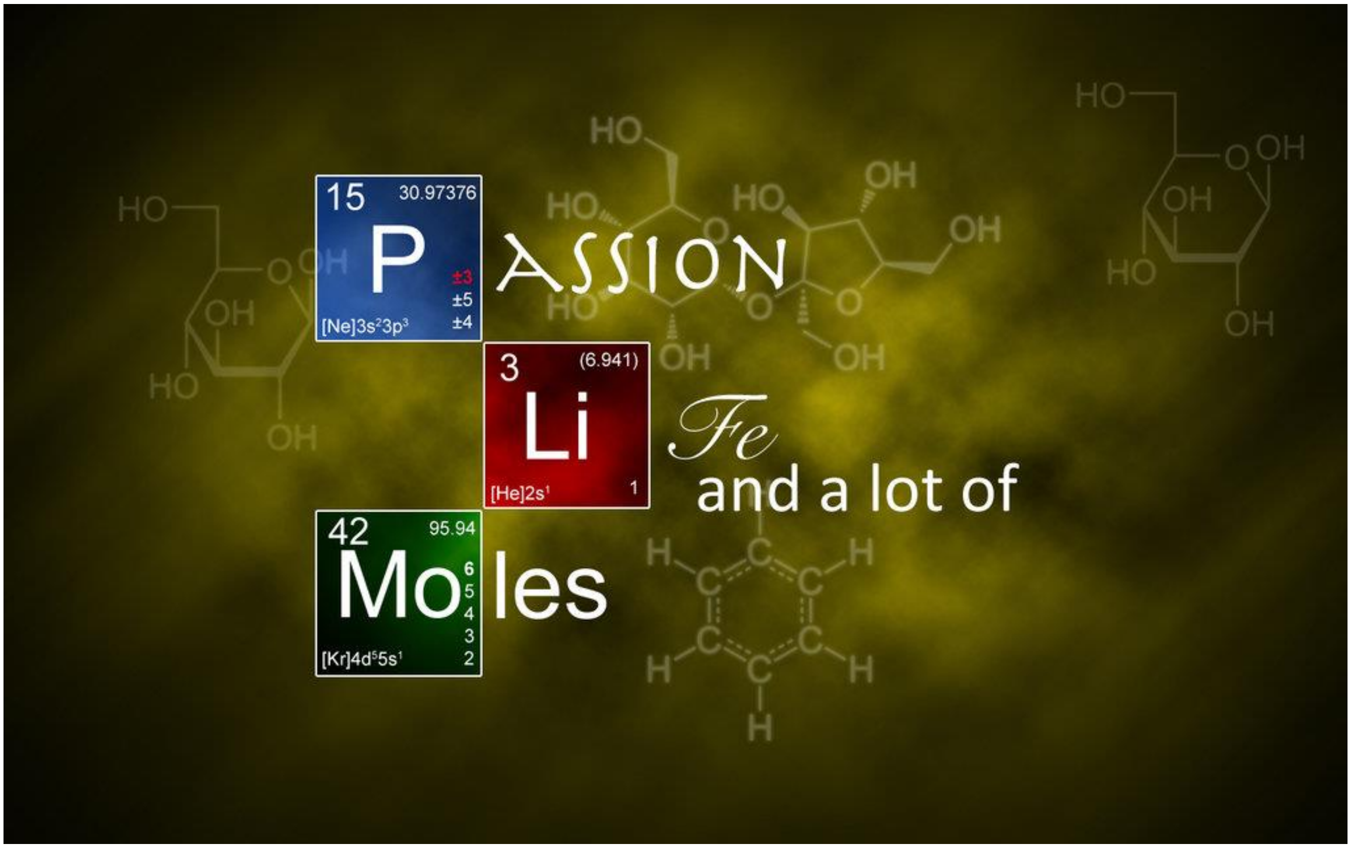


Volume 2 Issue.1:2016

INTERNATIONAL JOURNAL OF CHEMISTRY AND AQUATIC SCIENCES (IJCA)

WWW.CHEMISTRYJOURNAL.KYPUBLICATIONS.COM
ISSN:2455-040X

www.kypublications.com
Editor-in-Chief
Dr.Y.H.Rao
Email:submitijca@gmail.com

Managing Editor
Dr.Medikondu Kishore

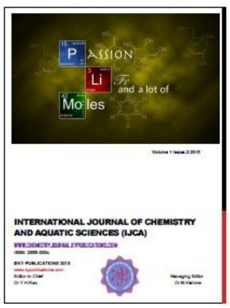
INTERNATIONAL JOURNAL OF CHEMISTRY AND AQUATIC SCIENCES (IJCA) II *Volume.2 Issue.1. 2015*

Bioaccumulation and bioavailability of heavy metals in benthic organism *(Oreohromis niloticus)* in Wudil river

RESEARCH ARTICLE

Azubuike Adams, (Ph.D)

Department of Biological Science, Faculty of Science, Nigeria Police Academy, Wudil,
P.M.B 3474, Kano – Nigeria.
Email: dr.azubuikeadams@yahoo.com



ABSTRACT

The study was conducted to assess the concentration of heavy metals in the Gills, liver, bone muscle in Oreochromis niloticus. Contamination by heavy metals such as Cadmium and chromium were evaluated in the water samples and tissues (muscles, gills, bones and liver) of Oreochromis niloticus collected from river wudil in Kano State, Nigeria. Different organs in the fish examined accumulate varying quantities of different heavy metals. Water samples and fish samples collected were analyzed using atomic absorption Spectrophotometer (AAS) to determine concentrations. The average weight of the fish samples was 60kg: average total and standard length were 136mm and 166mm respectively. Average surface temperature of the river was 270c, the PH value of 7.1, Transparency 19.18cm, and dissolved Oxygen determined was 2.5mg/l. The mean concentration of cadmium, chromium and lead in the fish samples were 9.92mg/l, 9.12mg/l and 10,0mg/l respectively. Highest value of chromium (12;07mgl) and lead (11.82mg/l) were examined from the Gills. Highest concentration of Cadmium (11;59mg/l) was analyzed in the Liver of O. niloticus. The concentration of cadmium, chromium and lead in both the fish and water samples were above the permissible limit set by WHO (1985), FAO (1983) and FEPA (2003). The level of chemical pollution in river wudil is of serious public health risk, close monitoring and quick government intervention to prevent fishing, irrigation and recreational services of the river is recommended.

