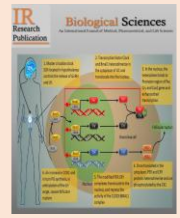
RESEARCH ARTICLE

Biological Sciences

(An International Journal of Medical, Pharmaceutical, and Life Sciences)

Journal home: https://irrespub.com/biolsciences/index.php/1/index



Estimation of the level of deposited lead in upper, middle and lower courses of river Jebba in Niger State, Nigeria

Fatokun, B.O.

Federal College of Wildlife Management, Forestry Research Institute, P.M.B. 268, New-Bussa, Niger State, Nigeria

ARTICLE HISTORY

Received: 10-04-2024
Revised: 31-05-2024
Accepted: 02-06-2024
Online: 04-06-2024

KEYWORDS

Aquatic
Contamination
Anthropogenic
Geological
Spectrophotometer
Matrix

ABSTRACT

Metals accumulating in tissues and organs of aquatic organisms due to their ability to bio-accumulate in aquatic ecosystems. Heavy metals generally enter the aquatic environment through natural and anthropogenic activities caused by individual effluent, domestic sewage, mining and agricultural wastes. This study is aimed at assessing the level of accumulated Lead (Pb) in the samples of four different species of fish found in the river (these includes: *Synodontis membranacea, Bagrus bayad, Hydrocynus forskalii* and *Mormyrus rume*), water and sediments sample collected from different courses of the river. The collected samples were analyzed using Atomic Absorption Spectrophotometer (AAS) at the laboratory of Nigeria Institute of science and laboratory Technology (NISLT), Ibadan. The results from this research showed that *Hydrocynus forskalii* (Tiger fish) has the highest bio-accumulated concentration of Lead (0.0685±0.006 mg/kg) while *Synodontis membranecea* (Karaya) shows the lowest level of deposited lead out of the species of fishes found in the river. It was discovered that water collected from station A (upstream) had the highest level of deposited Lead (0.93±0.031mg/ml) and water samples collected from station C (downstream) had the lowest level of deposited Lead (0.59 ± 0.01mg/ml). Also, the Sediment samples from the river shows the highest concentration of Lead (1.62±0.013 mg/Kg) at station A (upstream) while the lowest concentration (0.97±0.027 mg/Kg) of Lead (Pb) was noticed at the station C (downstream). However, all samples analyzed revealed values that are far above the permissible level of concentration in an aquatic environment.

Introduction

Lead, a metal with very high toxicity tends to accumulate in fish species when present in aquatic habitat where fishes live. It is known to inhibit active transportation mechanisms involving ATP, to suppress cellular oxidation-reduction reactions and to inhibit protein synthesis (Waldron and Stofen, 1974) and this makes its contamination a great concern to researchers. The carcinogenic property of this metal results from its interference with calcium metabolism in man and animals (WHO, 1998). Lead was found to be an abundant metal in muscle tissue of the fish from the study area. Fish is the major source of Lead poisoning in adults and

*Address for correspondence
Federal College of Wildlife Management, Forestry Research Institute, P.M.B. 268, New-Bussa, Niger State, Nigeria
Email: niyifatokundr@yahoo.com
DOI: https://doi.org/10.55006/biolsciences.2024.4206

