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RESEARCH ARTICLE

Assessment of Some Heavy Metal Concentration in Fish, Water, And Sediment Of River Ndakotsu, Lapai, Niger State

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Abstract

This research was conducted to assess the levels of heavy metals in fish tissue, sediment and water body, at river Ndakotsu, Lapai, Niger state, Nigeria. River Ndakotsu is the major river that serve as a boundary between Lapai local government and Agaie local government and is useful to surrounding towns and villages for irrigation farming fishing and domestic purposes. Due to this, it is necessary to monitor the level of heavy metals contamination in the water body, sediment and aquatic species tissue habiting this environment. The study water samples were collected using water sampler in three different locations. Equally, In-situ water physicochemical parameters such as temperature, ph and dissolve oxygen were determined using portable multi probes meter. Fish samples were collected from fishermen immediately they arrived from fish exploration and specimen were digested using concentrated nitric acid in wet digestion technique. The level of selected heavy metal in samples were determined by the use of Atomic Absorption Spectrophotometer (AAS model: Accusys 211 USA) after samples dilution. The water quality of the river was within the acceptable range for fresh water species. The concentration of heavy metals, cadmium (Cd), lead (Pb), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn). From the results obtained from this study, the concentrations of heavy metals (Mn, Zn, Cd, Cu, Pb and Fe.) found in all the water samples are lower than that in the fish sample species and higher in sediment sample than fish sample.

Keywords: Heavy metal; sediment; River Ndakotsu

Introduction

Heavy metal is a major pollutant in freshwater which may be through daily human activities such as farming, fishing, and domestic activities or from natural source. Some heavy metals like cobalt, copper, iron, manganese and zinc are essential for enzymatic activity and in various biological processes. while metals, like cadmium, lead, and mercury, are not known to play important roles in the body and are toxic even in little quantity (Looi, et al., 2013; Yi, & Zhang, 2012; Copat, et al., 2013 & Shuhaimi-Othman, et al., 2010) Generally, research on heavy metals is important on two main fronts, from a public health perspective and from an aquatic environment perspective. Heavy metals are found in the aquatic environment and can amass laterally with the food chain. Moreover, the little quantity of absorbed metals may either be kept for metabolic use for vital organic processes or detoxified to an inactive metabolic level and temporarily or permanently stored in the body (Copat, et al., 2013& Alina, et al., 2012) A number of environmental factors, particularly physicochemical parameters and water hardness, can contribute significantly to the accumulation of heavy metals in living things to dangerous amounts and harm to the ecosystem (Alhassan et al. 2022; Kumar, & Achyuthan, 2007). Substantial metal danger can bring about lower vitality levels and harm blood arrangement, liver, lungs, other crucial organs and kidneys, decreased or harmed focal and mental anxious capacity or even reason malignancy (Fernandes et al., 2008). This may result in bio-collection of substantial metals in man utilizing water and eating fish from this waterway. River Ndakotsu is the major river that serve as boundary between Lapai local government and Agaie local

government and is useful to bordering towns and village for irrigation farming, fishing and domestic purposes. However, daily activities around the river by surrounding town and villages may lead to anthropogenic effect this regime of operation go back to farm and availability of fertilizers and chemical for weeds and insecticides provided by government at the affordable prices. This, made it is necessary to monitor the quality and level of heavy metals pollution in the water body, sediment and aquatic species habiting this environment. Analysis of heavy metal should be taken in to consideration because metals may be contained in the fish as they feed on the water body. This study primarily aimed at to determine the concentration of some heavy metal in fish, water, and sediment of river Ndakotsu.

Materials and Method

Description of the Study Area

The area being sought that was used in this investigation is River Ndakotsu located in Lapai Local Government Area of Niger state, approximately between latitudes 9°.34˝N and longitude 6°.30˝E.

Fig. 1 MAP OF LAPAI SHOWING RIVER NDAKOTSU

Material and Method

Collection Of Samples

Fish, sediment and water samples were collected between the periods of July-Sept 2018 from river Ndakotsu, Lapai, Niger State, Nigeria. The fish, sediment and water samples collected for analyses of heavy metal were immediately packed in to Ice cooled box and transported to Ibrahim Badamasi Babangida University laboratory for identification of fish to species level and further preparation of sediment and water samples collected follows. Samples were collected and prepared in triplicates.