Keywords: Heavy metals, concentration, physic-chemical parameters, fish.

1.0 INTRODUCTION

1.1 Heavy metals

Heavy metals (i.e. zinc, copper, lead, cadmium, etc.) rank as major polluting chemicals in both developing and developed countries. Probably the heavy metals source was, and still is in some countries, the waste waters arising from mining activities, such as mine drainage water, effluent from tailings ponds (where waste crushed ore is settled out) and drainage water from soil heaps. Another important source is the industries that use these metals in various processes, especially electroplating and galvanizing of iron, where waste solution from the treatment vats are discharged without treatment (Richard, 1992).

Heavy metals are those with a specific gravity of five or more. Manganese, Iron, Zinc, Molybdenum, Cadmium, Mercury and lead have attracted more notice. Some are required as trace element for living organisms, although others (Cd, Hg and Pb) are not. At higher concentrations, even the trace elements are frequently toxic, although the mode of action is often obscure. Normal concentrations of these elements in unpolluted waters are around lµg 1^{-1}, with Zinc concentrations of l0µg 1^{-1}. Effluents from metal Industries and from the exposure of metal Sulphides to air and water in mine-waste dumps may, increase these concentrations by several orders of magnitude.(Moss, 1998).

A heavy metal is a member of a loosely-defined subset of elements that exhibit metallic properties. It mainly includes the transition metals, some metalloids, lanthanides, and actinides. Many different definitions have been proposed—some based on density, some on atomic number or atomic weight, and some on chemical properties or toxicity. The term *heavy metal* has been called a "misinterpretation" in an IUP AC technical report due to the contradictory definitions and its lack of a "coherent scientific basis"(Duffus,2002) There is an alternative term *toxic metal,* for which no consensus of exact definition exists either. As discussed below, depending on context, heavy metal can include elements lighter than carbon and can exclude some of the heaviest metals. Heavy metals occur naturally in the ecosystem with large variations in concentration. In modern times, anthropogenic sources of heavy metals, i.e. pollution, have been introduced to the ecosystem. Waste-derived fuels are especially prone to contain Heavy metals, so heavy metals are a concern in consideration of waste as fuel (Wikipedia, 2011).

Heavy metals are simply a certain class of metallic elements. Our bodies require trace amounts of some heavy metals, including copper, zinc, and others, but even these can be dangerous at high levels. Other heavy metals such as mercury, lead, arsenic, and cadmium have no known benefits, and their accumulation over time can cause serious illness and even premature death. The industrialization of our world has dramatically increased the overall environmental 'load' of heavy metal toxins. Today, heavy metals are abundant in our air, soil, and even drinking water. They are present in virtually every area of modern life from construction materials to cosmetics, medicines, processed foods, fuel, appliances, and even personal care products. It is very difficult for anyone to avoid exposure. However, you can take steps to understand and minimize this threat through acts of prevention and treatment that will help to lessen their negative impact on you and your family's health. Heavy metal toxins contribute to a variety of adverse health effects. There are over 20 different known heavy metal toxins that can impact human health. Accumulation within the body could lead to a decline in the mental, cognitive, and physical health of the individual (Infinite Health Resources, 2005 - 2012).

Heavy metals, such as copper, lead, mercury, and selenium, get into water from many sources, including industries, automobile exhaust, mines, and even natural soil. Like pesticides, heavy metals become more concentrated as animals feed on plants and are consumed in turn by other animals. When they reach high levels in the body, heavy metals can be immediately poisonous, or can result in long-term health problems similar to those caused by pesticides and herbicides. For example, cadmium in fertilizer derived from sewage sludge can be absorbed by crops. If .these crops are eaten by humans in sufficient amounts, the metal can cause diarrhea and, over time, liver and kidney damage. Lead can get into water from lead pipes and solder in older water systems; children exposed to lead in water can suffer mental retardation. Hazardous wastes are chemical wastes that are either toxic (poisonous), reactive (capable of producing explosive or toxic gases), corrosive (capable of corroding steel), or ignitable (flammable) (Hart, 2009).

Heavy metals are individual metals and metal compounds that can impact human health. Arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. These are all naturally occurring substances which are obtain present in the environment at low levels. In larger amount, they can be dangerous. Generally, humans are exposed to these metals by ingestion (drinking or eating) or inhalation (breathing).Working in or living near an industrial site which utilizes these metals and their compounds increases ones risk of exposure, as does living near a site where these metals have been improperly exposed. Subsistence lifestyles can also impose higher of exposure and health impacts because of hunting and gathering activities (Life extension Foundation, 1995-2010)

In small quantities, certain heavy metals are nutritionally essential for a healthy life. Some of these are referred to as the trace elements (e.g., iron, copper, manganese, and zinc). These elements, or some form of them, are commonly found naturally in foodstuffs, in fruits and vegetables, and in commercially available multivitamin products (International Occupational Safety and Health Information Centre,1999). Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Heavy metals may enter the human body through food, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, pharmaceutical, industrial, or residential settings. Industrial exposure accounts for a common route of exposure for adults. Ingestion is the most common route of exposure in children (Roberts 1999). Children may develop toxic levels from the normal hand-to-mouth activity of small children who come in-contact with contaminated soil or by actually eating objects that are not food (dirt or paint chips) (Dupler, 2001).

