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DETERMINATION OF HEAVY METALS ACCUMULATION IN TILAPIA FISH (*Oreochromisniloticus*) TISSUES HARVESTED FROM AJIWA DAM, BATAGARAWA, KATSINA STATE

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ABSTRACT

Aquatic animal species living in the wild like fishes came in contact with residences of heavy metals. Over time deposits of heavy metals are detected in tissues such as skin, muscles, gills, fin and bore. Concentration of heavy metals namely Au, Pb, Cd, Ag, As and Ca were detected in Tilapia *Oreochromisniloticus* tissues of Skin muscles, gills, fin and bone in this study. The fish samples were collected randomly from three fish landing sites at intervals of four weeks namely; Gajeren Giwa, Kwatami and Masabo sites A, B and C for analysis. Atomic Absorption Spectrophotometer (AAS) model A-6200, Agilent crop, Kyoto, Japan) was used for analysis. Results obtained revealed that the concentrations of heavy metals from Tilapia *Oreochromisniloticus* indicated Au, Pb, Cd, Ag, As and Ca levels (13.06ppm) to (7.73ppm) from skin and bone. 0.19) to 0.12 (ppm) (2519.87ppm) to (162.16ppm) (10.47ppm) to (0.31ppm), (0.75ppm), (0.75ppm), (0.28ppm) to (0.0ppm) from skin, muscles, gills, fin and bone (Ca>AU>Ag>As>PB>Cd). It showed significant difference in concentrations of metals with respect to the fish parts. Also the presence of reasonable concentrations Ag Cd, Pb, As and Ca reflects residues from fertilizer and herbicides application at farming sites proximity to the dam. The finding recommends Periodical studies of concentration of heavy metals should be mounted especially guided by seasonal variations unregulated use of fertilizers on farms neighboring the dam should be discouraged.

Keywords: Ajiwa Dam, Fish, Heavy metals Liquor, samples

INTRODUCTION

Heavy metals have gotten a lot of attention because of their toxicity, long-term persistence, bioaccumulation, and bio-magnification at different trophic levels (Ololade *et al.*, 2008).Heavy metal distribution in water, sediments, and organisms is used to assess the degree of contamination in the aquatic environment (El-Batrawy *et al*., 2018). Fish are at the top of the food chain and are widely used to biologically monitor the level of metal pollution in aquatic ecosystems (Al-Sayeghpet *et al*., 2012), as they can contains large amounts of certain metals from the water (Dariglus *et al*.,2002). Heavy metals are significant group of chemical pollutants that enter our bodies primarily through food; some heavy metals are irreversibly bound to human body tissues, such as cadmium to kidneys and lead to bones (Kaplan *et a*l., 2011). Fish is a significant source of heavy metals in food (Sivaperumal *et al*., 2007). Excessive accumulation of metals in the environment can cause problems for humans, animals, and plants (Al-Khateeb and Leilah, 2005). Because it occupies different food chain levels, fish has been found to be an excellent indicator of heavy metal contamination in aquatic systems (Karadede *et al*., 2007). Fish is one of the most abundant organisms in the aquatic environment and are regarded as one of the primary protein sources for humans (Rashed, 2001).A great deal of concern and attention was paid to the health effects on people caused by the consumption of metal-contaminated foodstuffs (Iwegbue *et al*., 2008). Heavy metals are found in the environment as a result of both natural processes and contaminants from human activities (Frank *et al*., 2005).Some heavy metals are known to be potentially toxic, such as arsenic, lead, aluminum, and cadmium, while others, such as iron, zinc, and copper, are essential (Abduljaleel and Shuhaimi 2011). Consumption of muscle tissue may not pose a risk to human health and is completely safe (Abdulali *et al*., 2012). The rate of heavy metal bioaccumulation in aquatic organisms is determined by the organisms' ability to digest the metals as well as the concentration of such metals in the water body (Ejike and Liman 2017). Also it has to do with the concentration of the heavy metal in the surrounding soil sediments as well as the feeding habit of the organism (Eneji *et al*., 2011). There is increasing concern about the quality of the aquatic food (e.g. fish) in several parts of the world (Ejike and Liman, 2017). Heavy metals are currently a major environmental concern; the metals come into contact with the organs and tissues of the fish and accumulate to varying degrees in different organs and tissues of the fish (Wakessa, 2020). Heavy metals occur naturally in soils as a result of weathering processes of parent materials or as a result of the geochemical component or formation of the soil area, but usually in trace amounts (Narwal *et al*., 2000).Water in motion could eventually carry naturally occurring heavy metals into water bodies and reservoirs where wild fishes survive because weathering processes of rocks can be influenced by water in motion as an agent. Heavy metals are defined as any metallic chemical element in the periodic table with a relatively high density (density greater than 5h/cm3) that is toxic at low concentrations (Otabor *et al*., 2018).Domestic activities near the reservoir were thought to be a major contributor to the accumulation of toxic heavy metals in the fish studied (Ahmad*et al*., 2018). The aim of this study therefore is the determination of heavy metals concentration of Tilapia fish (*Oreochromisniloticus*) from Ajiwa Dam, Batagarawa local government, Katsina State using AAS.

