [24], [6]. Some heavy metals such as Cu, Zn, Mn, and Co act as nutrients for the growth of animals and humans when present in small quantities, whereas others such as Cd, As, and Cr act a s carcinogens [18] and, Hg and Pb are associated with the development of abnormalities in children [14]. The aim of this research is to determine the level of heavy metals in tissues of some selected fish species from River Taraba at Bali, and to analyze the condition factor of these fish species inhabiting the river.

MATERIALS AND METHOD

Study Site

The study was carried out at River Tella in Tella town, Gassol Local Government Area of Taraba State, Nigeria. Gassol local government area of Taraba State lies between latitude 8o32 N and 7o26 N of the equator and longitude 10 o26 E and 46o 14 E of the prime meridian (Topographic sheet, 1968). It is found in dry guinea savannah. It is amongst the largest local Government in Taraba State, with an estimated land area of 5,548 km2. Based on the results of the 2006 National Population Census, Gassol local Government had a population of about 244,749 persons (NPC, 2006). It has

a tropical climate marked by two seasons; dry and rainy seasons. The rainy season starts around May and ends November occasionally, with 1300 – 1400mm rainfall annually. The dry season is from December to April. Gassol is one of the eight LGAs of Taraba State whose majority population is the Fulani and Wurkun people. The major occupation of the inhabitants is farming, fishing and nomadism. In addition, Public servants, traders and artisans also inhabit the area. Their water sources for domestic and agricultural uses are River Tella, Borehole, ponds and wells.

Samples collection and analysis

The fish samples (Clarias gariepinus, Oreochromis niloticus and Synodontis gambiense) were collected from River Tella town using standard procedures as described by [22]. Samples were collected randomly from fishermen catches at the landing sites between 9:30 am – 11:30 am bi-monthly for six (6) months from November 2019 – April 2020. The measurement of the total length (cm) of each fish was taking from the tip of snout (mouth close) to the end of caudal fin using meter rule. The body weight (g) was measured using electronic digital balance and the condition factors of individual fish sampled were recorded. The samples were then dissected and their organs (kidney, gills and muscles) were separated. The organs were oven dried and pounded into fine powder and kept in a plastic container for analysis [1]. The relationship between length and weight of the fish was examined by simple linear regression. The parameter of lengthweight relationship of sampled fish species were evaluated using the equations below; [16]. $W = aLb$ - - - - - - - - equation 1

Where, W is weight of fish (g), L is length of fish (cm), a, is initial growth coefficient, and b is growth coefficient. The values of constant 'a' and 'b' were estimated after logarithmic transformation of eqn. 1 using the least square linear regression given:

$\log10W = \log10a + b\log10L$ - - - - - - equation 2

The condition factor was calculated by the formula describe by [12]:

Condition Factor (K) = $100W/ L3$ - - - - - - equation 3

Where W is weight (g) and L is total length (cm).

Digestion of Sample and Heavy Metal Analysis

For each sample, 0.2 g was weighed into a digestion tube and 4.5 ml of the digest reagent was added. The tube was kept on a digestion block and at a

temperature of 3600. The mixture was allowed to digest for 2 hours then cooled off. 1 ml of H2O2 was added to each tube and then allowed to digest completely for another hour until a clear solution is obtained. The solution was allowed to cooled, filtered through a Whitman filter paper No. 42. The filtrate was made up to the 50 ml mark by adding distilled water. The mixture was used to analyze the heavy metals contents using AAS, based on the manufacturers' instructions for each heavy metal [15], [17].

Statistical analysis

Statistical analysis was conducted to determine the differences in the heavy metal contamination of the three species of fish within the studied site. Analyses of variance (ANOVA) have been conducted to determine the statistical significant difference among the three fish species due to presence of heavy metals in the river. The statistical significance level was set at $p<0.05$. All test procedures were performed in a computer program SPSS. III.

