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DETERMINATION OF HEAVY METALS IN SELECTED FISH SAMPLES OBTAINED FROM KAINJI LAKE NEW BUSSA NIGER STATE

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ABSTRACT

Two species of fishes namely *Oreochromis niloticus* and *Synodontis schall* obtained at a distance of 50m, 100m and 150m from Kanji dam were investigated for heavy metals and organic pollutants. The control sample was obtained from Yangba river along Wawa road in New Bussa, Niger State. Concentration of six (6) heavy metals namely; Copper, Manganese, Chromium, Zinc, Lead and Cadmium was determined using atomic absorption spectroscopy. The result showed that the concentration of these metals are higher at 50m and 100m away from the dam site respectively. The maximum concentration of these heavy metal in *Oreochromis niloticus* and *Synodontis schall* were observed at sampling point closer to the dam and decreases as the distance away from the dam increases. From the result analysed, the mean

Introduction:

Generally, the riverine ecosystem is a repository of a wide variety of plants and animals including green germ plasms; supplier of one of the best and relatively cheap forms of protein in the form of fish and a plethora of other benefits both economic and aesthetic (singh *et al* 2001). Economic benefits of rivers include being a source of water for drinking, irrigation, industrial processes, means of transportation etc. However, deforestation and catchment areas leading to increased silt load in rivers, increased abstraction of river water for irrigation, industrial and domestic purposes and

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concentration of manganese ranges from 2.153-7.820mg/Kg and 2.822-3.569mg/Kg, copper ranges from 3.240-5.330mg/Kg and 4.279-7.057mg/Kg, and chromium ranges from 1.557-3.010mg/Kg and 0.698-4.650mg/Kg, zinc ranges from 1.650-5.188mg/Kg and 4.385-5.097mg/Kg, lead ranges from 0.738-1.365mg/Kg and 1.689-2.354mg/Kg while cadmium ranges from 0.481-1.440mg/Kg and 1.132-2.013mg/Kg respectively. None of the heavy metals investigated was above the maximum permissible level set by the world health organization(WHO)

Keywords: Water, Kainji dam, Fish, bioaccumulation, Heavy Metals.

Pollution arising from the discharge of industrial and domestic effluents have resulted in the deterioration of water quality of world rivers (singh *et al).*

Pollution is the introduction into the environment of substances or effects that are potentially harmful and interfere with man's use of his environment or interfere with species or habitats (Porteus, 1996). Pollution can be material (smoke, chemicals etc.) or non-material (noise, light, radiation etc. means of transportation etc. means of transportation etc. However, deforestation and catchment areas leading to increased silt deforestation and catchment areas leading to increased silt (Agarwal, 2002). River pollution is the presence of any foreign substance (organic, inorganic radiological, biological) in the riverine ecosystem which tend to degrade the quality of the ecosystem so as to constitute a hazard to biota or impairs the usefulness of water(Agarwal,2002). Fish production from inland water resources (rivers, lakes and streams) is under threat from pollution, habitat alteration and degradation, changes in river flows and over-exploitation (Gupta, 2006). When pollutants like heavy metals enter rivers, they change the water quality, bind to sediments and accumulate in aquatic biota, causing anaemia, disturbance of physiological functions and mortalities of fish (Biney *et al*., 1994, Jenneth *et al*., 1980). This reduces production and income from fish and aquatic organisms. . According to Dougherty (2000), fish consumption is a major route of chemical exposure to man and heavy metal pollutants are potentially harmful to man when contaminated fish and water are consumed.

BIOACCUMULATION OF METALS IN FISH

Bioaccumulation is the deposition and storage of toxic chemicals in the tissues of aquatic organisms such that tissue concentrations continue to rise with prolonged exposure to the chemicals (Joblin, 1994). Sex, age, season, spawning periods, choice of food by younger and older fish and variations in pollutant exposures across fish tissues may influence uptake retention and bioaction of contaminants in fish tissues (Ikem *et al*, 2003). Toxicants enter fish through the body surface, the highly permeable gill epithelial membranes and through ingestion/gastrointestinal absorption. These toxicants are then metabolized and transported to the organs of fish. The rate, at which a chemical is metabolized, detoxified and cleared and from the body is a major factor determining the level of bioaccumulation. Since fish bio-accumulate metals their use as bio- monitors has the advantage of allowing the comparison of metal concentrations among sites, where water samples are near or below the detection limits of the atomic absorption technique (Ramelow *et al.* 1989).