MATERIALS AND METHODS

Description of Study Area

Ajiwa Dam is located at Batagarwa Local Government Area of Katsina State on Latitude and Longitude $12^0 54^0 69$" - $12^0 57^0 58$" N and $7^0 42^0 53$" - $7^0 47^0 50$" E (Figure 1). It is in the Sudan Savannah Zone of Nigeria with two district seasons

(Wet and Dry) the Wet Season period on the average last from May to October and Dry Season from November to April. The main purpose of the reservoir (Dam) is principally water supply to the resident of Katsina, Batagarawa, Mashi and Mani Local Government Areas, and secondary objective is irrigation. The dam was constructed in 1973 and commissioned in 1975. Its major source of water is River Tagwai. It has original height of 12m, but after being rehabilitated reservoir crest length is now 1491.8m. It also has surface area of 607.0ha. The storage capacity of water is about 22,730,000m^3 (Usman 2017). The Dam serves as source of livelihood to the nearby communities such as Ajiwa, Masabo, Tsagero, Kwatami, Maje and GajerarGiwa villages.

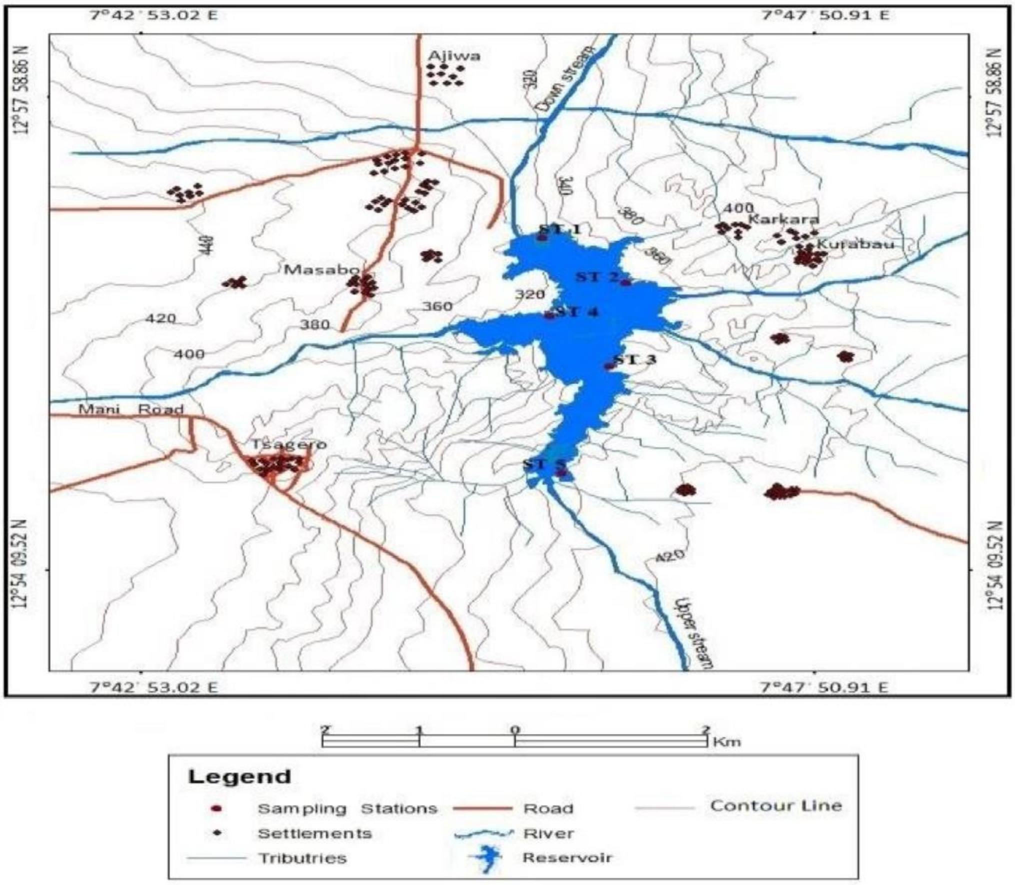

Figure 1: Map of the study area

Sampling Sites

Three (3) sampling sites were chosen for the purpose of this study and designated as A, B and C for collection of the fish samples (i.e. Gajeren Giwa (A), Kwatami (B) and Masabo (C) respectively. The choice of these sites was based on the ecological setting of the sampling area and geographical spread coverage of the Dam surrounding.

Site 'A' (Gajeren Giwa) is closely located to the Eastern embankment of the Dam. Site 'B' (Kwatami) is closely located to the Western embankment of the Dam and site 'C' (Masabo is closely located to the Southern embankment of the Dam.

Sample Collection

Sampling was done on weekly intervals of four (4) weeks in the month of August. During which fish samples were collected from all the sites mentioned, in the morning immediately on arrival were randomly purchased from fishermen at their landing sites in the location at the dam. Fish samples were put in cool boxes and transported to the department of Microbiology, Umar Musa Yar'adua University, Katsina.

