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AN APPRAISAL OF HEAVY METALS CONTENT IN TWO FISH SPECIES (*Bagrus bayad* and *Synodontis batensoda*) IN RIVER-NUN, AMASSOMA, BAYELSA STATE, NIGERIA

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AUTHOR'S CONTRIBUTION

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

An appraisal of heavy metals content in two fish species (*Bagrus bayad* and *Synodontis batensoda*) landed in the shores of River-nun, Amassoma Bayelsa State, Nigeria was investigated. This was done in order to investigate the safety of consuming these fish species from the river and gauge the pollution status of the creek. The concentrations of heavy metals Lead (Pb), Chromium (Cr), Nickel (Ni) and Iron (Fe) were measured in the flesh of the fish collected from three main landing areas (Jetty, Market front and sand field) in the River-nun at Amassoma. The data were analysed for means and standard deviation. An independent sample T-test was conducted to measure the variability and similarities in heavy metal parameters at the 95% (P=0.05) confidence limit. This was aided by the use of the SPSS® 20.0 statistics tool kit. The result of the study indicate that the levels of the heavy metals Pb and Fe were significantly different (P<0.05) while there was no significant difference (P>0.05) in Ni concentration between the two fish species. *Bagrus bayad* showed greater content of Ni and Fe than in Synodontis *batensoda* but lower Pb content. The levels of Ni and Pb show a greater amount in the fish than the European Union suggested maximum limit, but were within the FAO/WHO permissible limit. The presence of Pb a non-essential metal even in trace amounts in fish tissue portends grave danger if consumed in large amounts. Based on the findings from this study, it can be inferred that the consumption of these fish species in plenteous amounts may pose a serious threat to health because of the risk of bio-accumulation.

Keywords: Heavy metals; *Bagrus bayad*; *Synodontis batensoda*; river-nun; Amassoma; Bayelsa State.

1. INTRODUCTION

In Nigeria, fish is the cheapest and most accessible form of animal protein. Apart from its affordability, consuming fish provides an important source of protein, polyunsaturated fatty acids (PUFA), liposoluble vitamins and essential minerals, which are associated with health benefits and normal growth [1, 2]. Therefore, the American Heart Association recommended eating fish at least twice per week in order to reach the daily intake of omega-3 fatty acids [3]. It has a better nutritional value compared to meat [4]. Sadly, domestic fish production through capture and culture fisheries in Nigeria cannot meet local demand [4]. Importation of frozen fish from abroad remains the most veritable option. Interestingly, the government of Nigeria has banned the importation of fish leaving local production the only option.

Therefore considerable amounts of fish are landed daily in our shores by artisanal and commercial trawlers fishing in Nigeria coastal waters in an

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attempt to meet the humongous demand. The River-nun is one of such waters that provide a source for artisanal fishers to provide the much needed fish. In the River-nun at Amassoma axis, *Bagrus bayad and Synodontis batensoda* make up a remarkable percentage of daily landed fish catch of commercial importance [5]. They are highly priced fishes and constitute the main protein source in the delicacies of the Amassoma people.

Globally, fish constitute an important part of human diet therefore it is not surprising that the quality and safety aspects of fish are of particular interest. In the last few decades, the concentrations of heavy metals in fish have been extensively studied in different parts of the world [6]. Since diet is the main route of human exposure to heavy metals, the pollution status of our waters is of grave concern [7]. Pollution of the waters in the Niger Delta region of Nigeria is a constant phenomenon. Heavy metals enter water ways through municipal waste discharges, run-offs from agricultural fertilizers, crude oil spills through sabotage or equipment failures and illicit use of chemical detergents by international multinational companies (IOC's) to disperse crude oil and cover up their misdeeds.

There is presently, however, little or no information on the heavy metals concentration levels of fishes landed in the shores of River-nun at Amassoma despite its seemingly polluted status.

Thus, the knowledge about the potential accumulation of heavy metals in these fish species is very important for the health of the consumers. This study is therefore an attempt to address these health concerns and evaluate the environmental health of the River.