Heavy metals accumulate more in the visceral tissue (liver, kidney, intestines etc.) than in other organs and least in the muscles. Cheung et al (2006) evaluated the nutrient and heavy metals (zinc, chromium, copper, nickel and cadmium) concentration in tilapia and shrimps in tidal shrimp's ponds and concluded that all the metals studied accumulated in the viscera of tilapia but that body size wasn't the determining factor for metal accumulation in tilapia unlike in shrimp. Gbem *et al* (2001) in a static bioassay exposed *Clarias gariepinus* to two sub-lethal concentrations levels (2% and 6% v/v) of tannery effluents. After eight weeks, samples of fish muscles and organs were ashed at 450^0C and digested with HNO_3 before being analysed with FAAS. They concluded that metal concentrations were significantly higher in the liver ($p>0.05$) than other tissues followed by the gill and the gut. The lowest concentrations were found in the muscles.

Adakole (1995), in an experiment on a stretch of river kubanni, Zaria found that the accumulation of zinc and lead by *Oreochromis niloticus*, clarias and alestes were higher in the dry than n in the rainy season. Also the accumulation of zinc by all three fishes was high and that of lead was low. He concluded that *Oreochromis niloticus* may be a better indicator species for monitoring heavy metal concentration in aquatic ecosystem than clarias and alestes. Tukura *et al*

(2005) determined heavy metal concentrations in water, *clarias gariepinus* and *tilapia zilli* and found that, except for chromium; metal levels were higher in water samples than in fish and that zinc and lead were the most bio-available in the gills of both fish species. They concluded that apart from zinc, metal levels were higher in tilapia than in clarias thereby confirming the assertion by Adakole (1995) that tilapia is a good bio-monitor. Tariq *et al* (1996) reported a positive correlation between heavy metal content in fish and sediment. In an experiment to determine the pollution status of Indus river, Pakistan, they found that in some cases, metals content of fish was high at sites where metals content of sediment was also high.

METHODS

SAMPLING AND PRESERVATION

Collection of fish samples

Three samples each of sub adult sizes (115-180g body weight) of fish species namely *Oreochromis niloticus and Synodontis schall* were collected. This size range was to avoid different states of reproductive physiology. The use of older fish species was avoided as Dusek *et al* (2005) reported that older predator fish species living in moderately and heavy polluted sites show negligible statistical differences.

Fish samples was collected with cast net from Kainji lake at 150 metres,100 meters, and 50 meters to the dam site which serve as the sampling point. As shown in figure 1 below. The control sample were collected from Yangba river along Wawa road and each of the fish species were collected at each sampling point making a total of eight fish samples. A canoe was used as sampling craft and at each point the canoe was stopped for samples to be collected.

The samples were wrapped with polythene bags and stored in an iced plastic box and subsequently transported to the laboratory of Sokoto Energy Research Centre where it was stored in a deep freezer.

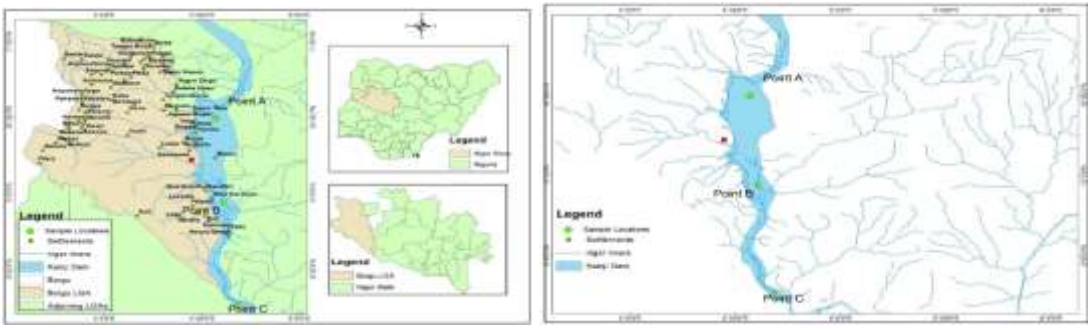


FIGURE 1: Sampling location at Kainji dam, New Bussa, Niger State

SAMPLE PRE-TREATMENT

a) Fish samples were dissected with plastic knife to separate the muscles from the head/viscera.