Sample Preparation

The fish sample were degutted, filleted and kept in the freezer at 18^{0}C prior to analyses. A portion of the fillet was used for analyses of microbial while the rest was minced using a meat mince (Model, M12TK) and packed in polythene Ziplock bags and kept in a freezer at - 18^{0}C for analysis of proximate composition and heavy metal profile.

Determinations of Heavy Metals

Heavy metals analysis was done using AOAC methods of analysis (AOAC, 2006). Two grams from ash sample were placed in a digestion tube and pre-digested using 10ml of HNO_3 and 1ml of $HCIO_3$ acids were added and temperature maintained at 135^{0}C until the liquor was colourless. The digested liquors were then filtered through a whatman 1 filter paper and diluted to 25ml with distilled water. The digested samples were then used for analysis of selected heavy metals (Au, Pb, Ca, As and Cd) using atomic absorption spectrometer (AAS) (Model A A-6200, Agilent Corp., Kyoto, Japan) Olowu *et al*. (2010) as suitable standard solutions were prepared and their abundance measured to prepare a standard curve. The standard curve was used to calculate the concentration of metals and minerals.

RESULTS AND DISCUSSION

The detailed results are presented in tables 1 and 2. Generally the concentrations of heavy metals from Tilapia O *niloticus* Gold (Au), Cadmium (Cd), Calcium (Ca), Arsenic (As) and Lead (Pb) were (13.06ppm) to (7.73ppm) from skin and bone (0.19ppm) to (0.12ppm), (2519.87ppm) to (162.16ppm), (10.47ppm) to (0.31ppm), (0.75ppm), (0.28ppm) to (0.0ppm) from skin, muscles, gills, fin and bone shown in table 1 and 2 which showed significant difference in concentration of metals with respect to the fish parts ($P \leq 0.05$; 0.000246). The findings are in conformity with the work of Olowu *et al*. (2010) on determination of heavy metals in fish tissues.