2. DESCRIPTION OF STUDY AREA

The study area is the River Nun, along the Amassoma axis which receives its source of water from the River Niger. The area of study lies between longitude 6°6' 56.35" E to 6°6' 49.05" E and latitude 4°58' 11.4" N to 4°58' 11.15" N in Amassoma community in Southern-Ijaw Local Government Area of Bayelsa State, Nigeria. The river serves as a major source of water supply to the inhabitants for transportation, fishing, artisanal dredging and dumping of waste.

2.1 Study Organism (fish: *Bagrus bayad* and *Synodontis batensoda*)

The two fish species; *Bagrus bayad* and Synodontis batensoda were selected for the study. They were purchased early in the morning from local fishers and identified to species level by template keys provided by Betancur-R [8].

2.2 Sample Collection and Transport

The fish samples were collected from fishers at the shores of River-Nun, Amassoma water front (Jetty, Market front and sand field areas). They were brought in plastic buckets to the Chemical Science Laboratory of the Niger Delta University, Amassoma, Bayelsa State.

2.3 Sample Preparation

Fish samples were brought to the laboratory alive. They were washed under a running tap, drained, dried and placed in sealed poly-ethylene bags and kept in a freezer at -4°C over night before chemical analysis. The fish were then thawed and the muscular tissues from dorsal, abdominal and tail regions of each fish were taken out and homogenized. Four grams of the homogenized muscles (without skin) were taken from each specimen and placed in 300 ml kjeldahl digestion tubes. A digestion mixture containing 6.0 ml of high purity nitric acid (Merck), 2 ml of hydrochloric acid (10 M) and 4 ml of hydrogen peroxide (35%) were then added to each tube [9].

The samples were then heated to 130°C by kjeldahl heating digester until clear solutions were obtained. The digested portions were filtered through Whitman filter paper (No. 42) and diluted to a final volume of 50 ml using deionized water. The analytical technique used to determine heavy metal levels in all samples was thermos-element Solar S4 Atomic Absorption Spectroscopy (International Equipment Trading Ltd, USA).

At each step of the digestion processes, acid blanks (laboratory blank) were prepared in order to ensure that the samples and chemicals used were not contaminated. They were analyzed using the atomic absorption spectrophotometry before the samples and their values were subtracted to ensure that the equipment read only the exact values for each heavy metal. Each set of digestion has its own acid blank and was corrected by using its blank.

2.4 Atomic Absorption Spectroscopy

This technique makes use of absorption spectrometry to assess the concentration of trace heavy metal in the sample. The digested fish samples were then subjected to atomic absorption spectroscopy analysis for the various trace metals. The analysis was done with acetylene/ air gas combination at various lamp current and wavelengths.

2.5 Statistical Analysis (Data Analysis)

Means and standard deviation were calculated for all metal parameters for the experimental fish samples. Independent sample T-test was used at the 95% probability level to compare means for the heavy metal characteristics of the different fish species from River-Nun, Amassoma, Bayelsa State. Correlation analysis was employed to measure the degree of variability and relatedness of the heavy metal characteristics. SPSS (R) (version 20.0) software was employed to aid in the data analysis procedure.

3. RESULTS

The heavy metal concentrations of Pb, Cr, Ni, and Fe in the muscles of the analyzed two fish species are presented in Table 1 by mean values and standard deviations. All results are expressed as µg/g wet weight. There were differences among the heavy metal concentrations in the muscles of the two fish species. The highest concentrations were for Fe, and the lowest were for Pb.

None of the fish species was consistently high for all metals. While *Bagrus bayad* had the highest levels of Ni and Fe, *Synodontis batensoda* had the highest levels of Pb. The heavy metal concentrations displayed the following trend: Fe> Ni> Pb >Cr for *Bagrus bayad* fish and Pb>Ni> Fe>Cr for *Synodontis batensoda* fish.