b) Washing- Glassware, plastic containers, crucibles, pestle, and mortar, were washed with liquid soap, rinsed with distilled water and then soaked in 10% HNO_3 solution for 24 hrs. (Todorovi *et al*, 2001). They were then washed with distilled water and dried in oven 60^0c for 5 hours.

DIGESTION OF FISH SAMPLES FOR HEAVY METAL ANALYSIS

Fish sample were digested as described by Olaifa *et al* (2004) as follows: 5g of fresh fish muscle was weighed and placed in beaker. 10ml of freshly prepared concentrated HNO_3/H_2O_2 (1:1) solution was added and the beaker was covered with watch glass for initial reaction to subside. The beaker was placed on water bath and boiled at a temperature not exceeding 160^0C for 2 hours to reduce the volume to 3-4mls. It was cooled and transferred to 50ml volumetric flask and made up to volume with distilled water for the metal analysis.

ANALYSIS OF HEAVY METALS USING FLAME ATOMIC ABSORPTION SPECTROPHOTOMETRY

Atomic absorption spectrophotometry is the most common method for the determination of heavy metals in waters, fish, and sediment. Flame atomization will be used for the AAS analysis (*Biney et al*, 1994). FAAS involves the atomization of a sample and measurement of the amount of radiation absorbed by atoms of interest when placed in the path of an incident radiation, which has been passed through a monochromator to isolate characteristic wavelength of absorption of the element of interest. Concentration of atom is then related to amount of radiation absorbed according to Beer-Lambert's law. The incident radiation is produced by a source lamp (usually Hollow Cathode Lamp) with the cathode made of the element of interest in order to reduce interference and make the instrument more sensitive.

In the AAS, a fine spray of the analyte will be passed into a suitable flame, frequently oxygen/acetylene or nitrous oxide/acetylene, which converts the elements to an atomic vapour. This vapour will be passed through radiation at the wavelength to excite ground state atoms to the first excited electronic level.

The amount of radiation absorbed can then be measured and then directly related to the concentration. A Hollow Cathode Lamp will be used to emit light with the characteristics narrow line spectrum of the analyte element. The detection system consists of a monochromator (to reject other lines produced by the lamp and background flame radiation) and a photomultiplier. Another key feature of the technique involves modulation of the source radiation so that it can be detected against the strong flame and sample emission radiation. The major limitation is that only one element can be detected at a time.

Preparation of aqueous stock solution and standard

i. Cadmium solution will be prepared by dissolving 2.7435g $Cd(NO_3)_2.4H_2O$ in 5ml concentration HNO_3. The solution will be made up to 1 litre with distilled water in a volumetric flask, giving 1000ppm cadmium solution
ii. Copper solution was prepared by dissolving 3.8031g of $Cu(NO_3)_2.3H_2O$ in 5ml concentration HNO_3 and making up to 1 litre with distilled water, giving 1000ppm copper solution.
iii. Chromium solution was prepared by dissolving 3.7353g K_2CrO_4 in 10ml concentration HNO_3 and making up to 1 litre with distilled water giving 1000ppm copper solution.
iv. Lead solution was prepared by dissolving 1.5895g $Pb(NO_3)_2$ in distilled water and making up to 1 litre, giving 1000ppm lead solution.
v. Zinc solution was prepared by dissolving 1.2444g ZnO in 5ml water, adding 25ml concentrated HNO_3 and making up to 1 litre with distilled water, giving 1000ppm zinc solution.
vi. Manganese solution was prepared by dissolving 0.2066g of $MnSO_4$ in in 5ml water, making it to 1litre with distilled water, giving 1000ppm with Manganese solution.