1.2 Justification of the study

Fish is an important source of protein worldwide and its analysis for toxic metals has been used as an indicator of the pollution status of the aquatic environment. *Oreochromis niloticus* is used by many countries and tribes in food. Neighboring houses, industries, farms, etc. pollute fish .habitat by wastes discharge in form of sewage, effluents, pesticide which contain heavy metals that affect the Physiology and metabolism of fish and also bioaccumulate in the fish tissues. In view of these, it is important to study the level of heavy metals in the fish and water to compare the result with the standard values to determine the quality and the potential human risk of consumption of *Oreochromis niloticus* in river wudil on human health.

1.3 Aims and Objectives

The research is aimed at evaluating the amount of heavy metals in the gill and tissues of *Oreochromis niloticus* river wudil.

Objectives

1. To determine the Physico-chemical Parameters of Water from river wudil.
2. To measure the level of heavy metals in the gills and tissues of *Oreochromis niloticus* in river wudil.
3. To find whether the water is suitable for fishery.

2.0 Materials and Method

2.1 Description of the study area

2.2 Fish Sample Collection and Analysis

The fish samples used for this study was obtained from river wudil fortnightly using gill nets, trap nets and cast nets. The fish samples collected was transported to the laboratory in an ice cool bucket to prevent spoilage, on coming to the laboratory; they were kept in a holding tank before the subsequent analysis for the metal contents.

The fish *Oreochromis niloticus* was identified according to a key by Williams et al (1976).

The total lengths and standard lengths were measured using measuring board while weight of each samples was recorded using analytical weighing balance. Each fish sample was placed in a polypropylene dissection board and killed by making a mid ventral incision along the base to expose the internal organs.

Three Hundred and eighty four (384) fish samples were collected for this research as calculated using Open Epi Version 2.2.1, 2008.

Population size (N) = 1000000

Hypothesize % frequency of outcome factor in the pupation (p) =50%

Confidence limit as % of 100(d) =50%

Design effects 1

Muscle, gill, liver and bones were removed from each fish sample. Each tissue was oven dried at 80°C for 48 h. Dried samples were standardized, enough to fill 50M1 glass bottles in which they were stored after grinding. Samples were stored in the fridge at temperature of -20°C until analysis.

Digestion of fish samples was performed using 1 .0 g of dried fish samples (muscles, gills, liver and bones) which were weighed in 100 ml Erlenmeyer flasks. 10 ml of HNO_3 (65%) and 3ml of H_2O_2 (65%) were added in each flask with each tissue type. The mixtures were heated up to 150°C for 4 h, after cooling, the mixtures were filtered in round bottom flasks, using a 0.45 um Whatman filter paper and be brought to a volume of 10 ml with deionized water (APHA, 1995)

This procedure was then repeated three times with a blank digest carried out the same way. The resulting solutions were analyzed for trace metal contents using Atomic Absorption Spectrophotometer model 210 VGP (AAS) by flame absorption mode.

2.3 Water sample collection and analysis:

Water sample was collected from three stations on the river (upstream, midstream and downstream) and stored in the fridge prior to analysis. The analysis for trace metal concentration was performed by adding 1ml of concentrated HNO_3 (65%) to the water sample of 50ml on the field in order to prevent or stop microbial activity (APHA, 1995).

2.4 Physico-chemical parameters

Temperature

The surface water temperature was measured using Mercury-bulb thermometer. The thermometer was placed in the water or 20 seconds and brought out, the reading was taken.

2.3.2 Transparency

This was measured using white and black Secchi disc and a ruler as described by Reid and Wood (1976). The Secchi disc was placed in the water and gently by holding to it, was lowered into the water, at the point of disappearance the ruler was used to measure the distance between the Secchi and the water in centimeter or millimeter.

PH

This was carried out using portable D.O Analyzer (McJefferson, Model JPB 607). The probe of the analyzer was placed in the water and brought out, and then the reading was taken.

Dissolved oxygen

This was carried out using portable D.O Analyzer (McJefferson, Model JPB 607). The probe of the analyzer was placed in the water and brought out, and then the reading was taken.

Heavy metals

In the laboratory, for the purpose of digestion, 9ml of concentrated HNO_3 (65%) was further added to the solution and be heated gently at 70^0C until the solution became transparent, the resulting solution was filtered and made up to volume by adding distilled water and be analyzed for heavy metals content using AAS (APHA, 1995).

2.5 Statistical Analysis:

Statistical analysis was carried out using SAS statistical package. The ANOVA was used to assess whether heavy metals concentrations varied significantly between the samples. The values obtained were presented as least significance Difference (LSD) of means at ($p<0.05$). correlation was also used to measure the relationship between the heavy metals concentration and the length and weight of the fish samples.

3.0 Results

Result of mean Cadmium Concentration in samples of *O. niloticus* is presented in table 1. Highest concentration was found (l0.0mg/kg) in August and lowest concentration in June (7.22mg/kg) for Bone. Liver has the concentration in November (13.33 mg/kg) and lowest concentration (7.64mg/kg) in June. Highest concentration was observed in October (11.67mg/kg) and lowest concentration (7.64mg/kg) in June for Gills. Muscles have the highest concentration in September (12.67 mg/kg) and lowest concentration (5.0 mg/kg) in August.

Table 1: Monthly Mean Cadmium Concentration (mg/kg Dry Weight) 2015

Tissues	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
6 one	7.22	9.00	10.00[a]	9.67	9.67	8.67[b]
Liver	7.64	7.67	11.33a	10.00	13.00	13.33[a]
Gills	7.64	10.33	11.33[a]	11/67	11.67	8.67[b]
Muscles	11.53	9.67	5.00[b]	12.67	12.00	8,67[b]
Grand Mean	8.51	9.17	9.42	11.00	11.59	9.83
LSD	4.18	2.69	2.03	11.00	3.75	2.00
Level of Signif.	NS	NS	**	NS	NS	**
% C V	11.1	4.2	8.5	2.7	12.7	2.9

Means followed by similar or no letter along a column are not significantly different using LSD. ** = Significant at 1%,* = Significant at 5%, NS=Not Significant at 1 & 5%.