4. DISCUSSION

This study was undertaken to investigate heavy metal concentrations in the landed catch of edible parts (muscle) of two commercially important fish species in River-nun, Amassoma, Bayelsa State, because the concentration of heavy metals in commercial fish species available in this region was rarely investigated. Although it is well known that fish muscle is not an active tissue in accumulating heavy metals [17], the present study is concerned with the heavy metal concentrations in the fish muscles because it is the most consumed portion by the Amassoma people in particular and Nigerians in general. Furthermore, it is documented that some fish in polluted regions may accumulate substantial amounts of metals in their tissues which sometimes exceeded the maximum acceptable levels [18]. While a large number of literature are available on heavy metal concentrations in fish, the majority of them are concerned either in different fish species collected from the other water bodies outside of the River-nun.

This investigation shows that the two different fish species contain different mean concentrations of heavy metals in their muscles (Table 1). Apart from Cr which was non detectable in fish tissues, heavy metal characteristics of Pb, Ni and Fe were high. This may not be unconnected with the fact that both fish species are bottom dwelling fishes who feed on sediment sources. Kilgour [19] indicated that animals which have close relationship with sediment, show relatively high body concentrations of metals. Grey mullet for instance tend to be near the sediment region feeding on detritus, diatoms, algae, microscopic invertebrates and fish parts .and therefore contain high concentration of pollutants in their tissues [17, 20].

The difference in metal concentration for the two fish species can also be explained in their different feeding habits. Metal bioaccumulation of fish is species-dependent. Feeding habits (as carnivores, herbivores, omnivores and limnivores) and habitats of species are strongly related to accumulation level [21, 22]. *Synodontis batensoda* is a limnivore feeding directly on the bottom sediment whilst *Bagrus bayad* is a carnivore that pouches on the former. The higher levels of Ni and Fe in the tissues of *Bagrus bayad* may therefore be as a result of bio-accumulation and magnification.

Metal bioaccumulation by fish and subsequent distribution in organs is greatly inter-specific. In addition, many factors can influence metal uptake like sex, age, size, reproductive cycle, swimming patterns, feeding behavior and living environment [23,24].

Table 1. Mean heavy metals concentration in fish species

Fish Types	Heavy Metals (Concentration µg/g)			
	Pb	**Cr**	**Ni**	**Fe**
Bagrus bayad	*0.14±0.00[a]	ND	0.2107±0.002[a]	8.305±0.002[a]
Synodontis batensoda	0.50±0.007[b]	ND	0.153±0.002[a]	1.275±0.001[b]

*ND – Not Detectable. *Mean±Standard deviation. Means with the same letter superscript along the same column are not significantly difference*

Table 2. Maximum standard levels (µg/g wet weight) of metals in fish

Organization	Metals					Reference
	Cd	**Cu**	**Mn**	**Ni**	**Pb**	
European community	0.05	-	-	-	0.2	[10]
FAO (1983)	-	30	-	-	0.5	[11]
England	0.2	20	-	-	2.0	[12]
Turkish guidelines	0.1	20	20	-	1	[13]
FAO/WHO limit	0.5	30	-	-	0.5	[14]
EU limit	0.1	10	-	-	0.1	[15]
Saudi Arabia	0.5	-	-	-	2.0	[16]