Calibration curve

Working solution were prepared from the stock solution by pipetting 10 ml of each of the standard and diluting to 100 ml with distilled water in a volumetric flask to give 100 ppm. From this 2ml, 4ml, 6ml, 8ml and 10ml was taken into another 100 ml volumetric flask and made to mark with distilled water to give 2ppm, 4ppm, 6ppm, 8ppm and 10ppm respectively. The standard and reagent

blank (Distilled water) solutions were aspirated into a pye-unicam (model 969) double beam digital Atomic Absorption Spectrophotometer. A calibration curve of metal concentration in the samples was prepared. The sample solution within aspirated into the AAS machine concentration of Heavy Metal was calculated from the Atomic absorption spectrometer reading using the formula:

Actual conc. = Conc. From AAS reading x (Final volume of digestion sample fish/ weight of fish taken)

= Conc. (From AAS reading x (50mls/2g))

= Concentration from AAS reading x 25

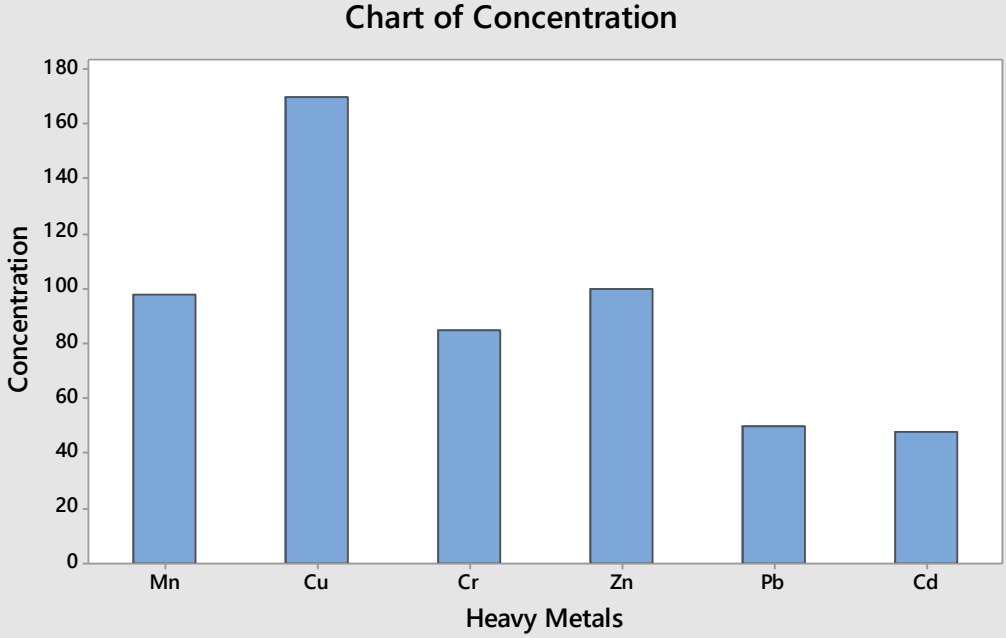
RESULTS AND DISCUSSION

The concentration of heavy metals in *Oreochromis niloticus* (mg/kg)

Distance	Mn	Cu	Cr	Zn	Pb	Cd
50m	4.5900±2.29	6.6660±0.6140	3.0100±3.810	1.8530±1.6720	1.0805±0.000252	1.0150±1.1550
100m	6.50±4.520	6.026±1.31	4.650±1.960	4.253±0.687	1.0805±0.000252	0.481±0.577
150m	2.15300±0.385	4.249±0.842	3.0400±0.751	5.188±0.295	1.365±1.528	1.8130±0.5770
Control	3.567±1.7310	3.240±1.410	1.5570±0.9440	4.3850±0.3780	2.354±0.579	2.130±1.000

3.3 Concentration of heavy metals in *Synodontis schall* (mg/kg).

Distance	Mn	Cu	Cr	Zn	Pb	Cd
50m	3.3330±0.8650	7.0570±0.8030	0.6980±0.5660	1.7390±0.3090	0.7380±0.5520	1.440±1.730
100m	7.28±4.30	6.456±5.990	4.454±0.837	1.650±0.760	1.0805±0.000252	1.127±1.000
150m	2.5430±1.214	7.590±2.270	3.0950±2.8	4.928±1.445	1.366±0.577	1.9020±0.5770
Control	2.8220±0.2070	5.330±1330	3.0100±2.090	5.0970±1.2000	1.6870±1.527	1.1326±0.00173