RESULT AND DISCUSSION

The result of this research suggests that the concentration of heavy metals in the river depends on the availability and nature of clay sediment present. The concentrations of heavy metals (Pb, Cu, Cr, Cd and Zn) were measured in the tissues of some selected fish species (Clarias gariepinus, Oreochromis niloticus and Synodontis gambiense) from River Tella at Gassol, and also the condition factor of these fish species inhabiting the river was evaluated. The concentrations of these heavy metals in the fish sample were determined by Atomic Absorption Spectrophometry (AAS). Table 1 below: Show the morphometric characteristics, average length, average weight and condition factor of the studied fish species. O. niloticus had the highest number of fish sampled; N = 51 with a total average length, ranging from 14.98 to 18.65 cm, and average weight ranging from 34.61 to 64.52 g. C. gariepinus had the medium number of fish sampled N = 45 with a total average length, ranging from 15.56 to 18.92 cm, and average weight ranging from 47.58 to 70.56 g. S. gambiense was the least species of fish sampled N = 42 with a range from 16.11 to 20.62 cm in total average length, and average weight ranging between 45.78 and 67.43 g. The highest

condition factor (K – value) = 1.92 was observed in S. gambiense by January, while the lowest K – value = 0.95 was recorded in C. gariepinus by April. O. niloticus had a marginal K – value of 1.79. The condition factor (K) gives information on the physiological condition of fish in relation to its welfare. It is reported that fishes with a low condition index are presumably believed to have experienced adverse physical environment or insufficient nutrition [13]. According to [7], from a nutritional point of view, increase in K values indicates the accumulation of fat and sometimes gonadal development. Meanwhile from a reproductive point of view, the highest K values are reached in species if the fish is fully mature, and have higher reproductive potentiality. It was observed that the three fish species sampled in this study recorded varying condition factors, some samples shows slight increases in K – value while others within the normal range. Most of the fish species sampled in this present study had condition factors ≥1, and were within the normal ranges as recommended by [21] who stated that condition factor greater or equal to one is good, indicating a good level of feeding, and proper environmental condition. It was recommended from previous research that K value range from 2.9 – 4.8 is suitable for matured fresh water fish [2]. The condition factors of the three fish species sampled in the present study revealed that the fish species had their K values outside and within the range recommended as suitable for matured fish in fresh water. This could be caused due to environmental factor such as damming the river [21].

Table 1: The morphometric characteristics, average length, average weight and condition factor of the studied fish species.

Collection Month	English Name of the fish	Scientific Name	Sample Size (N)	Average Weight (g)	Average Total Length (cm)	K – value
November	Cat Fish	Clarias gariepinus	8	65.66	18.34	1.27
December			9	64.40	17.81	1.61
January			9	47.58	15.56	1.87
February			7	51.42	18.99	1.23
March			7	59.81	15.67	1.87
April			8	70.56	18.92	0.95

November	Tilapia	Oreochromis niloticus	9	56.61	17.97	1.23
December			8	64.52	18.65	1.17
January			9	34.61	14.98	1.44
February			8	49.43	15.72	1.79
March			9	62.23	16.56	1.57
April			10	62.70	17.37	1.70
November	Nile Squeaker	Synodontis gambiense	7	67.43	20.62	0.99
December			7	45.78	16.53	1.39
January			9	56.90	16.11	1.92
February			8	65.81	18.98	0.97
March			8	64.43	17.63	1.60
April			7	57.56	18.51	1.34

The comparison among fish species in River Tella according to their metal accumulation levels in tissues is given in Table 2 below. The result show that among the five elements analysed (Pb, Cu, Cr, Cd and Zn), the concentration of Cu and Zn were detected in all the samples collected while Pb was detected in the months of November, December and January in little quantity. Cr and Cd were below the limit of detection. The mean value of metal concentration of Cu in C. gariepinus, O. niloticus and S. gambiense is 0.159, 0.285 and 0.194 mgkg-1 respectively. Similarly the mean value of metal concentration of Zn in C. gariepinus, O. niloticus and S. gambiense is 0.248, 0.303 and 0.260 mgkg-1 respectively. From the obtained, the concentration of heavy metal was found to be slightly higher in the months of November and lowest in the months of February and March. An analysis of variance (ANOVA) has been conducted to determine whether there was significant difference in the concentration of heavy metals in fish flesh of the various fish species. The results of the ANOVA pointed that there is no significant difference in various flesh of fish species at (P-value < 0.05) due to heavy metals concentration as stated by [19], that heavy metals entering into the rivers through various sources are adsorbed onto suspended particulates and form free metal ions and soluble chemical complexes that are available for uptake by aquatic organisms.