Table 2 shows the monthly mean of Chromium Concentration in samples of *O. niloticus.* Highest values of Chromium (10.57 mg/kg, 13.57 mg/kg, 13.57 mg/kg, and 10.57 mg/kg) was found in the month of august in all the fish samples (Bone, Liver, Gills and Muscles). Lowest concentration (6.40 mg/kg and 6.37 mg/kg) of chromium in the month of November in Gills and Muscles, and also (7.11 mg/kg and 6.10 mg/kg) in June and July in Bone and Liver respectively.

Table 2: Monthly Mean Chromium Concentration (mg/kg Dry Weight) 2015

Tissues	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
Bone	7.11	9.70	10.57[b]	8.93	9.50	9.93
Liver	6.12	6.10	13.57[a]	8.07	12.20	7.30

Gills	8.36	9.17	13.57[a]	9.20	9.20	6.40
Muscles	10.24	8.37	10.57[b]	9.47	9.73 .	6'37
Grand Mean	7.96	8.33	12.07	8.92	10.16	6.37
LSD	3.61	2.10	9.67	2.53	2.27	6.75
Level of Signif.	NS	NS	**	NS	NS	NS
%CV .	8.5	18.8	5.6	17.9	11.1	1.9

Means followed by similar or no letter along a column are not significantly different using LSD. ** = Significant at 1%,* = Significant at 5%, NS=Not Significant at 1 & 5%.

Result of mean Lead Concentration in samples of *O. niloticus* were presented in table 3.Highest concentration was found (12.26mg/kg) in July and lowest concentration in November (7.21mg/kg) for Bone. Liver has the concentration in August (12.42mg/kg) and lowest concentration (8.62 mg/kg) in June. Highest concentration was observed in June (11.79mg/kg) and lowest concentration in November (8.09mg/kg) for Gills. Muscles have the highest concentration in September (11.53 mg/kg) and lowest concentration (8.10 mg/kg) in August.

Table 3: Monthly Mean Lead Concentration (mg/kg Dry Weight) 2015

Tissues	Jun.	Jul.	Aug.	. Sept.	Oct.	Nov.
Bone	9.03	12.26	8.25[b]	10.61[ab]	11.07	7.21
Liver	8.62	12.42	10.16[3]	9.11[C]	10.46	8.96
Gills	11.79	11.11	10.29"	10.87[8]	9.71	8.09
Muscles	9.99	11.53	8.10[b]	11.76[8]	11.20	8.53
Grand Mean	9.03	11.83	9.31	10.59	10.61	8.20
LSD	3.00	2.38	1.25	1.51	2.03	1.51
Level of Signif.	NS	NS	**	**	NS	.NS
%CV	4.8	6.5	13.4	2.9	3.6	1.1

Means followed by similar or no letter along a column are not significantly different using LSD. ** = Significant at 1%,* = Significant at 5%, NS=Not Significant at 1 & 5%.

Table 4 shows the correlation between heavy metal concentrations length and weight of the fish samples in June. There was a strong positive correlation between weights of the fish samples. Also there was a negative correlation between cadmium concentration and weight and length of the fish sample. The correlation between chromium and lead concentration with the length and .weight of the fish samples is not statistically significant. The correlation that exists between lead arid chromium concentration with cadmium concentration is not statistically significant. There was a positive correlation between lead and chromium concentration.

Table 4: Correlation between heavy metals, Length and Weight of the fish samples in June 2015

Treatment	Length	Weight	Cadmium	Chromium	Lead
Length	1				
Weight	**	1	r		
Cadmium	*	*	1		
Chromium	NS	NS	NS	1	
Lead	NS	NS	NS	*	1

* (indicate the existence of association between heavy metals and the length and weight of the fish samples). ** (indicate the existence of strong association between heavy metals and the length and weight of the fish samples).NS (indicate that the association is not significant)

Table 5 shows the correlation between heavy metal concentrations length and weight of the fish samples hi July. There was no significant correlation between length and weight of the fish samples. Also the correlation between cadmium and chromium concentration with length and weight of the fish samples was not significant. There was a negative correlation between lead concentration and the weight of the fish samples, but the correlation between lead concentration and length of the fish samples is not statistically significant. The correlation that exists between cadmium and chromium concentration with lead concentration is not statistically significant, also correlation between chromium concentrations with cadmium concentration is not statistically significant.

Table 5: Correlation between heavy metals, Length and Weight of the fish samples in July 2015

Treatment	Length	Weight	Cadmium	Chromium	Lead
Length	1				
Weight	NS	1.			
Cadmium	NS	NS	1		
Chromium	NS	NS	NS	1	
Lead.	NS	*	NS	NS	1

* (indicate the existence of association between heavy metals and the length and weight of the fish samples). * * (indicate the existence of strong association between heavy metals and the length and weight of the fish samples).NS (indicate that the association is not significant).

Table 6 shows the correlation between heavy metal concentrations length and weight of the fish samples in August. There was a strong positive con-elation between length and weight of the fish samples. There was a negative correlation cadmium concentration and length of the fish samples, but the correlation between cadmium concentration and weight of the fish samples is not statistically significant. There was no correlation significant correlation between chromium concentration with length and weight of the fish samples. There was a negative correlation between lead concentration weights of the fish samples, but the correlation between lead concentration lengths of the fish samples is not statistically significant. There was a significant positive correlation between cadmium and chromium concentration with lead concentration, positive correlation exists between chromium concentrations with cadmium concentration.

