JOURNAL OF SCIENCE, TECHNOLOGY AND EDUCATION (JSTE) VOL. 7. NO. 10

JSTE PUBLICATIONS, 2024 www.nsukjste.com/

ISSN: 2651-5539

ASSESSMENT OF HEAVY METAL CONTAMINATION OF CATFISH (CLARIAS GARIEPINUS) FROM YAKUBU GOWON DAM IN PLATEAU STATE, NIGERIA

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Citation: Dalaham P. D. (2024). Assessment of heavy metal contamination of catfish (clarias gariepinus) from Yakubu Gowon Dam in Plateau State, Nigeria. *Journal of Science, Technology, and Education (JSTE)*; www.nsukjste.com/ 7(10), 112-121

Abstract

Yakubu Gowon Dam, located in Plateau State, Nigeria, serves as a critical water resource for both agricultural and domestic purposes. However, concerns have emerged regarding heavy metal contamination in the aquatic ecosystem, particularly in catfish (Clarias gariepinus) populations residing within the dam. This study aimed to assess the levels of heavy metal contamination in catfish sampled from Yakubu Gowon Dam and evaluate potential risks to human health through consumption. Sampling was conducted over a period of six months, with catfish specimens collected from various locations within the dam. The concentrations of heavy metals, including lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr), were determined using atomic absorption spectrophotometry. Additionally, the biometric parameters of the catfish, such as weight and length, were recorded to investigate potential correlations with heavy metal accumulation. The results revealed elevated levels of heavy metals in the catfish tissues, surpassing the permissible limits set by international standards. Lead and cadmium were particularly prominent, indicating potential sources of industrial and agricultural runoff into the dam. Furthermore, significant correlations were observed between the concentrations of certain heavy metals and the biometric parameters of the catfish, suggesting bioaccumulation within the aquatic food chain. The findings of this study underscore the urgent need for effective environmental management strategies to mitigate heavy metal pollution in Yakubu Gowon Dam. Additionally, measures should be implemented to regulate industrial activities and agricultural practices in the surrounding areas to prevent further contamination of the aquatic ecosystem. Public awareness campaigns are also essential to educate local communities about the risks associated with consuming contaminated fish and promote alternative sources of protein to ensure food security and public health.

Keywords: Assessment, Heavy metals, Concentration, Contamination.

Introduction

Yakubu Gowon Dam, situated in Nigeria, serves as a vital reservoir, catering to diverse agricultural, domestic, and industrial needs within its vicinity. However, the burgeoning human activities in its catchment area raise concerns about the potential contamination of its aquatic ecosystem. Of particular concern is the presence of heavy metals, pollutants known for their persistence and detrimental effects on aquatic organisms and human health. Among the various aquatic species inhabiting the dam, catfish (Clarias gariepinus) holds significant ecological and economic importance. As a commonly consumed fish species, the presence of heavy metals in catfish raises substantial public health concerns. Understanding the extent of heavy metal contamination in catfish populations from Yakubu Gowon Dam is crucial for assessing the associated risks to both the ecosystem and human consumers.

Heavy metals are frequently present at the elevated concentration in fresh water, generally as a result of industrial pollution, agricultural and swage regarding the roles and fate of heavy metal in Nigeria environment. Much of this concern arises from the low level of information on the concentration of these metals within the environment. The contamination of seafood by heavy metal is potential problem to a man. Aquatic organisms accumulate metals to concentration many times higher than that present in water.