Table 2: Heavy Metal Concentration (mgkg-1) of the Fish Species in River Tella

Month	Fish Species	Pb	Cu	Cr	Cd	Zn
November	CG	0.021	0.232	BDL	BDL	0.372
	ON	0.024	0.144	BDL	BDL	0.262
	SG	0.018	0.122	BDL	BDL	0.196
December	CG	0.017	0.273	BDL	BDL	0.185
	ON	0.014	0.146	BDL	BDL	0.273
	SG	0.011	0.244	BDL	BDL	0.333
January	CG	0.008	0.144	BDL	BDL	0.396
	ON	0.009	0.098	BDL	BDL	0.266
	SG	0.004	0.144	BDL	BDL	0.369
February	CG	BDL	0.089	BDL	BDL	0.285
	ON	BDL	0.186	BDL	BDL	0.239
	SG	BDL	0.232	BDL	BDL	0.321
March	CG	BDL	0.166	BDL	BDL	0.163
	ON	BDL	0.188	BDL	BDL	0.245
	SG	BDL	0.184	BDL	BDL	0.098
April	CG	BDL	0.049	BDL	BDL	0.087
	ON	BDL	0.092	BDL	BDL	0.234
	SG	BDL	0.236	BDL	BDL	0.239
Mean	CG	0.015	0.159	BDL	BDL	0.248
	ON	0.042	0.285	BDL	BDL	0.303
	SG	0.011	0.194	BDL	BDL	0.260

NB: BDL = Below Detection Limit, CG = C. gariepinus, ON = O. niloticus, SG = S. gambiense

The mean concentrations of heavy metals in tissues of the fish were different among species; this indicated that different species from the same area contained different levels of heavy metals in their tissues. The metal concentration of fish species in River Tella and its comparison with International Standards (FAO, WHO, and USFDA) is given in table 3 below. The result revealed that the concentration of metals among the three fish

species as compared with the international permissible limit were within the acceptable value.

Table 3: Permissible limits of heavy metal concentration (mgkg-1) in fish

Heavy metal	FAO 1983	FAO 2003	WHO 2006	USFDA 1993	HM concentration in fish for current study		
					C. gariepinus	O. niloticus	S. gambiense
Pb	0.5	0.5	2.0	0.5	0.015	0.042	0.011
Cu	30	30	3.0	-	0.159	0.285	0.194
Cr	1.0	-	0.15	-	BDL	BDL	BDL
Cd	0.5	0.5	-	0.01-0.21	BDL	BDL	BDL
Zn	30	40	20	-	0.248	0.303	0.260

NB: BDL = Below Detection Limit

The table 4 below indicates the monthly record of water quality parameters (Temperature, pH, Conductivity, Dissolve Oxygen and Total Dissolve Solid) of River Tella. Water quality testing is an important part of this research and of environmental monitoring. When water quality is poor, it affects not only aquatic life but the surrounding ecosystem as well. Hence the mean value of the water quality parameters at the study area are; temperature is 28.75 oC, pH is 7.85, conductivity is 36.92, Dissolve Oxygen is 8.06 and Total Dissolve Solid is 3.07.

Table 4: Mean Value of Water Quality Parameters of River Tella

Month	Temp. (oC)	Ph	Conductivity	DO	TDS
November	28.69	8.87	40.07	6.71	2.44
December	27.98	8.25	40.01	7.44	2.95
January	27.73	8.03	38.42	8.01	3.11
February	28.67	7.65	34.32	8.36	3.23
March	29.45	7.25	37.40	8.53	3.26
April	29.97	7.05	31.28	9.30	3.45

Mean value	28.75	7.85	36.92	8.06	3.07

CONCLUSION

The concentration of some heavy was successfully determined using atomic absorption spectrophotometric method. The mean concentrations of heavy metals in the fish tissues were different among species; this shows that different fish species from the same area contained different levels of heavy metals in their tissues. The result revealed that the concentration of metals among the species as compared with the international permissible limit (FAO, WHO, and USFDA) were within the acceptable limit. The result shows no significant difference in the concentration of heavy metals in fish flesh of the various fish species at (P-value < 0.05). It was also observed that the fish species recorded varying condition factors, some samples shows slight increases in K – value while others within the normal range. Most of the fish species sampled in this present study had condition factors ≥ 1, and were within the normal ranges as recommended by [20] who stated that condition factor greater or equal to one is good, indicating a good level of feeding, and proper environmental condition. Therefore, the results of the present study can serve as baseline data for these species and for comparisons with future studies.

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