Table 6: Correlation between heavy metals, Length and Weight of the fish samples in August 2015

Treatment	Length	Weight	Cadmium		Lead
Length	1				
Weight	**	1			
Cadmium	*	NS	1		
Chromium	NS	NS	*	1	
Lead	NS	*	*	*	1

* (indicate the existence of association between heavy metals and the length and weight of the fish samples). ** (indicate the existence of strong association between heavy metals and the length and weight of the fish samples).NS (indicate that the association is not significant)

Table 7 shows the correlation between heavy metal concentrations length and weight of the fish samples in September. There was a positive con-elation between length and weight of the fish samples. There was a no significant correlation between cadmium^ chromium and lead concentration with weight and length of the fish samples. The correlation that exists between chromium with cadmium concentration and lead with chromium concentration is not statistically significant. There is a significant positive correlation between lead with cadmium concentration.

Table 7: Correlation between heavy metals, Length and Weight of the fish samples in September 2015.

Treatment	Length	Weight	Cadmium	Chromium	Lead
Length	1				
Weight	*		1		
Cadmium	NS		NS	1	
Chromium	NS	NS	NS	1	

Lead	-NS	NS	*	NS	1

* (indicate the existence of association between heavy metals and the length and weight of the fish samples). ** (indicate the existence of strong association between heavy metals and the length and weight of the fish samples).NS (indicate that the association is not significant)

Table 8 shows the correlation between heavy metal concentrations length and weight of the fish samples in October. There was no significant correlation between length and weight of the fish samples. Also there was no significant correlation between cadmium, chromium and lead concentration with weight and length of the fish samples. The correlation that exists between cadmium and chromium concentration with lead concentration is not statistically significant, also correlation between chromium concentrations with cadmium concentration is not statistically significant.

Table 8: Correlation between heavy metals, Length and Weight of the fish samples in October. 2015

Treatment	Length	Weight	Cadmium	Chromium	Lead
Length	1				
Weight	NS	1			
Cadmium	NS	NS	1		
Chromium	NS	NS	NS	' 1	
Lead	NS	NS	NS	NS	1

*. (indicate the existence of association between heavy metals and the length and weight of the fish samples). ** (indicate the existence of strong association between heavy metals and the length and weight of the fish samples).NS (indicate that the association is not significant).

Table 9 shows the correlation between heavy metal concentrations length and weight of the fish samples in November. There was a strong positive correlation between length and weight of the fish samples. There was no significant correlation between length and weight of the fish samples with cadmium and lead concentration. There was a negative correlation between chromium concentrations with weight of the fish samples, but correlation does exit not between chromium Concentrations with lengths of the fish samples. The correlation that exists between chromium With cadmium concentration and lead with chromium concentration is not statistically Significant. There is a significant positive correlation between lead with cadmium concentration.

Table 9: Correlation between heavy metals, Length and Weight of the fish samples in November 2015.

Treatment	Length	Weight	Cadmium	Chromium	Lead
Length	1				
Weight	**	1			
Cadmium	NS*	NS	1		
Chromium	NS.'	*	NS	1	
Lead	NS	NS	*	NS '	1

* (indicate the existence of association between heavy 'metals and the length and weight of the fish samples). ** (indicate the existence of strong association between heavy metals and the length and weight of the fish samples).NS (indicate that the association is not significant)

Table 10 shows mean Physico-chemical Parameters of Jakara Dam from June to November 20 ML Temperature ranges between 26.0 °c -29.20 °c with mean value of 27 °c. Dissolved Oxygen (DO) with a range of 2.2 mg/1 -2.8 mg/1 and a mean value of 2.5 mg/1. Transparency values ranges between 25.6cm-28cm with a mean value of 19:1 8cm. P^H values falls between 6.4-7.9 with a mean value of 7.1. Chromium, Cadmium and Lead ranges between 4.0 mg/1 -12.5 mg/1, 10.0 mg/1 20.0 mg/1 and 7.0 mg/1 -13.64 mg/1 with a mean values of 8.4 mg/1, 15mg/l and 9.17 mg/1 respectively.

Table. 10: Mean Physico-Chemical Parameters of river wudil (Jun.-Nov. 2014)

Parameters	Mean	Range	Standard limit
Temp. (°c)	2.7	26.0-29.2	<40 (FEPA, 1991 , WHO, 1999)
DO (mg/1)	2.5	2.2-2.8	5-7 (FEPA, 1991, WHO, 1999) ;
Transp. (cm)	19.1	25.6-28	20-40 (Chackroff, 1978)

pH	7.1	. 6.4-7.9	6-9 (FEPA,1991,WHO,1999)
Or (mg/1)	8.42	4-12.5	0.1 (EPA), 1.0 (FDA)
Cd(mg/l)	15	10-20	0.005 (EPA,FDA)
Pb(mg/l)	9.17	7.0-13.64	0.015 (EPA)

Table 11 revealed the average length and Weight of the fish samples *(O. niloticus).* Highest value of standard length, total length and weight of the fish samples was found in June with a mean value of 141mm, 174mm and 70kg respectively. A lowest value of standard length, total length and weight of the fish samples was found in September[1] with a mean value of 132mm, 159mm and 50kg respectively.

