

ASSESSMENT OF HEAVY METALS IN SOME SELECTED FISH SPECIES FROM RIVER NIGER, ILLUSHI, EDO STATE, NIGERIA

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ABSTRACT

This study was conducted in River Niger at Illushi, Edo State, Nigeria to determine the concentration of Arsenic, Cadmium, Iron, Manganese and Nickel in *Bagrus bayad macropterus*, *Clarias gariepinus*, *Malapterurus electricus*, *Parachanna obscura*, *Synodontis batensoda* and *Synodontis budgetti*. The sampling was done monthly from April to November, 2017. Heavy metal concentrations were determined using Atomic Absorption Spectrophotometer (AAS Bulk scientific VGP 210 model) according to the standard method. *Synodontis budgetti* accumulated the highest level of heavy metals (32.13%), followed by *Bagrus bayad macropterus* (19.72%), *Clarias gariepinus* (17.80%), *Synodontis batensoda* (10.68%), *Parachanna obscura* (10.61%) and the least was *Malapterurus electricus* (9.02%). The accumulation of heavy metals in the fish species was in the order $Fe > Ni > Mn > Cd > As$ (*B. bayad macropterus*), $Fe > Mn > Ni > Cd > As$ (*C. gariepinus* and *S. budgetti*), $Fe > Ni > Mn > As > Cd$ (*M. electricus*, *P. obscura* and *S. batensoda*). *Clarias gariepinus* and *Synodontis budgetti* had Mn exceeding the limit, other fishes had concentration below permissible limit. The level of Ni, Cd and As in all the fishes were below the permissible limit, while the level of Fe in all the fishes exceeded the limit.

Key words: Pollution, concentration, anthropogenic sources.

INTRODUCTION

River Niger at Illushi an important fishing site in Edo State, is surrounded by various anthropogenic sources of contaminants such as agricultural activities, dredging, wastes disposal and leaching of fertilizers from farms. Through these activities, heavy metals gain access into fresh water, therefore increasing their concentration. Heavy metals are chemical elements that have high atomic weight and are denser than water (Ogaga *et al.*, 2015). They are members of a subset of elements that exhibit metallic properties which include solubility in water, non- degradability and strongly attachment of polypeptides and proteins. Previous studies on freshwater ecosystem revealed high concentration of heavy metals, especially in the water, sediment and biota samples collected at point of intense human activities (Edema and Egborge, 1999; Wogu and Okaka, 2011).

In Nigeria, fish and other products obtained from fish is up to 60% of entire protein intake in adults of rural habitats and they are also used as medicine (Fish oil), in recreation (Argungu fishing festival in Kebbi State) and vital inclusions as farm animals feed supplement (Igwegbe, 2013). It is also a source of minerals, vitamins and polyunsaturated fatty acids, especially omega-3-fatty acid (Khoshnood *et al.*, 2014). Currently, the demand for fish is on the increase as nearly one billion people, most of which are from less developed countries, rely on fish as their major source of protein (Toth *et al.*, 2012). It is estimated that fishes make up more than 6% of the world's annual animal protein and it

as well supplies relatively low caloric content (FAO, 2007).

This study was designed to assess the concentration of some selected heavy metals in the muscle of *Bagrus bayad macropterus*, *Clarias gariepinus*, *Malapterurus electricus*, *Parachanna obscura*, *Synodontis batensoda* and *Synodontis budgetti* from River Niger, Illushi, Edo state, Nigeria.

Study Area:

This study was carried out in River Niger, Illushi, Esan South East Local Government Area, Edo State, Nigeria (Figure 1). It is situated in the Niger Delta region of Nigeria. Illushi is 140 km from Benin along Ubiaja/Illushi road. It lies between latitude 6° 40' 0" North and longitude 6° 38' 0" East. The River serves as sink for agricultural, domestic and market wastes from Illushi community. The source of River Niger is in the Guinea highland in South Eastern Guinea. It flows through Mali, Niger, on the boundary with Benin republic and through Nigeria and empties into a huge delta, well-known as the Niger Delta and then into the Atlantic Ocean. The inhabitants of Illushi are actively engaged in fishing and farming. The climate of Illushi is tropical with the dry season running from November to April while the wet season runs from May to October. The vegetation around the study area includes elephant grass (*Pennisetum purpureum*), rice (*Oryza sativa*), white water lily (*Nymphaea lotus*), water lettuce (*Pistia stratiotes*) and mango (*Mangifera indica*).