Preparation of the fish sediment and water samples for heavy metal analysis

0.5 gram of fish, 1g of sediment and 50mL were processed with nitric corrosive and perchloric corrosive at proportion 3 to 1. That is, 15mL of nitric corrosive and 5mL of perchloric corrosive were added to 1g of test in an assimilation tube, it was put in a Kiedjal warming square and warmed at 150°C until blend explains (turns dreary – This could take 2-3h). Refined water was added and resulting to cooling. The samples were analyzed for copper, manganese and magnesium using the Atomic Absorption Spectrophotometer (AAS model: Accusys 211 USA).

Data Analysis

Descriptive statistics was used to calculate ranges, means and standard deviations from the data. The differences in mean were compared at ($P < 0.05$). The package used in the statistical analysis was SPSS. (Scientific package for social sciences).

Results

The heavy metal concentration of river Ndakotsu water is reported below, including the concentration of lead, copper, Cadmium, iron, zinc and manganese. From the result below There were no cadmium and lead in the water of river Ndakotsu, but copper was present in station 1 and absent in station 2 and 3, zinc was found the highest heavy metals concentration follow by iron and manganese at last.

Table 4.1 Heavy Metal Concentration Of River Ndakotsu Water

Parameters	Location 1	Location 2	Location 3
Cadmium	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)
Lead	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)
Copper	0.89 ± 0.06^{b} (0.83-0.95)	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)
Iron	3.67 ± 0.409^{a} (3.20-3.92)	10.2 ± 0^{a} (10.1-10.44)	2.56 ± 0^{a} (2.55-2.56)
Manganaze	0.67 ± 0.06^{a} (0.66-0.67)	0.65 ± 0.015^{a} (0.63-0.66)	0.124 ± 0.6^{a} (0.12-0.13)
Zinc	4.08 ± 0.05^{a} (4.04-4.13)	6.36 ± 0.15^{a} (6.27-6.49)	5.76 ± 0.55^{a} (5.70-5.81)

Table 4.2 Scientific Classification of this species above

SPECIES	KINGDON	CLASS	GENUS	SPECIES
Clarias gariepinus	Animalia	Actinopterygii	Clarias	C. gariepinus
Heterobranchus bidorsalis	Animalia	Actinopterygii	Clarias	H. bidorsalis
Clarias anguillaris	Animalia	Actinopterygii	Clarias	C. anguillaris

The heavy metal concentration of river Ndakotsu fish is reported below, including the concentration of Cadmium, lead, copper, iron, manganese and zinc. From the result below There were no cadmium lead and copper in the fish of River Ndakotsu, but there was present of zinc which was found the highest heavy metals concentration follow by iron and manganese at last.

Table 4.2.1 Species of Fish Counted At The Stations

SPECIES OF FISH	STATION 1	STATION 2	STATION 3
Clarias gariepinus	7	_	_
Heterobranchus bidorsalis	_	6	_
Clarias angullaris	_	_	10
T0TAL	7	6	10

Table 4.2.2 Heavy Metal Concentration of River Ndakotsu Fish

PARAMETERS	STATION 1	STATION 2	STATION 3
Cadmium	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)
Lead	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.0-0.0)
Copper	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.00-0.00)	0.0 ± 0^{a} (0.0-0.0)
Iron	16.04 ± 0^{a} (15.6-16.5)	10.85 ± 0^{a} (10.7-11.0)	17.62 ± 0^{a} (17.29-17.88)
Manganaze	0.44 ± 0.03^{a} (0.42-0.47)	0.33 ± 0.02^{a} (0.32-0.35)	0.43 ± 0.02^{a} (0.41-0.45)
Zinc	68.87 ± 1.72^{b} (67.30-70.70)	89.47 ± 1.21^{c} (88.20-90.60)	65.27 ± 1.32^{b} (64.10-66.70)

The heavy metal concentration of river Ndakotsu sediment is reported below, including the concentration of Cadmium, lead, copper, iron, manganese and zinc. From the result below There was cadmium in station 2 but absent in station 1 and 3, also lead and copper was present in station 1 and 2 but absent in station 3 in the sediment of river Ndakotsu, but also zinc was found the highest heavy metals concentration follow by iron and manganese at last.