children's consumers. In Nigeria today different types of illnesses have been reported to be associated with accumulation of heavy metals in the body of animals and man. The major heavy metal poisoning cases in Nigeria were believed to be associated with Lead Poisoning and the primary pathway of Lead exposure as reported by Galadima et al. (2011) is by ingestion of contaminated soil, food and air inhalation. The river provides fresh irrigation water to local farmers, indicating that human absorption through food chain and occupational exposure is very possible. On a similar trend Nubi et al. (2011) showed marine water from Lagos coastal areas to contain Lead (Pb) concentrations far greater than the acceptable WHO and FEPA limits. According to Centers for Disease Control and Prevention (CDCP, 2002) public health measures should continue to be directed at the reduction and prevention of exposure to Lead by reducing the use of the metal and its compounds and by minimizing Lead containing emissions that result in human exposures. Lead poisoning can cause a variety of symptoms and signs which vary depending on the individual and the duration of Lead exposure. Symptoms are non-specific and may be subtle; an individual with elevated Lead levels may be presented with no symptoms. Symptoms usually develop over weeks to months as Lead builds up in the body during a chronic exposure, but acute symptoms from brief, intense exposures also occur (Karry et al., 2008). Symptoms from exposure to organic Lead, which is probably more toxic than inorganic Lead due to its lipid solubility, occur rapidly (Timbrell, 2008). Poisoning by organic Lead compounds has symptoms such as insomnia, delirium, cognitive deficits, tremor, hallucinations, and convulsions and these symptoms are predominantly found in the Central Nervous System (Ragan and Turner, 2009). Symptoms may be different in adults and children; the main symptom in adults are headache, abdominal pain, memory loss, kidney failure, male reproductive problems, and weakness, pain, or tingling in the extremities (Pearce, 2007). Early symptoms of Lead poisoning in adults are commonly non-specific and include depression, loss of appetite, intermittent abdominal pain, nausea, diarrheoa, constipation, and muscle pain (Patrick, 2006). Other early signs in adults include malaise, fatigue, decreased libido, and problems with sleep. Unusual tastes in the mouth and personality changes are also early signs (Karry et al., 2008). In adults, symptoms can occur at levels above 40μg/dl, but are more likely to occur only above 50–60μg/dl, abdominal colic, involving paroxysms of pain, may appear at blood Lead levels greater than 80μg/dL (Karry et al., 2008). Signs that occur in adults at blood Lead levels exceeding 100μg/dl include wrist drop and foot drop, and signs of encephalopathy (a condition characterized by brain swelling), such as those that accompany increased pressure within the skull, delirium, coma, seizures, and headache (Bellinger, 2004). Symptoms begin to appear in children generally at around 60μg/dL (Needleman, 2004). However, the Lead levels at which symptoms appear vary widely depending on unknown characteristics of each individual (Bellinger, 2004). At blood Lead levels between 25 and 60 μg/dL, neuropsychiatric effects such as delayed reaction times, irritability, and difficulty concentrating, as well as slowed motor nerve conduction and headache can occur. Anemia may appear at blood Lead levels higher than 50μg/dL (Patrick, 2006). In children, signs of encephalopathy such as bizarre behavior, dis-coordination, and apathy occur at Lead levels exceeding 70 μg/dl. For both adults and children, it is rare to be asymptomatic if blood lead levels exceed 100 μg/dL (Karry et al., 2008). Hence, this study aimed at investigating the importance and effects of human activities on the quality status of streams, rivers and its resources within the upper, middle and lower courses of river Jebba in Niger State, Nigeria. Specifically, the study was carried out to determine the level of Lead deposited in different species of Fish caught from river Jebba, Niger State, where artisanal mining usually takes place; assess the level of Lead deposited in water samples retrieved from river Jebba and to evaluate the level of Lead deposited in Mud sample collected from river Jebba in Niger State, Nigeria.

Materials and Methods

The Study Area

The study was carried out in river Jebba which is located in Jebba North in Moro Local Government Area of Kwara State, Nigeria. This is the major river where the inhabitants of the area carry out activities such as washing, drinking, bathing and fishing, it is also a major area for extracting the gold mined in and around the locality, a process which is capable of depositing Lead into the aquatic environment thus affecting both the aquatic inhabitants and humans consuming the products from this river.

Study Design

A cross-sectional study was carried out for a period of eight (8) weeks of sample collection and analyses. Fish, water and sediment samples were randomly collected from different points in the experimental site on weekly basis for a period of eight (8) weeks.

Water and sediment sample collection and analysis.

Water and sediment samples were collected separately from three sampling stations of 150 meter interval on the Lake: the upstream (A),

Table 1. Different species of fishes identified.

Common Name	Scientific Name	Local Name
Catfish	*Synodontis membranacea*	Karaya
Catfish (silver)	*Bagrus bayad*	Doza
Tiger fish	*Hydrocynus forskalii*	Zawai
Trunk fish	*Mormyrus rume*	Milligi

Table 2. Determined level of Lead in fishes caught from River Jebba in milligram per kilogram (mg/kg).

Common Name	Scientific Name	Local Name	Lead concentration (mg/kg)
Catfish	*Synodontis membranacea*	Karaya	$0.0180^{b} \pm 0.015$
Catfish (silver)	*Bagru sbayad*	Doza	$0.0497^{ab} \pm 0.023$
Tiger fish	*Hydrocynus forskalii*	Zawai	$0.0685^{a} \pm 0.006$
Trunk fish	*Mormyrus rume*	Milligi	$0.0376^{ab} \pm 0.137$

Table 3. Determined level of Lead in Water Samples collected from different points in River Jebba (g/l).

Sample Stations	**Concentration of Lead (g/l)**
Station A (upstream)	$0.93^{a} \pm 0.031$
Station B (midstream)	$0.74^{ab} \pm 0.023$
Station C (downstream)	$0.59^{b} \pm 0.01$

$^{a, ab, b}$ Means on the same row with different superscripts differs significantly (P<0.05).