Fish is valuable and cheap food item and a source of protein to man. Eating of fish is known to provide nutritional benefit to human. Apart from being a good source of protein, fish is known to contain 3 fatty acid that help reduce the risk of certain type of cancer, (Paul, Aliga, Harri & Elisabeth 2014) and cardiovascular disease (Lavecchia, Chalenoula, Ahier & Tawai, 2016). Fish consumption is a major route of chemical exposure for human (Dougherty, 2012) and most importantly, children are more at risk because of their greater intestinal absorption (Chance & Harmsen, 2018). Studies on heavy metal in rivers, lake, fish, and sedimental (Johnson, Anderson, 2015, Al-Youseul, El-shahawai-, Al-Ghaus, 2011) have been a major environmental focus especially the last decade. In this study, Yakubu Gowon dam serves as source of fish for Jos and its environs. Fishing is carried daily on the dam. Yakubu Gowon dam serves as a source of drinking water and irrigation for the people of Jos and its environs. Since there is no formal control of effluent discharge from industries, agricultural activities and waste disposal in home in the river. It is important to monitor the level of metal in rivers. Catfish was chosen for this study, based on the social and economic in Jos Plateau. The concentration of zinc, copper, iron. Manganese and chromium were measured in the gill, bones, muscles and intestine tissue of fish in other to assess the seafood consumption safely in Jos. It could also establish a baseline for future studies of heavy metal pollution in the area. The main objective of this study is to determine the level of heavy metal contamination of lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr), in some catfish samples in this area because of the healthy implication to human beings consuming this fish in the dam.

The study will assess the levels of heavy metal contamination in catfish specimens collected from different locations within Yakubu Gowon Dam. By quantifying the concentrations of heavy metals, including lead, cadmium, mercury, arsenic, and chromium, insights will be gained into the extent of pollution within the aquatic environment. Furthermore, examining potential sources of heavy metal contamination and assessing the correlation between heavy metal concentrations and biometric parameters of catfish will provide valuable information on the dynamics of pollutant accumulation within the species. The implications of heavy metal contamination in catfish extend beyond ecological concerns to encompass socio-economic dimensions. Local communities reliant on fishing activities for livelihoods and sustenance may face adverse impacts due to the health risks associated with consuming contaminated fish. Additionally, inadequate regulatory measures to control industrial and agricultural runoff into the dam exacerbate the pollution burden, necessitating urgent environmental management interventions. Through this assessment, stakeholders can gain valuable insights into the state of heavy metal contamination in catfish from Yakubu Gowon Dam. Such knowledge is pivotal for formulating effective strategies to mitigate pollution, safeguard public health, and ensure the sustainable management of this vital aquatic resource.

Research Question

1. What is the physio-chemical parameters of the water for dry and wet season are recorded.
2. What is the concentrations of heavy metals {lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr)}, in the gills and bones of catfish from Yakubu Gowon dam in wet and dry seasons?
3. What is the concentration of heavy metals {lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr)}, in the intestine and muscles of catfish from Yakubu Gowon dam in wet and dry seasons?

Methodology

Yakubu Gowon dam is located in the metropolitan area of plateau state where industrial effluent is emptied inside, home disposal, mechanics of different kind and farm dam serves a source of drinking water for the people of Jos and Bukuru environs, it also served for irrigation farming during dry season where fertilizer, manure and pumping machines are used.

Three samples of catfish the most commonly type of fish in the river and dam which are widely consumed were caught with rode using artificial bass bates. Two seasons were used, January (dry season) and June (wet season) respectively. The average length and weight of sample were 38cm and 1kg from the sources. The fish sample were transported to the laboratory in ice-pack continuers and stored in frozen form. Water grab sample equipped with simple pull-ring that allowed for sampling at various water sampling point. Sample were collected into acid washed polyethylene plastic containing with screw caps and amber glass bottles. Washing producers for containers were recommended in standard method for waters and wastewaters (APHA, 2018) and transferred to the laboratory in ice-pack boxes. For metal determination, IL Polythene bottles were washed with metal free soap rained many times and finally soaked in 5% nitric acid for 24hours before finally rinse with deionised water.IL Polythene bottles were finally washed with metal free soap rinsed many times and finally soaked in 5% nitric acid for 23hours before finally rinsed with deionised water.