Concentration of Heavy Metals at each sample location

In sample 1, at the control point copper has the highest concentration and cadmium has the least likewise for sample 2 at the control point also in both species of the fish. In Sample copper have the highest concentration and cadmium has the least concentration in sample 2. This is in line with the work of Mansour and sidkey,(2003), who reported a cadmium concentration of 1.1002 - 1.1342±0.000143 in *synodontis schall* while working on heavy metal contamination on fish in Wadi elrayan wetland region of Egypt. For the result for the Synodontis schall at the control point manganese happens to have the highest concentration, this is in line with work of Binning and Baird, 2003 who investigated the concentration of heavy metals namely: chromium, lead, Zinc, copper, manganese, titanium, and tin in fishes from swartcops rivers estuary, South Africa.copper concentration was 6.68mg/chromium 4.56mg/,zinc6.02mg/g,lead2.54mg/g,cadmium1.15mg/kg

For sample 3 taken at 50 km from the dam site representing *Oreochromis niloticus*, . the concentration of chromium was the highest and cadmium the lowest. This is in contrast to the work done by Adakole 1995, who reported a value of 0.39 for chromium,which is the least concentration. the concentration of

heavy metals and chromium was reported to have the least concentration i.e 0.39, from my investigation the concentration of chromium was the highest ;the variation of the result can be attributed to the presence of minning activities closer to the vicinity of the sampling area.

For sample 4 taken at 50km from the dam site representing *Synodontis schall* species of the fish, . the concentration of copper was the higest and lead the lowest.This in line with research work of baeyenis etal, 2005 who reported a value of 8.700-3.00mg/kg for zinc and 7.825-6.520mg/kg for copper.He discovered that the high concentration of copper and zinc can lead to decrease in concentration of cadmium.

The overall result indicates that the concentration of manganese and copper was more in the control area than the damsite. Iron has the highest concentration in all the sampling point while lead has the least concentration except for *Oreochromis niloticus* with the least concentration of 1.0150 of cadmium at 50km to the dam.

For sample 5 representing sampling point 100km away from the dam site, the speci es of fish caught was *Oreochromis niloticus*. This result obtained is in agreement with the work of bayens etal who analyse manganese, copper, chromium, zinc, and lead in Oreochromis niloticus. The metal with least concentration was found to be cadmium.The concentration of the various metals agrees with the maximum alliabe limit for heavy metals in fish samples when compared to UNEP,DPR,WHO,USEPA,FAO standard for heavy metals in fish muscle as found in page 10 0f this study.

For sample 6 representing Synodontis schall species taken at 100km from the dam site, . The concentration of zinc was between 2.4800-0.9880$\pm$0.7600 while the concentration of lead was found to be 3.0530-0.0520$\pm$1.5280 while for cadmium the concentration range between 2.1340-0.1340$\pm$1.000.The result obtain is in agreement with the result obtain by Tasik Mutiara,2005 who determines heavy metals in Synodontis schall and obtain 2.432-0.975 as the concentration of zinc and 3.1000-0.0518 as the concentration of lead.

Sample 7. The result obtain is in agreement with the result reported by baaeyens etal 2005 after studying the presence of heavy metals in Niwar lake, the result for chromium was 4.787-3.300 while lead was 3.0298-0.0321.

For sample 8 representing point at 150km from the dam site and the species of fish caught was *Synodontis schall*. This equally agrees with the work of Binnig and Baird, 2003 who reported a value of 9.78mg/kg for copper and 2.195mg/kg for lead and the UNEP, DPR, WHO, USEPA, FAO standard for maximum detectable limit of heavy metal in fish muscle.

CONCLUSION

Going by this result it could be inferred that the concentration of Organic pollutants in the studied fish sample were within their acceptable limit set by World Health Organization (WHO), and National Agency for Food Administration and Control(NAFDAC).

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