Table 4. Determined level of Lead in Sediment Samples collected at different points from River Jebba (mg/kg).

Sample Stations	**Lead Concentration (mg/Kg)**
A (upstream)	$1.62^{a} \pm 0.013$
Station B (midstream)	$1.24^{ab} \pm 0.019$
Station C (downstream)	$0.97^{b} \pm 0.027$

$^{a, ab, b}$ Means on the same row with different superscripts are significantly (P<0.05) different.

midstream (point source of mining effluent) (B) and downstream (C) using plastic sampling bottles of 50cl by dipping the bottles 15cm below the water level while using calibrated Auger collector for sediment at designated sampling stations. Prior to sample collection, all the plastic bottles were thoroughly washed and sun-dried; and before collection, the plastic bottles were then rinsed twice with the same water to be collected. After which sampling bottles were carefully labelled with dates and collection stations and then taken to laboratory to determine the concentration of heavy metals.

Fish sample collection and analysis

Four different species of fishes were caught in the experimental site and the samples were taken to National Freshwaters Fisheries Research Institute (NFFRI) for authentication and identification. Species identified are given Table 1.

Digestion of Fish Sample

Fresh fish from the experimental site were oven dried to constant weight in a Gallenkamp hot box oven and two (2g) of the dried fish samples were weighed separately into a 250ml conical flask, 5ml of Perchloric acid (HClO4) and 15ml Tri-oxo nitrate (IV) acid (HNO3) were added. The mixture was then heated till the solution became clear 5mls of 20% Hydrochloric acid (HCl) was added. The mixture was filtered into a 100ml volumetric flask using NO.42 atman filter paper and made up to mark with distilled water. The digest was stored in a 100ml plastic reagent bottle ready for Atomic Absorption Spectrophotometer (AAS) analysis as described by Galyean, (2010). Fish, water and sediment digest were analyzed for the presence and concentration of Lead (Pb) by means of an Atomic Absorption Spectrophotometer (Unicam 696 series) equipped with solar software using air acetylene flame. Concentration of metals in water and fish were expressed in g/l and mg/kg respectively. The samples were analyzed in duplicate as part of the quality assurance procedures.

Digesting water Samples

The water samples from different sources were separately pipette into a 250ml conical flask after which 5mls of 70% Perchloric acid (HClO4) and 15ml of 55% Tri-oxonitrate (IV) acid (HNO3) were added simultaneously. The mixture was then heated until the solution becomes clear. 5mls of 20%

Hydrochloric acid (HCl) was added and content was poured into a 100ml volumetric flask and made up to mark with distilled water. The digest was stored in 100ml plastic reagent bottles prior to Atomic Absorption Spectrophotometer analysis as described by Galyean (2010).

Statistical Analysis

Statistical software (GENSAT version 13.3 for Windows) was used for data analysis. One way analysis of variance (ANOVA) was used to test for significant differences between mean values of heavy metals at 5% probability level, Duncan multiple range Test was used to separate significant means.

Results

The results from table 2 above revealed that *Hydrocynus forskalii* (Tiger fish) has the highest level of deposited Lead (0.0685 ±0.006 mg/kg) while *Synodontis membranacea* (Catfish) has the lowest level of deposited Lead(0.0180 ±0.015 mg/kg). Significant difference ($P<0.05$) exists in the concentration of Lead deposited in different species of fishes caught from the river.

Lead Concentration in Water Samples from River Jebba (g/l)

Results from table 3 above shows the level of Lead determined in water samples retrieved from different locations of river Jebba in Jebba North of Kwara State of Nigeria. From the table it was discovered that station A had the highest level of Lead (0.93 ± 0.031 g/l) deposits while station C had the lowest level of Lead deposit (0.59 ±0.01 g/l). Significant difference ($P<0.05$) exist in the level of deposited Lead in the water samples collected from the different sampling stations.

The results obtained from the analysis of sediment samples obtained from three different sample stations are as shown in table 4 above and it was discovered that sediment samples from the upstream (station A) had the highest concentration of deposited lead (1.62 ± 0.013) while the lowest value of lead concentration was noticed in the sediment sample from the downstream (station C) section having the values of 0.97 ± 0.027. It was observed that Significant difference ($P<0.05$) exist in the values of the deposited Lead concentration among all the sampled station.