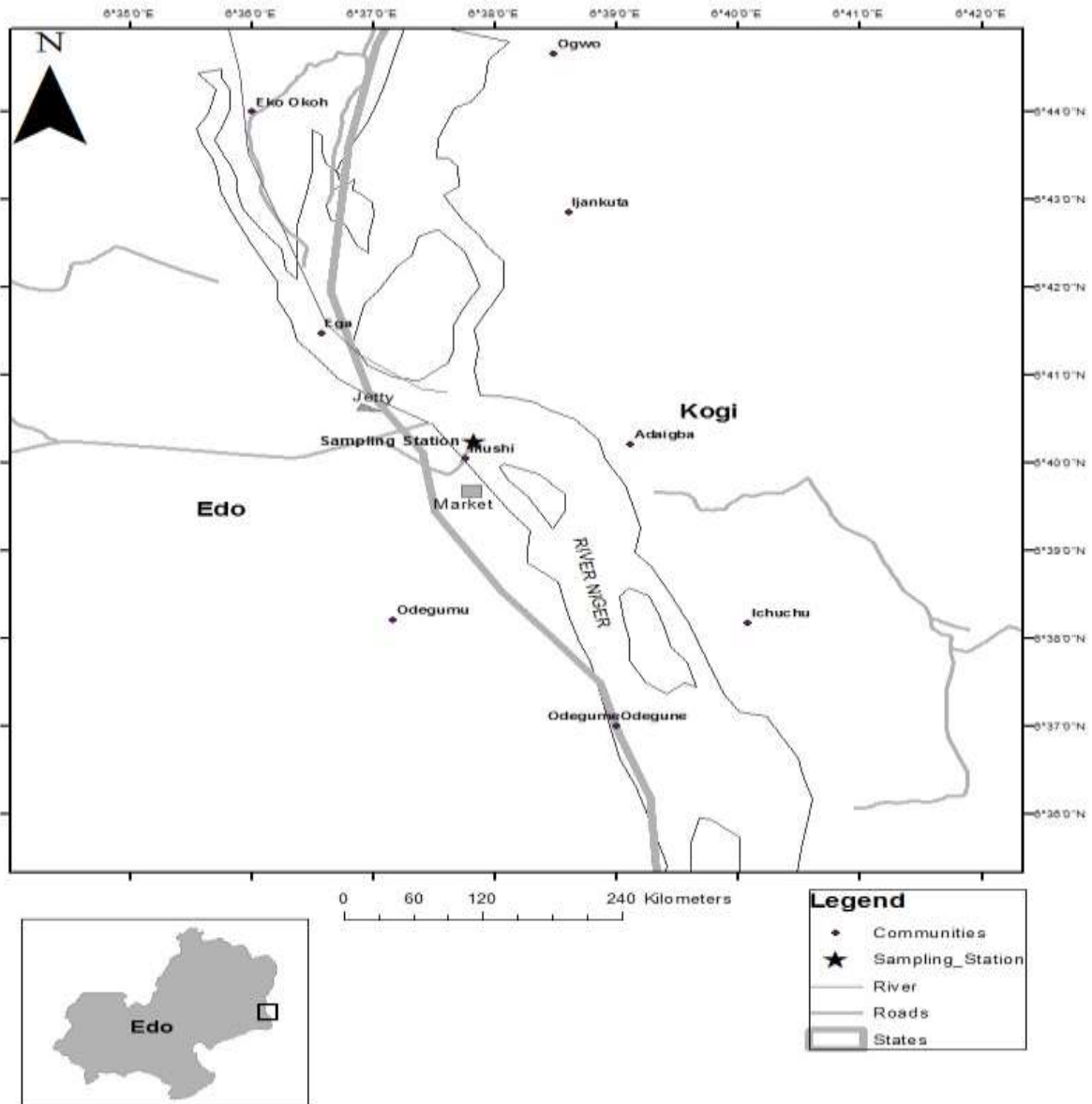


Figure 1: Map of Illushi showing sampling station

MATERIALS AND METHODS

The collection of fishes was done once a month for the period of eight months (April to November, 2017). A total of 52 fishes belonging to 5 families and six species were collected by commercial fishermen. They were stored in a cooler packed with ice block in order to maintain their freshness and transported to the laboratory immediately. Identification was done using a standard guide by Idodo-Umeh (2003) and Olaosebikan and Raji (2013).

The fishes were digested using the standard method of the Association of Official Analytical Chemist (AOAC, 2000). The concentration of heavy metals in the digested fish samples was determined using Atomic Absorption

Spectrophotometer (AAS) (Bulk scientific VGP 210 model).

Data obtained from this study was statistically analyzed using the Statistical Package for Social Science (SPSS) version 16. Analysis of variance was used to check for the significant difference, followed by Duncan multiple range test.