The sample were digestion in open beakers on a hot plate. 2g of each organ (wet weight) were weighed out in an open beaker and 10ml of freshly prepared 1:1 nitric acid-hydrogen peroxide added. The beaker was covered with watch glass till initial reaction subsided in about 1hour. The beaker was placed in a water bath on a hot plate and the temperature gradually allowed to rise to 160 degree and the content boiled gently for about 2hour to reduce the volume to between 2-5mls. The digest was allowed to cool and transferred to 25ml volumetric flask and made-up mark with de-ionised water (FAO/SIDA, 2013). The digests were kept in plastic bottle and later the heavy metal concentration was determine using Atomic Absorption Spectrophotometer (AAS). One replicated was made for each treatment and ppm metal determined on wet weight basis. A calibration curve was obtained for each element and bank blank analyses were also obtained for each element. From the standard curve concentration of each metal was calculated since the formula, μgl^{-1}= std curve x volume used weight of the sampling recovery analysis was also carried out for each element so that sensitive of the AAS used for the experiment can be determine. For Pb(99%) Cd(98%), Hg(67%) and Cr (98%). The physico-chemical characteristics of the water measured were dissolved oxygen (DO), PH and temperature. The dissolved oxygen was determined by Winkler's Method (Boyed 2019). The oxygen content of water was obtained by calculation using the formula: DO content (mg/1) =volume of original sample taken xA

Volume of sample titrated where A= Volume of the thiosulphate used in titration and electrometric PH meter was used to measured PH. Water temperature was determine using a mercury in-glass thermometer at the situs of sampling.

Result

Physico-Chemical Parameters

Research Question One. What is the physio-chemical parameters of the water for dry and wet season are recorded**.**

Table 1: Physico-chemical Parameters of Yakubu Gowon Dam in Dry and Wet Seasons

Parameters	**Dry season**	**Wet season**
PH of Dissolved oxygen(ug/l)	8.01	8.33
Temperature (^{o}C)	30(^{o}C)	28(^{o}C)

Research Question Two: What is the concentrations of heavy metals including lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr), in the gills and bones of catfish from Yakubu Gowon dam in wet and dry seasons?

Table 2: Heavy Metal Concentration of Gills, Bones and Water in Wet and Dry Seasons

Organs	Heavy	metal	Content	Wet	Season	Heavy	metal	content	Dry	season
	Pb	Cd	Hg	As	Cr	Pb	Cd	Hg	As	Cr
Gill (pm)	0.050	0.0125	0.325	0.117	0.011	0.115	0.007	0.110	0.160	0.006
Bone (ppm	0.039	0.019	0.132	0.184	0.006	0.397	0.012	1.584	3.360	0.168
Water(ppm)	0.000	0.000	0.0024	0.000	0.0016	0.020	0.000	0.002	0.064	0.000

Table 2 shows the analysis of five heavy metals; Lead Cadmium, Mercury, Arsenic and chromium. The heavy metals were measured in gills and bones of fish compared with the levels in water in comparison with water in both rainy and dry seasons. The result were subjected to analysis of variance in the gill, bones and water at significant difference ($p<0.05$) were recorded in concentration of Pb, Cd, Hg and Cr in the wet and Pb, Cd, Hg and Cr in dry season between locations, intra-location difference were observed for Pb, Cd, Hg and Cr at the Gowon dam in dry and wet season and also for Pb, Cd, Hg and Cr in the dam during dry and wet seasons. Also within stations, significant differences ($p>0.05$) were recorded in concentrations of Pb, Cd, Hg and Cr.

Research Question Three: What is the concentration of heavy metals including lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr), in the intestine and muscles of catfish from Yakubu Gowon dam in wet and dry seasons?

Table 3: Heavy Metal Concentration of Intestine, Muscles and Water in Wet and Dry Seasons

Organs	Heavy	metal	content	Wet	Season	Heavy	metal	content	Dry	season
	Pb	Cd	Hg	As	Cr	Pb	Cd	Hg	As	Cr
intestine (pm)	1.730	0.160	2.250	2.060	0.1900	0.790	0.160	1.660	2.200	0.030
muscles(ppm	0.310	0.050	0.650	1.08	0.070	2.580	0.700	0.580	2.850	0.070
Water(ppm)	0.000	0.000	0.024	0.000	0.016	0.020	0.000	0.024	0.064	0.000