Table 11: Average length and Weight of the fish samples *(O. niloticus)*

S/N	Month	Standard length(mm)	Total length (mm)	Weight(g)
1	Jun.	142	174	70
2.	Jul.	140	168	65
3	Aug.	137	166	60
4	Sept	132	159	50
5.	Oct.	132	163	55
6	Nov.	134	167	60

4.0 DISCUSSION, CONCLUSION AND RECOMMENDATION

4.1 DISCUSSION

The temperature ranges during the period was within the range of 16 °C-30 °C as reported by Chapman (1992); 22 °C and 31 °C reported by Adeneji and Ovie (1982) for the survival and optimum growth of aquatic organisms and Boyd and Frobish (1990) reported an optimum temperature of 25°C-31 °C for fish production and the aquatic organisms. Though fluctuations in the water temperature within the study period was observed. The observed result of temperature was within FEPA (1991) and WHO (1999) standard maximum limits of 40 °C. Work conducted in Bompai-Jakara catchment basin by Imam and Balarabe, 2012 (23.3 °C - 26.1 °C) agreed with the result obtained in this study, that shows fluctuations in the water temperature.

The DO recorded in the river is within the normal range stated by FEPA ' (1991) of 5-7mg/L, and that of Ragnar (2004) of >6 mg/L. Also according to 'several authors such as King and Udoidoing (2000) and Bankole (2000) insufficient quantity of Dissolved Oxygen concentration 0.5 mg/L-2.5 mg/L in stagnant water bodies translate enormous activities of decomposers, bacteria , fungi, virus etc which is a reflection of high level of pollution. This indicates that water is not suitable for fishery. *Table 10.*

Transparency restricts light penetration that will limit photosynthesis, which is very within the recommended range of 20cm-40cm reported by Chackroff (1978). The result of this study is in contrast to the work of Imam and Balarabe, 2012 in Jakara-Getsi river system where lower values were recorded.

The water pH in the present study (TJjk 10) fall within the FEPA (1991), WHO (1999), Pandey (1997) and Ragnar (2004) standard range of 6.0-9.O.It was in the line with the work of Imam and Balarabe, 2012.Shehu, 2011 reported that Fish grows best between the pH 6.5 and 9 and would prefer slightly alkaline water closed to neutral pH. *Table 10.*

The pattern of concentration of heavy metals in Jakara Dam from June to November were in the order of Cd>Cr>Pb. Cadmium level ranges between 1 Omg/l-20mg/l (TabIn 10) which is high above the permissible limits set by FEPA (2003); WHO (2003); EPA and FDA of <1.0mg/l; 2.0mg/l and 0.005mg/l respectively. Chromium level (Table 10) lies between 4.0 mg/l-12.5mg/l In the water samples which is far exceeded the recommended limit of 2.0mg/l (Lenntech, 2008); O.lppm (EPA); FDA < 1.0 ppm. Lead level ranges between 7.0 mg/1-13.64 mg/1 also exceeded the standard limits of 0.7mg/l and 2.0mg/l set by CCME (1995) and FEPA (2003) respectively. The pattern of heavy metal accumulation of Abdel -baki *el al* (2012) supports that of this study. A reversal of pattern of the concentration of the heavy metals was observed in the Work of Shabanda and Itodo (2012). Higher concentration of metals than their permissible limits was probably due to increase in population, urbanization, industrialization and agricultural practices have further aggravated the situation. The heavy metals concentration level above the allowable limit is a threat to human health as people were actually using the water from the Dam for fishery and Irrigation. Table 10.

Cadmium in fish tissues follows the Liver > G ills > Muscles > Bone, this is because the organs are the liver, placenta, Kidneys, lungs, brain and bones (Roberts 1999,ATDSR ToxQs for Cadmium) and also larger doses of "Cadmium can accumulate in liver and kidneys. The results of Cadmium accumulation in this study confirmed what has previously been observed by Jessica, *et* (2006); Farkas, *et al.* (1997); Lieven Bervote (2008); Obasohan (2007); Ayotunde, *et al.* (2012); Akan (2009) that Liver accumulates more Cadmium than other tissues and organs. Due to high concentration of cadmium in Jakara Dam as a result of untreated industrial effluent, Cadmium concentration in all the tissue samples exceed the recommended limit of 0.5 set by FAO (1983), O.OO Sppm set by EPA and FDA, 0.05 set by EC (2001) and 2.0ppm set by WHO (1985) and FEPA (2003). Eating of such contaminated fishes can results severe damage to the lungs may occur through breathing high levels of cadmium. Ingesting very high levels severely irritates the stomach, leading to vomiting and diarrhea. Long-term exposure to low levels leads to a buildup in the kidneys and possible kidney disease, lung damage and fragile bones (Sabine and Wendy, 2009). In low doses, cadmium can produce coughing, headache, and vomiting. In larger doses, cadmium can accumulates in the liver and kidneys, and can replace calcium in bones leading to painful bone disorders and to a renal failure. The Kidney is considered to be the critical target organs in humans chronically exposed to cadmium by ingestion EPA (1999) and USEPA (1999). Cadmium in humans, long-term exposure is associated with renal dysfunction. High exposure can lead to obstructive lung disease and has been linked to lung cancer, and damage to human's respiratory systems (Emel, 2012)

Higher concentration of Chromium in the fish samples of Jakara Dam. Gills have the concentration followed by Bone, Muscles and Liver. Akan (2009) confirmed this by reporting higher concentration Chromium in Gills and low Chromium concentration in Liver in *C. anguillaris, S. budgetti, O. niloticus* from Lake Chad. Target organs such as Gills is metabolically active that accumulate Chromium in high levels as shown in various fish species, in *Cyprinus carpio* from canal of Berverlo and Fort 6 in eel and Bream from lake Balaton, in *P. obscure* from Ogba River, in *Entropius* from lake Chad reported by Lieven Bervoets *et al.* (2009); Farkas (2000); Obasohan (2007) and Akan (2009) respectively. From the of this study, all the fish samples exceed the allowable limit of .O.lSppm-l.Oppm set by WHO (1995); FEPA (2003); FAO (1983) in fish food. Chromium (VI) compounds are toxins and known human carcinogens, whereas Chromium (iii) is an essential nutrient. Breathing high levels can cause irritation to the lining of the nose, nose ulcer, running of the nose and breathing problem, such as dsthma, cough, and shortness of breath or wheezing. Skin contact to Chromium can cause skin Ulcer and Allergic reaction consisting of severe redness and swelling of the skin have been noted. Long term exposure can cause damage to liver, kidney, circulatory and nerve tissues, as well as skin irritation. Subchronic and chronic exposure to chronic acid can cause dermatitis and ulceration of the skin (U.S.E.P.A, 1999). Long-term exposure can cause kidney and liver damage, and damage to circulatory and nerve tissue. Chromium often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high levels of chromium. Chromium is vised in metal alloys and pigments for paints, cement, paper, rubber, and other materials. Low-level exposure can irritate the skin and cause ulceration (Emel, 2012). Table 10.