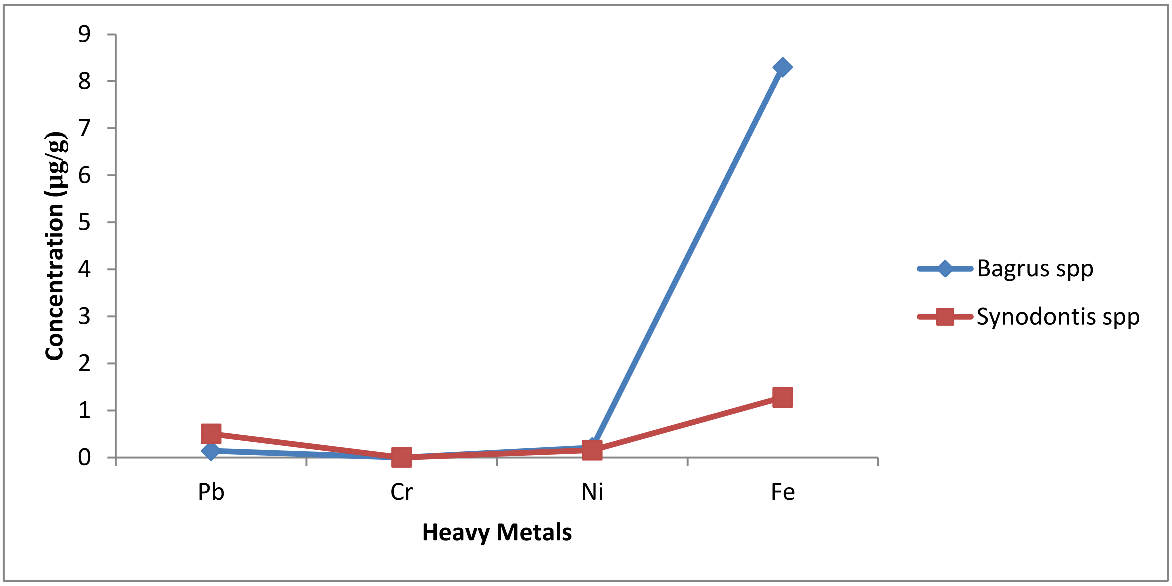

Fig. 1. Heavy metal concentrations in fish species in study area

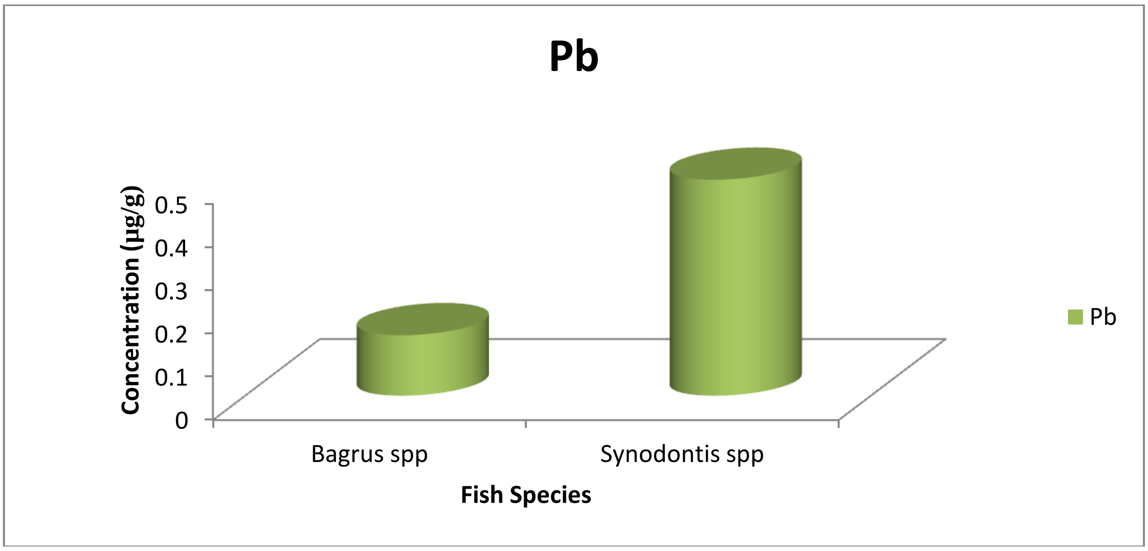

Fig. 2. Pb concentrations in fish species in study areas

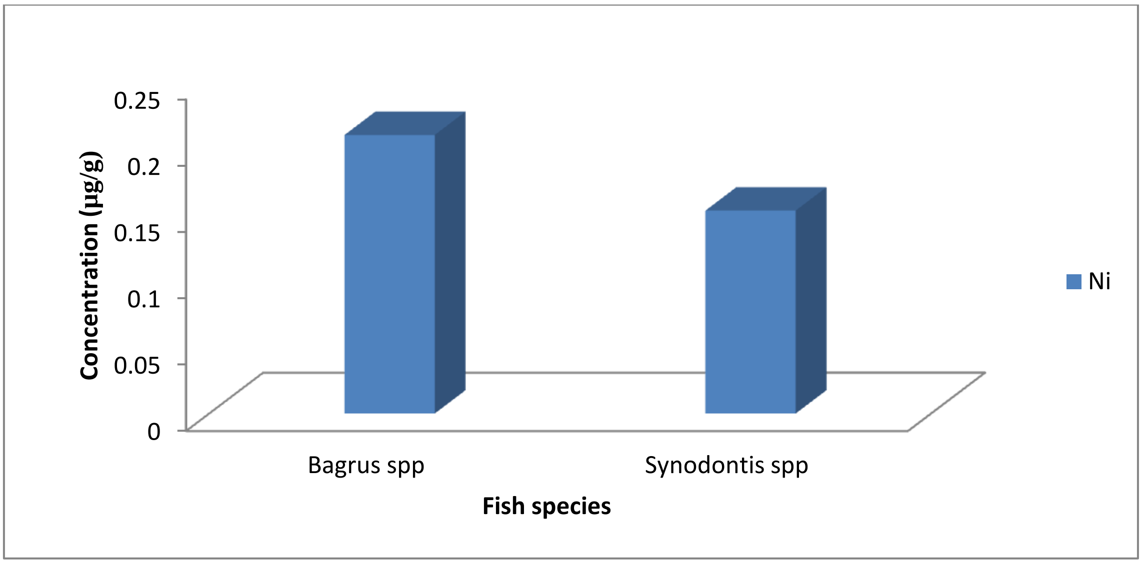

Fig. 3. Ni concentrations in fish species in study areas

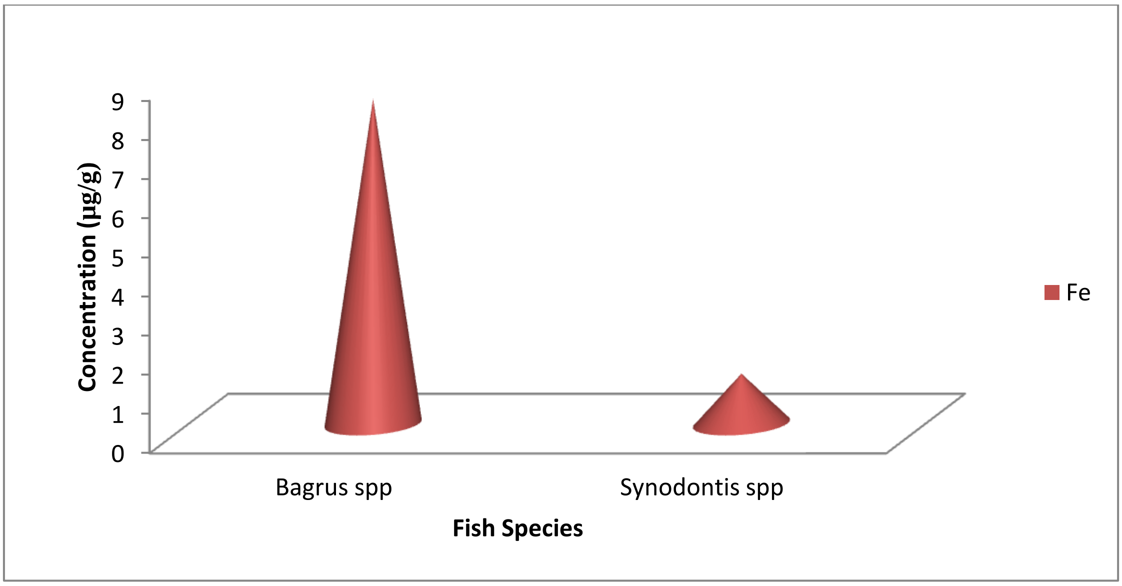

Fig. 4. Fe concentrations in fish species in study areas

The non-detectability of Cr in fish tissues in this study may be due to the fact that Cr (III) compounds are very insoluble in water and remain suspended in water. *Bagrus bayad* and *Synodontis batensoda* are bottom dwellers and the risk of interaction is minimal or remote.