Discussion

Though this is a preliminary work on the aquatic animals, water samples and sediment samples from Jebba river, the results obtained revealed that out of all the species of fishes caught from the river, *Hydrocynus forskalii* (Tiger fish) which is locally known as Zawai has the highest level of deposited Lead (0.0685 ± 0.006 mg/Kg) while *Synodontis membranacea* (Catfish) which is locally known as Karaya has the lowest level of deposited Lead (0.0180 ±0.015mg/Kg). This might not be unconnected with the resistance of some species of fishes to some metals either because of their physiological status, innate immunity or differences in the rate of metabolism of heavy metals. Water and Sediment samples from station A has highest concentration of deposited Lead (0.93 ± 0.031g/L and 1.62 ± 0.013mg/Kg respectively) while station C has reduced or little level of lead concentration in both the water (0.59 ± 0.01g/L) and the sediment (0.97 ± 0.027mg/Kg) samples due to the flow of the river from point source which is the upstream (point A) where artisanal mining usually takes place to point C where the river flows after the extraction of gold at the upstream and no artisanal mining takes place. The increase in the level of heavy metals observed could be due to the high level of contaminants entering the river as a result of the artisanal mining directly washed into the river. Elevated levels of heavy metals in aquatic ecosystem can result in deleterious effect on organisms and consumers of aquatic products which may result to death. Thus, an urgent action needs to be taken in educating the entire populace on the dangers involved in the consumption of aquatic products from areas where artisanal mining takes place. Increase in the level of heavy metal concentration in water bodies where artisanal mining takes place is in agreement with the level of deposit in the river.

Conclusion

From the results obtained in this research, it can be concluded that the concentration of Lead ion (Pb^{2+}) in fish samples, water samples (0.93± 0.031) and sediment samples (1.62± 0.013) were highest in the upper part of the river (Station A) which is the major area where mined gold are being extracted by washing in water. Tiger fish/ Zawai (*Hydrocynus forskalii* which is the species of fish found mostly in the upstream/upper part of the river had the highest level of Lead concentration (0.0685± 0.006) while which is the specie of fishes commonly seen in the lower course of the river (station C) while *Synodontis membranacea* (Catfish) which is commonly seen around the lower course of the river had the lowest level of deposited Lead (0.0180 ±0.015 mg/kg). The concentration of the Lead deposit decreases as the river flows from the upstream to the downstream, this indicates that some quantities of the dissolved Lead were lost as the water flows away from the origin. Recommendation: From the results obtained in this work it is therefore recommended that if fishes are to be consumed from the river in the experimental site, *Synodonti smembranacea* otherwise known as Catfish/Karaya are to be consumed because of the low level of heavy metal deposition in them and water from station C (lower course of the river) is recommended for usage because of the low concentration of heavy metal deposit around here.

Contribution of authors

Unknown

Acknowledgments

Unknown

Conflict of Interest

None

Funding

Unknown

References

Adesulu E.A, and Sydenham, D.H.J (207). The freshwater fishes and fisheries of Nigeria. Macmillan Nigeria limited Ibadan, Nigeria Pp 397

Bellinger, D.C (2004). Lead. Pediatrics 113 (4 Supplementary): 1016–1022.

Centers for Disease Control and Prevention, (CDCP), (2002). Managing elevated blood levels among young children:Recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention Report: (Accessed June 26, 2012). http/www/cdc.gov/nceh/casemangement/casemange_main html.

Galadima, A. Garba, Z.N. Leke, L. Almustapha, M.N. Adam, I.K (2011). Domestic water pollution among local Governments in Nigeria, causes and consequences. European Journal of Scientific Research, (23):592-608.

Galyean, M.L (2010) Laboratory Procedures in Animal Nutrition and Research. Department of Animal and Food Sciences. Texas Technical University, Lubbock Pp193..

Karry, S.K. Saper, R.B. and Kales, S.N. (2008). Lead encephalopathy due to traditional medicines. Current Drug Safety, 3(1): 54–59.

Needleman, H. (2004). Lead poisoning. Annual Review of Medicine, (55): 209–22.

Patrick, L. (2006). Lead toxicity, a review of the literature. Part 1, Exposure, evaluation, and treatment. Alternative Medicine Review: A Journal of Clinical Therapeutics, 11(1): 2–22.

Pearce, J.M. (2007). Burton's line in lead poisoning. Journal of European Neurology, 57(3) 23-25.

Ragan, P. and Turner, T (2009). Working to prevent lead poisoning in children: getting the lead out. Official Journal of The American Academy of Physician Assistants (JAAPA), 22 (7): 40.

Timbrell, J.A., ed. (2008). Biochemical mechanisms of toxicity: Specific examples. Principles of Biochemical Toxicology (4th ed.). Information Health Care.

Waldron H.A. and Stofen D., 1974. Sub-clinical lead poisoning. NewYork: Academic Press pp. 98-99.

*World Health Organisation (WHO) 1998.*Guidelines for Drinking water, World Health Organisation criteria and supporting information.