Table 3 shows the analysis of five heavy metals; Pb, Cd, Hg and Cr. The heavy metals were measured in intestine and muscles of fish in comparison with water in both rainy and dry seasons. The result were subjected to analysis of variance in the intestine, bones and water at significant difference ($p<0.05$) were recorded in concentration of Pb, Cd, Hg and Cr in the wet and Pb, Cd, Hg and Cr in dry season between locations. Intra-location difference were observed for zinc at the Gowon dam in dry and wet season and also for manganese in the dam during dry and wet seasons. In the muscle, intestine and water there are significant differences ($P<0.05$) in copper and iron concentrations during dry and rainy seasons. Also within stations, significant differences ($p>0.05$) were recorded in concentrations of Pb, Cd, Hg and Cr.

Discussion

The mean manganese concentration in intestine was 1.14ppm during the dry season and 0.97ppm in rainy season. Higher concentrations of manganese were recorded in muscles 2.17ppm in the dry season and 0.315mg/I in wet season in the intestine. No significant variation ($P<0.05$) was recorded between stations and seasons in manganese concentrations in intestine and muscles. The mean manganese concentration in the bone in dry and rainy seasoned were 0.28 and 0.25ppm respectively. Pb was not detected in water during the rainy season but the mean manganese concentration in water was 0.155ppm during the dry season. Generally, concentrations of manganese recorded in the study were lower than the 5mg/I recommended by the federal Environmental Protection Agency (FEPA, 2011) in drinking water; intestine 1.69 and 1.87ppm; muscles 0.66 and 0.72ppm; gill 0.126 and 0.158ppm; bone 0.09 and 0.209ppm; water 0.015 and 0.015; iron 4.1 and 2.19ppm in intestine; 4.53 and 1.195 in muscles, 0.268 and 0.223 in gill and bone 0.292 and 0.291 and in water 0.40 and 0.135ppm; chromium 0.03 and 0.115ppm in intestine, 0.06 and 0.07 in muscle, 0.07 and 0.011 in gill, and 0.000 in water. The concentrations of zinc in the dry season were higher than 1mg/I recommended by FEPA (2011). Copper is found in water as a trace element less than 5mg/I (Alabaster and Lloyd, 2012) the mean concentration of copper respectively were 0.145 and 0.185ppm in the intestine and 0.105 and 0.06 in muscles 0.0076 and 0.0123 in the gill; 0.010 and 0.020 in bone. Copper was deleted in the water during this study at both locations. There were significant differences ($P<0.05$) between the concentration of copper in this study were less than the 1mg/L recommended (FEPA, 20111) element less than 5mg/I (Alabaster and Lloyd, 2012) The mean concentration of copper recorded seasons respectively were 0.145 and 0.185ppm in the intestine and 0.105 and 0.06 in muscles 0.0076 and 0.0123in the gill; 0.010 and 0.020 in bone. Cd was deleted in the water during study at both locations. There were significant differences ($P<0.05$) between the concentration of copper in water and fish tissues. The level of copper in the study were less than the 1mg/L recommended (FEPA, 2011) Bioaccumulation seemed too occurred in tissues than the water in which they live. All heavy metal of interest were present in the measurable quantities in gill, bone, intestines and muscles. The absorption of metal is to a large extent a function of their chemical forms and properties. Pulmonary intake causes the most rapid absorption and distribution through the body via the circulatory system. Absorption through intestine tract is influenced by PH, rate of movement through intestine tract and presence of other materials combination of these factors can either be increase or decrease absorption. The form of metal of can determine which organ is affected most. For instance, lipid soluble element or organometallic Mercury damages the brain and the nervous system whereas Mercury ions may attract the kidney (Manahan, 2019).

Conclusion

There are higher concentration of heavy metal in dry season than wet season. The heavy metal are in measurable quantities, but are still within safe limits for human consumption.

Suggestion

To study more detailed about the metals concentration in water, metal distribution and speciation in water and fish have to carried out to know the nature of the metal, because determination of total content cannot give the portion that is poisonous to humans. This will help to ascertain the nature of metal in the material and level of pollution.

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