The levels of Ni and Pb show a greater amount in the fish than the European Union suggested maximum limits, but were within the FAO/WHO [14] permissible limit. The presence of Pb a non-essential metal even in trace amounts in fish tissue portends grave danger if consumed in large quantities. Based on the findings from this study, the consumption of these fish species in plenteous amounts may pose a serious threat to health because of the risk of bio-accumulation.

5. CONCLUSION

Pollution of inland waters in Nigeria is a perennial problem and constitutes a significant threat to man and the entire aquatic ecosystems. The consumption of heavy metal infested fish for instance poses serious implications to human health if consumed. Therefore, an appraisal of heavy metals content in two fish species (*Bagrus bayad* and *Synodontis batensoda*) landed in the shores of River-Nun, Amassoma Bayelsa State, Nigeria was investigated. This was done in order to investigate the safety of consuming these fish species from the River and gauge the pollution status of the creek. The concentrations of the heavy metals Lead (Pb), Chromium (Cr), Nickel (Ni) and Iron (Fe) were measured in the flesh of the fish collected from three main landing areas (Jetty, market front and sand field) in the River-nun at Amassoma. The data were analysed for means and standard deviation. An independent sample T-test was conducted to measure the variability and similarities in heavy metal parameters at the 95% (P=0.05) confidence limit. This was aided by the use of the SPSS® 20.0 statistics tool kit. The result of the study indicates that the levels of the heavy metals Pb and Fe were significantly different ($P<0.05$) while there was no significant difference ($P>0.05$) in Ni concentration between the two fish species. *Bagrus bayad* showed greater content of Ni and Fe than in Synodontis *batensoda* but lower Pb content. The levels of Ni and Pb show a greater amount in the fish than the European Union suggested maximum limit, but were within the FAO/WHO permissible limit. The presence of Pb a non-essential metal even in trace amounts in fish tissue portends grave danger if consumed in large amounts. Based on the findings from this study, the consumption of these fish species in plenteous amounts may pose a serious threat to health because of the risk of bio-accumulation. Pollution of our waters must be discouraged by government and other stakeholders by the promulgation and enforcement of laws and other safeguards.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDICES

APPENDIX I: Means and standard deviation of Heavy metal in the Fish species

catfish		Pb	Cr	Ni	Fe
Bagrus spp	Mean	.1400	.0000	.2107	8.3050
	N	3	3	3	3
	Std. Deviation	.00000	.00000	.00208	.00200
	Std. Error of Mean	.00000	.00000	.00120	.00115
Synodontis spp	Mean	.5017	.0000	.1530	1.2750
	N	3	3	3	3
	Std. Deviation	.00723	.00000	.00200	.00100
	Std. Error of Mean	.00418	.00000	.00115	.00058
Total	Mean	.3208	.0000	.1818	4.7900
	N	6	6	6	6
	Std. Deviation	.19815	.00000	.03164	3.85049
	Std. Error of Mean	.08089	.00000	.01292	1.57196

APPENDIX II: Independent Sample T-Test

Metal	F	Sig.
Pb	15.337	0.017
Ni	0.073	0.801
Fe	0.80	0.422

APPENDIX III; Correlation analysis of heavy metals in fish

		Catfish	Pb	Cr	Ni	Fe
catfish	Pearson Correlation	1	1.000**	.b	-.998**	-1.000**
	Sig. (2-tailed)		.000	.	.000	.000
	N	6	6	6	6	6
Pb	Pearson Correlation	1.000**	1	.b	-.998**	-1.000**
	Sig. (2-tailed)	.000		.	.000	.000
	N	6	6	6	6	6
Cr	Pearson Correlation	.b	.b	.b	.b	.b
	Sig. (2-tailed)	.	.		.	.
	N	6	6	6	6	6
Ni	Pearson Correlation	-.998**	-.998**	.b	1	.998**
	Sig. (2-tailed)	.000	.000	.		.000
	N	6	6	6	6	6
Fe	Pearson Correlation	-1.000**	-1.000**	.b	.998**	1
	Sig. (2-tailed)	.000	.000	.	.000	
	N	6	6	6	6	6

***. Correlation is significant at the 0.01 level (2-tailed).*
b. Cannot be computed because at least one of the variables is constant

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