Table 1: showing the Heavy metals concentrations from *Tilapia* O *niloticus*

Samples	Gold (Au)	Cadmium (Cd)	Calcium(Ca)	Silver(Ag)	Arsenic(As)	Lead(Pb)	P-value
Skin	7.95	0.13	832.17	0.31	0.53	0.05	*0.00024
Muscles	7.73	0.12	162.16	0.39	0.58	0.09	0.4293
Gills	10.93	0.14	2519.87	0.47	0.62	0.0	
Fin	12.08	0.16	1361.7	10.47	0.61	0.05	
Bone	13.06	0.19	784.05	0.58	0.75	0.28	

*(0.00024) Showing significant difference in concentrations of the metals between the parts.

The concentrations of metals from Tilapia, *O. noliticus* gold (Au), Cadmium (Cd), Calcium (Ca),Arsenic (As) and Lead (Pb) were 13.06mg/kg to 7.73mg/kg from skin and Bone 0.19mg/kg to 0.12mg/kg, 2519.87mg/kg to 162.16mg/kg 10.47mg/kg to 0.31mg/kg, 0.75mg/kg to 0.53mg/kg, 0.28mg/kg to 0.0mg/kg from skin , muscles, gills ,fin and bone shown in (Table 3).

Which showed significant different in concentrations of metals with respect to the fish parts ($P \leq 0.05$; 0.000246).