Table 4.3 Heavy Metal Concentration of River Ndakotsu Sediment

PARAMETERS	STATION 1	STATION 2	STATION 3
Cadmium	0.0±0[a] (0.00-0.00)	0.17±0.06[b] (10-.20)	0.0±0[a] (0.00-0.00)
Lead	11.73±1.67[a] (10.40-13.60)	19.20±0.87[a] (18.20-19.80)	0.0±0[a] (0.00-0.00)
Copper	1.48±°C (1.40-1.60)	21.37±0[d] (20.60-22.10)	0.0±0[a] (0.00-0.00)
Iron	3054±22.6[c] (3029-3074)	10.34±251.8[d] (141.30-146.6)	1474.4±5.60[b] (1469.3-1480.4)
Manganaze	233.3±6.14[c] (228.2-240.1)	239.4±5.96[d] (235.1-246.2)	56.47±2.60[b] (53.90-59.10)
Zinc	483.3±7.40[e] (475.8-490.6)	571.97±3.97[f] (569.1-576.5)	318.8±1.65[d] (317.2-320.5)

Table 4.4 Physico-Chemical Parameters of River Ndakotsu Water

Parameters	Location 1	Location 2	Location 3
TEMPERATURE (°C)	28°C	26°C	28°C
pH (m)	8.3 m	7.8 m	6.0 m
DISSOLVED OXYGEN (pp/m)	1.7 ppm	6.3 ppm	6.0 ppm

Discussion Conclusion and Recommendation

Discussions

Fish samples

The results of heavy metals concentration in fish were shown in table 3 above. The result revealed that certain heavy metals are present in fish samples.

The species of fish found across the three station of the rivers are:

Clarias gariepinus in station one, Heterobranchus bidorsalis in station two and Clarias anguillaris in station three. Therefore, Clarias gariepinus was present in station one but absent in station two and three while Heterobranchus bidorsalis was present in station two and absent in station one and three and finally Clarias anguillaris was present in station three and absent in station one and two.

From the analysis obtained from concentration of river Ndakotsu Lapai Niger State, it was found that cadmium, lead and copper was absent across the three station of the rivers.

Concentrations of Zn and Fe was found to be higher in all fish samples.Its concentration ranges from Zn 68.87±1.72[b]mg/kg, 89.47±1.21[c]mg/kg and 65.27±1.32[b]mg/kg across the three station of the river. This finding is supported by the report of Oluseye et al. (2012), Although These figures were much higher than the general guidelines limit of 50mg/kg for Zn in food recommended by UK Ministry of Agriculture, fishes and food (2007). In spite their higher values, these concentrations were statistically significant at $p<0.05$ and can induce infections. This finding is however in dissimilar with the findings of Tabinda et al. (2013).

Fe, its Concentration ranges from 16.04±0[a]mg/kg, 10.85±0[a]mg/kg and 17.62±0[a]mg/kg This finding is however negated by the report of Oluseye et al. (2012), who revealed that High concentrations of Fe in fish samples could be due to pollution that occur/intake of these polluted particles by the fish samples in the water.

Mn was found to be the lowest concentration of heavy metals across the three station of the river, ranges from 0.44±0.03[a]mg/kg, 0.33±0.02[a]mg/kg and 0.43±0.03[a]mg/kg and they all have the same significant differences across the three station of the river, this finding is supported by the report of Oluseye et al. (2012), who also recorded low concentration for Clarias garienpinus and Oreochromis niloticus. However, Mn fish helps in fish reproduction and normal functioning of nervous system (Olowoyo et al., 2011). the findings of this research shows that concentration of Mn was significant at $p<0.05$. Cu and Pb was found absent across the three station of the rivers.