Fishes of wudil river particularly *O. niloticus* were highly contaminated with lead as shown in Table 10. The pattern of accumulation is Gills > Muscles > Liver > Bones. Similar findings by Ayotunde, 2012 shows high levels of lead in liver followed by Gills and lowest limit in Bones of *C. cmguillaris, S. budgetti, E. niloticus* and *Protepterus.* The findings of Obasohan (2007) in *P. obscure in* Ogba River. Akan (2009) in *O. niloticus* in Lake Chad and Ayotunde (2012) in Catfish Cross River is in opposition with the present study by having low concentration of lead in Gills and high amount in Liver. Higher concentration of lead in the body can cause death or permanent damage to the central nervous system, the brain and Kidneys (Jennings, *et al,* 1996). Lead is considered the number one health threat to children, and the effects of lead poisonings can last a life. Not only does lead poisoning stunt a child's growth, damage the nervous system, and cause learning disabilities, but also it is now linked to crime and anti-social behaviors in children (US.G.A.O, 2000). Lead in humans, Long exposure can occur acute or chronic damage to nervous system in humans (Emel, 2012). EPA has determined that lead is a probable human carcinogen. Lead can affect every organ and system in the body. Long-term exposure of adults can results in decreased performance in some tests that measure functions of the nervous system; weakness in fingers, wrists or ankles; small increases in blood pressure; and anemia. Exposure to high lead levels can cause death. In pregnant women, high levels of exposure to lead may cause miscarriage.

4.2 Conclusion

Regarding the mean concentrations of the total heavy metals concentrations in the samples, it can be said that the concentrations in the samples are generally above the recommended maximum limits set by various authorities due to addition of untreated municipal wastes and human activities around the river hence the Water and the aquatic organisms especially the Fishes are not safe for human consumption and the water is not suitable for fishery. The bioaccumulation may pose great hazard to health to humans and animals that relay on the fish and water from river wudil.

4.3 Recommendation

In view of the importance of fish to man, especially in the diets of man, it is necessary that biological monitoring of the water and fish meant for consumption and irrigation should be done regularly to ensure continuous safety of the aquatic food. Safe disposal of domestic sewage and the industrial effluents should be practiced where possible, recycled to avoid these metals and other contaminants from going into the environment. Laws should be enacted to protect aquatic environment from pollution. The researcher recommend to the local and state government to utilize this study as guidelines to protect the public from possible adverse effects. Lastly, the level of chemical pollution in river wudil, is of serious public health risk, closed monitoring and quick government intervention to prevent fishing is advisable. Irrigation and recreational service of the river is recommended.

REFERENCES

[1]. Abdel-baki, A. B., Dkhil, M. A. and Al- quraishy, S. (2011): bioaccumulation of some Heaavy metls in tilapia Fish Relevant to their Concentration in waater and Sediment of Wadi hanifah, Saudi *Arbia. African journal of Biotechnology* Vol. 10(13), P.p. 2541-2547, 28, March, 2011.

[2]. Adeniyi, H.A. and Oyie, S.T (1982: Study and Appraisal for the Water Quality of the Asa Oil Land Niger Rivers. NIFER Annual Report. P. p. 15-20

[3]. Akan, J.C. Abdurrahman, O.A. Sodipo and P.I Akandu (2009): metals Bioaccumulation of Some Heavy metals of Six Fresh Fishes Caught from Lame chad in Doron Buhari, Maiduguri, Borno State Nigeria. Nigerian Journal Applied Science Environment Management. 4:103 114.

[4]. Alabaster j.s.and Lioyd, R. (1980): Water Quality Criteria for Fresh Water Fish. FAO and Butter Worth's, London. Pp 297.

[5]. APHA (1999): *American* public health Authority: Standard methods for waste 'water. 16th Edition. Washington DC.PP113.

[6]. APHA (1995): *Standrad methods for the Examination* of water and waste water. Washington, D.C., USA.

[7]. Bankole, N.O. (2003): Fishery of lake Alau in maiduguri Borno, Nigeria. PhD thesis. Bayero University, kano

[8]. Boyd, C.E. (1981): Water Quality in warm water fish ponds: Agricultural experimental station, Aubum University Craft Master publ. co. Alabama, USA 2nd Edition Pp359

[9]. Chackroff, M. (1978): Fresh Fish pond Culture and Management. Peace Core and Volunteers in volunteers in Teach an Assistance Virginia U.S.A. Pp 72-79. Cited by Yisa, M. In: Biological and Environmental Science Journal for the tropics.2007, vol 4.no.1.

[10]. Chapman, D. (1992): *Water Quality Assessment:* A Guide to the use of biota and water in environmental monitoring. Chapman and hill pub. Ldt. 2-6

[11]. Boundary Row London. Pp.585.

[12]. Dupler (2001): In: life Extension Foundation (1995-2010).Heavy metal toxicity. Health concern mht.

[13]. Dupree, K.H.and Hunner, J.V. (1984): the status of warm water fish farming and progress in fish farming research. V,S. fish and Wild service, Washington D.C., U.S.A. In: Yisa, M. (2006): Physical and Chemical water Quality parameters in fish pond Management; A Review. *Biological and Environmental Science Journal for the tropics.* Vol 4, no.1:147,138-139.