RESULTS

As ranged from 0 to 0.33 mg/kg across the fish species. The highest mean concentration of As as shown in table 1 was recorded in *S. batensoda* (0.211±0.031 mg/kg), followed by *M. electricus* (0.135±0.028 mg/kg), *P. obscura* (0.126±0.025 mg/kg), *C. gariepinus* (0.102±0.024 mg/kg), *S. budgetti* (0.088±0.03 mg/kg) and *B. bayad macropterus* (0.041±0.015 mg/kg). There was high

significant difference ($p < 0.01$) between the fish species.

In Cd, the concentration ranged from 0 – 0.4 mg/kg. The highest mean was recorded in *C. gariepinus* (0.138 ± 0.047 mg/kg), followed by *S. budgetti* (0.128 ± 0.055 mg/kg), *S. batensoda* (0.110 ± 0.029 mg/kg), *B. bayad macropterus* (0.102 ± 0.024 mg/kg), *P. obscura* (0.076 ± 0.024 mg/kg) and *M. electricus* (0.046 ± 0.017 mg/kg). There was no significant difference ($p > 0.05$) between the fish species.

Fe ranged from 0.1 in *C. gariepinus* to 12.23 mg/kg in *B. bayad macropterus* and the highest mean concentration value was recorded in *S. budgetti* (6.874 ± 1.39 mg/kg), followed by *B. bayad macropterus* (4.330 ± 1.378 mg/kg), *C. gariepinus* (3.058 ± 0.675 mg/kg), *S. batensoda* (1.809 ± 0.314 mg/kg), *P. obscura* (1.801 ± 0.773 mg/kg) and *M. electricus* (1.348 ± 0.233 mg/kg). There was high significant difference ($p < 0.01$) between the fish species.

In the case of Mn which ranged from 0.1 mg/kg in *S. batensoda* and *S. budgetti* to 5.9 mg/kg in *S. budgetti*, the highest mean (0.950 ± 0.708 mg/kg) was recorded in *S. budgetti*, followed by *C. gariepinus* (0.813 ± 0.569 mg/kg), *B. bayad macropterus* (0.440 ± 0.109 mg/kg), *P. obscura* (0.310 ± 0.049), *M. electricus* (0.265 ± 0.027 mg/kg) and *S. batensoda* (0.246 ± 0.036 mg/kg). There was no significant difference ($p > 0.05$) between the fish species.

Ni ranged from 0.01 mg/kg in *S. batensoda* to 2.3 mg/kg in *S. budgetti*. The highest Ni mean was recorded in *S. budgetti* (0.825 ± 0.286 mg/kg), followed by *C. gariepinus* (0.801 ± 0.180 mg/kg), *M. electricus* (0.695 ± 0.203 mg/kg), *P. obscura* (0.615 ± 0.082 mg/kg), *S. batensoda* (0.572 ± 0.146 mg/kg) and *B. bayad macropterus* (0.528 ± 0.052 mg/kg). There was no significant difference ($p > 0.05$) between the fish species.

Table 1: Heavy metals comparison in the different fishes

Heavy metals	B. bayad macropterus X±SE (min-max)	C.gariepinus X±SE (min-max)	M. electricus X±SE (min-max)	P. obscura X±SE (min-max)	S. batensoda X±SE (min-max)	S. budgetti X±SE (min-max)	P-value	FEPA Limit (2003)
As	0.041 ± 0.015 c (0.0 - 0.1)	0.102 ± 0.034 b (0.0 - 0.21)	0.135 ± 0.028 a (0.0 - 0.22)	0.126 ± 0.025 a (0.0 - 0.23)	0.211 ± 0.031 a (0.12 - 0.33)	0.088 ± 0.03 b (0.0 - 0.2)		0.5
Cd	0.102 ± 0.024 (0.0 - 0.15)	0.138 ± 0.047 (0.0 - 0.31)	0.046 ± 0.017 (0.0 - 0.1)	0.076 ± 0.024 (0.0 - 0.14)	0.110 ± 0.029 (0.0 - 0.2)	0.128 ± 0.055 (0.0 - 0.4)	$p > 0.05$	0.2-1.8a
Fe	4.330 ± 1.378 a (0.76 - 12.23)	3.058 ± 0.675 b (0.1 - 5.2)	1.348 ± 0.233 c (0.31 - 1.75)	1.801 ± 0.773 b (0.32 - 7.1)	1.809 ± 0.314 b (0.54 - 3.4)	6.874 ± 1.39 a (2.14 - 12.2)	$p < 0.01$	1
Mn	0.440 ± 0.109 (0.12 - 1.01)	0.813 ± 0.569 (0.21 - 4.8)	0.265 ± 0.027 (0.18 - 0.39)	0.310 ± 0.049 (0.15 - 0.57)	0.246 ± 0.036 (0.1 - 0.37)	0.950 ± 0.708 (0.1 - 5.9)	$p > 0.05$	0.5
Ni	0.528 ± 0.052 (0.27 - 0.71)	0.801 ± 0.180 (0.37 - 1.88)	0.695 ± 0.203 (0.3 - 1.9)	0.615 ± 0.082 (0.3 - 0.82)	0.572 ± 0.146 (0.01 - 1.04)	0.825 ± 0.286 (0.05 - 2.3)	$p > 0.05$	25-150b