Water samples

The concentration of Zn and Fe, was found as the highest range, Zn range from (4.08±0.05[a]), (6.36±0.15[a]) and (5.06±0.55[a]) for Fe ranges from 3.67±0.41[a]mg/l, 10.2±0[a] to 2.56±0[a]mg/l having the highest value and were significant at $p<0.05$. Although, station 2 and station 1 had the highest values across the three station and were significant at $p<0.05$. These concentrations were greater than 0.03mg/l which was

the standard concentration of Iron in water according to NESREA (2011) for drinking water. Based on my finding is due some anthropogenic activities that take place at the river such as washing of cloths, bathing, washing of plate etc. also fertilizer used in agricultural activities and block industries found close to the river also flush down the waste product in to the river causes pollution to the aquatic organism

Low concentrations Mn was obtained, based on this finding they range from (0.67 ± 0.06^{a}), ($0.65\pm0.0.02^{a}$) and 0.12 ± 0.6^{a} were significant at $p<0.05$ except for Cu least concentration which was not significant. The report of this research is in line with the findings of Tabinda et al., (2013), who reported similar ranges of these heavy metals in their research carried out on Riverine water and fishes. According to the approved standard by NESREA (2011). Mn is a mineral required by the body in trace amount for manufacturing of enzymes necessary for metabolism. Excess amount of it may lead to poor bone formation, impair fertility and also causes death (Mergler et al., 2009).

Cu was found as the lowest range, Cu was also found only in station 2 with range of (0.89 ± 0.06^{b}) and absent in station 2 and 3 which their standard concentrations were 3.0mg/l, 2.0mg/l and <2.0mg/l for Cu respectively. This signifies low concentration in River Ndakotsu Lapai, Niger state and cannot be consumed at moderate rate with effect of Cu, related diseases. Although, the metals when consumed at higher rate may lead to Liver, kidney and circulatory problems in human being (Wachira, 2007). high concentrations observed for Mn and Fe may render River Ndakotsu Lapai water undrinkable because they can induce cancer related disease, despite the fact that high concentration were observed for Zn. To be at the safer side it is however no recommended for consumption based on the findings of this research.

Sediment Sample

Heavy metals concentration of River Ndakotsu Sediment, according to this research cadmium was found only in the sediment of the river and absent in water and fish sample the concentration ranges from 0.17 ± 0.06^{b} in station 2 only and absent in station 1and 3.

The concentration of cadmium was found at lowest range all over the three station of the river,

Concentration of Zn, Fe and Mn was found the highest range from Zn (483.3 ± 7.40^{e}), (571.97 ± 3.97^{f}) and (318.8 ± 1.65^{d}) Fe range from (3054 ± 22.6^{c}), (10.34 ± 251.8^{d}) and (1474.4 ± 5.60^{b}) then Mn range from (233.3 ± 6.14^{c}), (239.4 ± 5.96^{d}) and (56.47 ± 2.60^{b}).

This finding is supported by the report of Oluseye et al. (2012), In spite their higher values, these concentrations were statistically not significant across the three station and can induce infections. This finding is however in contrast with the report of Tabinda et al. (2013).

Concentration of Cu and Pb was found at station 1 and 2 but absent in station and also at low range from Cu ($1.48\pm$°C) and (21.37 ± 0^{b}) Cu was statistically not significant Pb (11.73 ± 1.67^{a}) and (19.20 ± 0.87^{a}), Pb was statically significant. The low concentration for Cu. The concentration could be attributed to bioaccumulation of pollutant over a long period of time from other pollutant source. However, low concentrations of Pb inhibit inactive transport mechanisms involving ATP and also suppress cellular oxidation-reduction reaction (Olowoyo et al. 2011).

Physico chemical parameters of River Ndakotsu water

This analysis was carryout at the sampling station with the used of equipment such as thermometer, pH meter (manual) and dissolved oxygen meter across the three stations of the river,

Temperature

Temperature was found the highest value of 28°C in station 1 and 3, in station 2 it was 26°C which is found at low value. The water quality parameters were within the acceptable range for temperature (Swann, 2006). According to Federal Ministry of Environment FME (2006) the temperature of 20 - 33°C is recommended as permissible limit standard for aquatic life.