[14]. EC (2001): Commission Regulation (EC) No. 466/2001 of 8 March 2001. Official Journal of European Communities.1.77/1

[15]. Emel.K. (2012: Heavy metal toxicity. Human health, mht.

[16]. Engel king, p. (2008): pollution. Microsoft Encarta. Redmond. WA: Microsoft Corporation.

[17]. FAO (1983): Compilation of legal Limits for Hazardous substance in fish and fishery products (food and agricultural Organization). *FAO* Fishery Circular, no 446. Pp 5-100.

[18]. FAO/ WHO (2010): Report of the joint FAO/ WHO Expert Consultation on the Risks and benefits of fish Consumption. Rome and Volunteers in Technical Assistance. Viginita, U.S.A

[19]. Farkas, A., Sala'anki, J. and Varanka I. (200): heavy metal Concentrations in fish of Lake Balaton. Balaton Limn logical Research Institute of the Hungarian Academy of Science, PO Box 35, 8237 Tihany, Hungary. Lakes & Reservoirs: Research and management 200 5: 271-279

[20]. Federal Environmental protection Agency (FEPA) (2003): Guidelines and standard for Environmental pollution Control in Nigeria.

[21]. Felt, P.A. and Health, A.G. (1984): Interaction of temperature and sublehal Copper Exposure on the Energy metabolism of the Gill in lepomis macrochiris (rafineaque).*Journal of fish biology.* 25:445-453.In: Haruna Ben, Hassana publishers, Abuja.

[22]. Gigurere, A., Campbell, P.G.C., L., Mc Rasmussen, JB. (2004): Influence of Lake Chemistry and on Camium, Copper and Zinc Concentrations in Various organs of Indigenous yellow Perch (Perca flavescens Canada *Journal of Aquatic Science 61:702-*

[23]. Hart, J. (2009): Air pollution Microsoft Student 2009. Redmond, WA, Microsoft Corporation, 2008.

[24]. Imam, T.S. and Balabe, M.L. (2012): Impact of Physiochemical factors on Zooplanton species richness and abundance in bompai-jakara catchment basin, Kano State, northern Nigeria. *Bayero Journal* of pure and Applied Sciences, 5(2):34-40.

[25]. Infinite health Resources (2005-2012): htt//heavy%20metals %20your% 20 body mht. Infinite Health Resource. Com/store/ recourses/cat/1//1.html

[26]. International Occupation Safety and health Information Centre (1999) life Extension foundation (1995-2012): http:/ heavy% 20metal%20toxicity%20 arsenice%20mercury%extension%20health%concern mht.

[27]. ITTIS (2014): ITTIS< Standard Report Updated September, 2014.

[28]. Jennings, G.D., Sneed, R.E., and Clair, M.B.(1996): *metals in drinking water* Published by: North Corolina Cooperative Extension service publication no A.G.-473-1. Electronic version 3, 1996.

[29]. Life Extension Foundations (1995-2012) http./heavy%20metal%20toxicity%20 arsenic %20mercury%20life%20extension%20health%20concern.mht.

[30]. Lind, O.S (1979): *Handbook of common method sin limnology.* The C.V. Most by publ., Missouri, USA 2nd edition. Pp199

[31]. Lloyd, R. (1992): pollution and freshwater fish USA. Blackwell science publication. Pp14

[32]. Mansour, S.A. & Sidky, MM. (2002): Ecotoxicological studies on Heavy metals contaminating water and fish from Fayoum Government, Egypt. Food Chem.78:

[33]. 15-22.

[34]. Mason, C.F. (1996): Biology of freshwater pollution.3rd Ed. Longman, Singapore publishers (Pte) Ltd. Pp1748

[35]. Mokhatar, M.B., Aris, A.Z., Manusamy, V. and praveena, S.M.(2009) Assessment level of heavy metals in penaeus monodon and *Orechromis Spp* in selected Aqua cultural ponds of Density Development Area. Euro. *Journal of science Recourses.* 30 (3): 348-360.

[36]. Moss, Brian (1998): *Ecology of freshwaters.* Man and Medium past to future 3rd edition. Semantic Graphics, Singapore University press, Cambridge.

[37]. Obasohan, E.E. (2007) Heavy Metals Concentration in the Offal, Gill, Muscle and Liver of a freshwater Mudfish (*parachana obscura)* from Ikpoba River in Beniu City, Nigeria.

[38]. Ranar, R. (2004): Enviromental Load. Charnet-Aquafamer, www.holar.is aqafermer accessed 05.2009

[39]. Richard Lioyd (1992.) *pollution and fresh fishing.* A Buckland foundation book. Fishing news Books.1st publication. Great Britain by hartnolls, B. dmin Corn wall@ Trustees, the Buckland foundation. PP. 77,78

[40]. Robert (1999): In Extension Foundation (1995-2012) uhttp:/heavy%20metal%20toxicity%20 concern.mht.

[41]. Shabanda, I. S. and Itodo, A.U. (2012): Toxins in Gills and flesh of *Synodontissorex and Bagrufilamentsus. International journal of Ecosytem* 2012; 2

[42]. Udoidong, O.M and King R.p.(200): Fauna Assemblage of Some Nigeria Rain Forest stream.

[43]. U.SGAO (2000): health Effect of lead in Drinking water. U.S. General Accounting Office reports 2000. Water in Environmental Monitoring. Chapman and Hill, Publishers Limed, Londan. Pp.585.

[44]. WHO (1999): World health organization guidelines for Drinking water quality vol 1. Recommendation WHO. Geneva. Pp.130.

[45]. Wikipedia; heavy metals Retrieved on 21st Nov.2011.