Note: Similar letters (superscripts) indicate values that are not significantly different from each other ($p > 0.05$). ($p < 0.01$) indicate high significant difference. Minimum and maximum in bracket

DISCUSSION

This study has shown that six commercially important fish species (*Bagrus bayad macropterus*, *Clarias gariepinus*, *Malapterurus electricus*, *Parachanna obscura*, *Synodontis batensoda* and *Synodontis budgetti*) accumulated heavy metals at different concentrations in their muscles (Table 1). The observation from this study is similar to that of Oluwa *et al.* (2010) who observed earlier that fishes accumulate metals differently as some usually have higher concentrations than others. Though there was no significant difference ($p > 0.05$) in the concentration of Mn, Ni and Cd between the six fish species as shown by ANOVA, there was variation in the level of accumulation of these metals. There was high significant difference ($p < 0.01$) in the concentration of As and Fe

between the six fish species. *Synodontis batensoda* had the highest concentration of As, followed by *Malapterurus electricus*, *Parachanna obscura*, *Clarias gariepinus*, *Synodontis budgetti* and *Bagrus bayad macropterus*. The higher As in *Synodontis batensoda* than the other species could be as a result of different microhabitats and metabolic rate. The sources of As include paints and wood preservatives. In the case of Fe, *Synodontis budgetti* had the highest concentration followed by *Bagrus bayad macropterus*, *Clarias gariepinus*, *Synodontis batensoda*, *Parachanna obscura* and the lowest concentration was recorded in *Malapterurus electricus*. The high Fe recorded in this study could be due to corrosion of metals and weathering of rocks. The difference in the concentration of As in these fishes could be as a

result of their different micro habits, metabolic rate and food habit (Kotze *et al.*, 1999).

The mean concentration of Mn in *Clarias gariepinus* and *Synodontis budgetti* in this study exceeded the permissible limit (FEPA, 2003), this is similar to the study carried out by Nasir *et al* (2015) in *Clarias gariepinus*. The sources of Mn are petrol and fertilizers used for farming. Mn is useful to humans, it is a major component of enzymes, and prolonged exposure to high level of Mn causes damage to the liver, abnormal development of foetus (Saha and Zaman, 2012). Ni was lower than the permissible limit in all the fishes. The low nickel values could be as a result of dilution as the study was done mostly in the rainy season. The sources of Ni are metal scraps and batteries. The effects of prolonged exposure to high level of Ni include skin irritation and damage to mucous membrane. The mean concentration of Cd in all the fishes was lower than the permissible limit possibly as a result of the high volume of water as at the time of this study.

The sources of Cd are paints, fertilizers and batteries. Cd is a non-essential element which has no nutritional value. According to Munize *et al.* (2004), high concentration of Cd causes kidney dysfunction and damage to the liver. The mean concentration of As in all the fishes was lower than the limit recommended by the Federal Environmental Protection Agency (FEPA, 2003). Paints, corrosion of metals and insecticides are the sources of As. High As causes sore throat, irritation of the stomach and intestine. Among the heavy metals, Fe was the most prevalent metal in the six fish species. This is similar with the study conducted by Omeazu *et al* (2015) in River Niger in Onitsha. The high iron concentration recorded in this study could be as a result of boating activities such as maintenance of faulty boats, corrosion of Fe containing metals and weathering of rocks in addition to its natural occurrence in the water body. Edward *et al* (2013) recorded Fe concentration of 1.09 mg/kg in *B. bayad macropterus* from Odo-Ayo River, which is lower than the value recorded in this study. Iron is an essential element that is needed for structural and functional component of hemoglobin in red blood cell. The result obtained from this study is contrary to the study conducted by Williams and Edobor- Osoh (2013) in fish species from Lagos Lagoon, which showed that the level of Fe in fishes was within acceptable limits.

CONCLUSION

This research has proven that *Bagrus bayad macropterus*, *Clarias gariepinus*, *Malapterurus electricus*, *Parachanna obscura*, *Synodontis batensoda* and *Synodontis budgetti* from River Niger, Illushi had various levels of contamination of heavy metals. The total concentration of Mn in *Clarias gariepinus* and *Synodontis budgetti* and Fe

in all the fishes exceeded the permissible limit, and could endanger public health since these fish species are mostly consumed in the locality.

Therefore, there is a need for proper waste disposal, and the existing environmental laws should be complied with to reduce the rate at which pollutants are deposited into River Niger, Illushi.

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