Hydrogen Concentration

Hydrogen concentration (pH) was found the highest value of 8.3m in station 1 follow by 7.8m in

station 2 and the lowest value was 6.00m in station 3. The pH can also affect fish health. For most freshwater species, a pH range between 6.5 - 9.0 is ideal, but most marine animals typically cannot tolerate as wide range pH as freshwater animals, thus the optimum pH is usually between pH 7.5 and 8.5 (Boyd, 1998).

Dissolved Oxygen

Dissolved oxygen (pp/m) in station 1, 7.2 ppm was found as the highest value follow by 6.3 ppm in station 2 and 6.0ppm in station 3 which was found as the lowest value. (FME, 2006) reported the permissible limit standard of dissolved oxygen for aquatic life is 6.8-10 ppm.

Conclusion

From the results obtained from this study, the concentrations of heavy metals (Mn, Zn, Cd, Cu, Pb and Fe.) found in all the water samples are lower than that in the fish sample species and higher in sediment sample than fish sample, this may be as a result of bioaccumulation over a long period of time. The bio-accumulation of some metals in the fish gills were due to polluted water from river Ndakotsu containing various municipal wastes from the village inhabitant.

Recommendation

The need for regular checkups of the heavy metal concentrations in River Ndakotsu, selected tributaries since the river serves as source of irrigation and fish for the local inhabitants in the study area. Vegetation covers of riverine characteristics is pertinent to be established along the river for heavy metal absorption from the water and sediments.

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Appendix

Appendix 1 Row data of Heavy metal analysis of water (mg/L)

Sample	Cadmium	Lead	Copper	Iron	Manganese	Zinc
ST1 water	0.00	0.00	0.88	3.916	0.668	4.08
	0.00	0.00	0.95	3.906	0.672	4.04
	0.00	0.00	0.83	3.201	0.661	4.13
ST2 water	0.00	0.00	0.00	10.436	0.652	6.32
	0.00	0.00	0.00	10.124	0.658	6.49
	0.00	0.00	0.00	10.105	0.629	6.27
ST3 water	0.00	0.00	0.00	2.556	0.124	5.76
	0.00	0.00	0.00	2.560	0.129	5.81
	0.00	0.00	0.00	2.549	0.118	5.70

Appendix 2 Row data of heavy metal analysis of fresh fish (mg/100g)

Sample	Cadmium	Lead	Copper	Iron	Manganese	Zinc
ST1 fish	0.00	0.00	0.00	15.95	0.44	68.6
	0.00	0.00	0.00	16.53	0.47	70.7
	0.00	0.00	0.00	15.64	0.42	67.3
ST2 fish	0.00	0.00	0.00	10.82	0.33	89.6
	0.00	0.00	0.00	10.69	0.35	88.2
	0.00	0.00	0.00	11.03	0.32	90.6
ST3 fish	0.00	0.00	0.00	17.68	0.43	65.0
	0.00	0.00	0.00	17.29	0.45	66.7
	0.00	0.00	0.00	17.88	0.41	64.1

Instrument: Bulk Scientific AAS; Model: Accusys 211; Manufacturer: USA

Appendix 3 Row data of Heavy metal analysis of sediment (mg/Kg)

Sample	Cadmium	Lead	Copper	Iron	Manganese	Zinc
ST1 SD	0.00	11.2	1.45	3059.5	228.2	483.5

	0.00	13.6	1.60	3029.3	231.5	490.6
	0.00	10.4	1.40	3073.6	240.1	475.8
ST2 SD	0.20	19.6	21.4	14400.1	246.2	570.3
	0.20	18.2	22.1	14600.6	235.1	576.5
	0.10	19.8	20.6	14100.3	236.9	569.1
ST3 SD	0.00	0.00	0.00	1473.5	56.4	318.8
	0.00	0.00	0.00	1469.3	59.1	320.5
	0.00	0.00	0.00	1480.4	53.9	317.2

Instrument: Bulk Scientific AAS; Model: Accusys 211; Manufacturer: USA