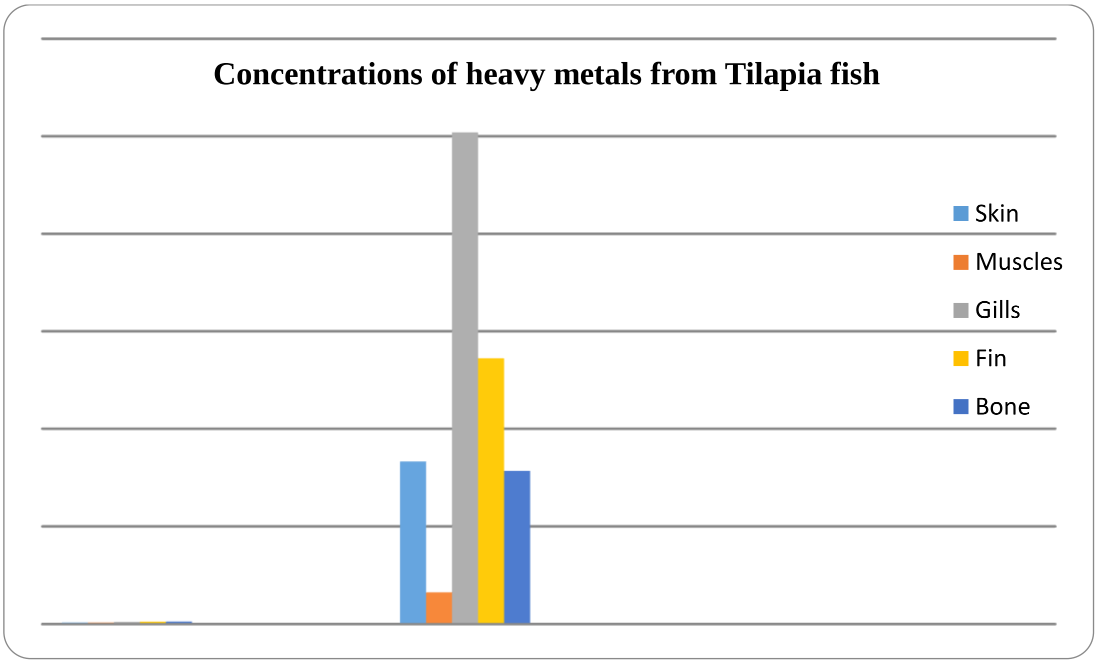

Figure 2: Concentration of Heavy Metals from Tilapia Fish

The comparison among the Tilapia fish tissues in AjiwaDam according to their metal accumulation level as given in the table, accordingly bone has highest concentration of gold 13.06mg/kg, cadmium 0.19mg/kg, Arsenic 0.75mg/kg and lead 0.28mg/kg, gills 2519.87mg/kg has highest concentration of calcium and fin 10.47mg/kg has highest concentration of silver. However, according to overall concentrations of heavy metals in the fish tissues Ca showed highest concentration followed by Au, Ag, As, Cd and Pb. Metal accumulation orders in tissue parts of Tilapia *O.niloticus* (Ca>Au>As>Ag>). Bone has highest concentration of AU, Cd, As and PB in comparison to skin, muscles, gills and fin that was examined. However, a gill has highest concentration of Ca, while fin has highest concentration of Ag. Importantly for Cd and PB the concentrations obtained of 0.19 and 0.28mg/kg does not exceeded the acceptable limits of FAO and WHO (2000) and non of the tissues studied exceeded the acceptable limits of Cd – 0.2mg/kg and Pb – 0.3mg/kg respectively. The highest concentration levels of As (0.75ppm) obtained in the bone tissue of the Tilapia *O.niloticus* could be associated with fish exposure to residues of herbicides used by irrigation farmers at the dam sites which concur with related findings (Lone et al., 2008) similarly as reported on the concentration of Cd from application and contact with phosphate fertilizer and sewage sludge used by farmers at the dam sites. For PB highest concentrations obtained in fish muscles (0.09mg/kg is lower than the FAO/WHO and EU limit of 0.5kg/g and 0.1kg/g respectively. (Wakessa 2020). Higher concentrations of Ag in the fin tissue could be associated with intake of smaller aquatic invertebrates organisms that wild fishes feeds on as reported by Hans (1998). The organisms viewed as most sensitive to silver are small aquatic invertebrates, particularly embryonic and larval stages.

The mean value of Cd from this study was lower than reported values from other studies of Kah*et al*.(2015), Rahman *et al*, (2013), for all the tissues analyzed the concentrations of Pb, in the fish samples were below the 0.5mg/kg net weight limit stipulated by the FAO. The Pb level in fish of this study was also lower than reported by others such as (Abdulali T. et al 2003, Kamaruzzaman *et al*., 2008 and Shuhaimi – Othman et al., 2009). The MFA acceptable limit for Pb concentration is 2mg/Kg. All the Pb concentrations of fish species were also found to be lower than the acceptable limit suggested by MFA and FAO, seasonal variation indices was not included in the period under review.

CONCLUSION

This study revealed that the heavy metals variables such as Pb, Au, Ag, As, Cd and Ca in the Tilapia *O.niloticus* fish were below or within the range of the recommended limits of FAO/WHO and EU. However, in the detected samples; concentration of Ca>Au>Ag>As>Pb>Cd ranges were obtained. The highest concentration of Ca recorded could be associated with exposure of the Dam with in-organic manure residues from farming activities. Bone tissues of the fish constitute higher concentration of Au, Cd, As and Pb but at world standard acceptable levels. Highest concentration of Ag in the fins indicates respiratory contact of dissolved particulates in water. The high concentration of Pb might be caused by the closeness of the water to exposure of machineries and equipments emission of greenhouse gases. The concentration of heavy metals in the tilapia fishes tissues studies is associated and influenced by the discharge of massive amounts of agricultural inputs. However, this could be a reason for the presence of heavy metals concentrations in the water body and invariably the aquatic species of fauna and flora inhabiting the study area as influenced by the discharge of massive amounts of domestic sewage as well as agricultural and industrial effluents. Periodical studies of concentration of heavy metals should be mounted especially guided by seasonal variations unregulated use of fertilizers on farms neighbouring the Dam should be discouraged. Health awareness campaign and education on effects of heavy metals consumption through bioaccumulation should be mounted periodically. Present Ajiwa Dam from been used as dumping sites of refuse. Encourage feature researchers to include more species of fishes and other aquatic animals inhabiting the Dam. Neighbourhood irrigation and raining seasons farmers should be trained on sustainable use of farm inputs especially fertilizers and herbicides to regulate effects of long term bioaccumulation of heavy metals on fish products. It is recommended that the wider community consuming the fishes captured from the dam should be sensitized on the health effects of heavy metals beyond acceptable standards.

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