



Comparative Analysis of Heavy Metals in Fishes (Tilapia and Catfish) Found in Damba and Wanke Road Dams –Gusau, Zamfara State, Nigeria

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Abstract

The study was a response to the growing concern as regard the roles and fates of Heavy Metals in the Nigerian environment and its impact on human health. The concentrations of eight Heavy Metals (Pd, Zn, Cr, Mn, Cd, Fe, Cu and Ni) was determined in sediment, soil, water and two variety of Fish Namely Tilapia and Catfish; using atomic absorption spectrophotometer. Interestingly Cadmium, Lead and Nickel have not been detected in all the samples analysed. However the levels of Cr and Zn were extremely higher than their respective permissible limits in soil (100mg/kg and 300mg/kg), water (0.05mg/l and 5.0mg/l) and sediment (121mg/kg and 37.6mg/kg) respectively. The concentration of Zn in sediment of Damba Dam was 60 times higher than the permissible limits, indicating accumulation of this toxic metal in the dam. Cr concentrations were also higher than the permissible limits in sediment of Wanke Road Dam. Contamination of both Cr and Zn was also obtained in the edible parts of fish from these Dams.

Keywords: *Tilapia; Catfish; Heavy Metal; accumulation; Toxic.*

1.0 INTRODUCTION

Pollution is a worldwide problem and its potential in influencing health of the human population is great (Khan and Ghouri, 2011). The impact of pollution in the vicinity of overcrowded cities and from industrial effluents and automobiles has reached a disturbing magnitude and is

arousing public awareness (Begum *et al.*, 2009). Excessive levels of pollution are causing a lot of damage to human and animal health, plants including tropical rain forests as well as the wider environment (Khan and Ghouri, 2011). Pollution is the cause of many diseases, which affect not only the old but also the young and the

energetic and all animals and plants (Kanmony, 2009). The WHO report points out that twenty million children worldwide suffer from pollution which has become critical because of over population (Pain, 2008; Kanmony, 2009). An estimated 1.2 billion people drink unclean water which is the source of water related diseases that kill between five to ten million people mostly children around the world (Ahuja, 2009).

The most common environmental pollutants in the world are heavy metals (Papatilippaki *et al.*, 2008). The presence of heavy metals at trace level and essential elements at elevated concentration causes toxic effects if exposed to human population (Fong *et al.*, 2008).

The pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms. Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystem. (Indrajit *et al.*, 2011).

There is increasing concern about the quality of foods in several parts of the world. The determination of toxic elements in food has prompted studies on toxicological effects of them. (Shrivastava *et al.*, 2011).

2.0 MATERIALS AND METHODS

2.1 MATERIALS

2.1.1 Sample Material.

Fresh fish species were used as biological indicators for heavy metal pollutant. These include *Clarias gariepinus* (Catfish) and *Oreochromis niloticus* (Tilapia). Other samples collected from the study site were Dam's waters, bottom sediments and surrounding soils.

2.1.2 Study Area

The Damba Dam and Wanke Road Dam are Located in Gusau the Capital City of Zamfara State, Northern Nigeria. They are major reservoirs of portable water for the inhabitant of the state capital. They lies within the coordinates of 12°10'N and 12°30' N latitudes and 6°15' E and 6°38' E longitudes, respectively.

Heavy metals are considered the most important form of pollution of the aquatic environment because of their toxicity and accumulation by marine organisms (Indrajit *et al.*, 2011).

Metals are natural components of the earth crust. They cannot be degraded or destroyed (Lenntech, 2004). Increase in agricultural, mining and industrial processes have resulted in an increase concentration of metals in air, water, sediment and soil. These metals taken in by plants and animals subsequently find their way into the food chain and enter the human body through ingestion. Inhalation and absorption through the skin are the other sources through which they gain access into the human body.

The human brain is most affected by lead intake. Children appear to be especially sensitive to lead, and lead exposure has been correlated to decreased IQ and poor learning in children (Ogabiela *et al.*, 2004). Fishes are major part of the human diet and it is therefore imperative to determine the level of heavy metals in Fish which many people depend on as a source of protein.

Hence this study was conducted to study the accumulation of the selected heavy metals in fish, water, soil and sediment of the two dams- Damba Dam and Wanke road Dam and make comparative analysis with similar works and some international standards.

2.2 Sample Collection

2.2.1 Fish Samples

Samples for analysis include fresh *Clarias gariepinus*, and *Oreochromis niloticus* caught by local fishermen at the site of the two different sources: Damba Dam and Wanke road Dam in Zamfara State, Nigeria.

A total of 80 fish samples 40 from each dam for the different varieties each of the species were purchased for the analyses. These species were widely distributed in the aquatic environment and have commercial importance. The fishes obtained from these dams were transported to the laboratory in an ice container for Laboratory analysis at Usmanu Danfodio University Sokoto Agric. Lab. and kept under frozen condition until analysis.

2.2.2 Water Sample

Water samples were collected from each dam in pre-cleaned 150 ml plastic bottles with screwed caps. The sample bottle was deepened in the dam's water with the neck bent at about 45° and 30cm below the water surface and about 70cm from the boat of the fisherman.

2.2.3 Sediment Sample

Sediments were collected by randomly selecting ten different sites per dam. For each site, bottom sediments were taken using soil auger. About 100g of sediments were taken from each dam site. The composite sample was prepared by mixing all the samples thoroughly and allowed to dry in the laboratory. The mixture was ground gently with porcelain mortar and pestle, sieved through a 2mm brass sieve and kept for analyses (Stewart *et al.*, 1974).

2.2.4 Soil Sample

The sampling was carried out at the dam's surrounding. Each sample was collected using clean, stainless materials. Soil samples were systematically collected from six different spots within 100m radius of each sample area of the two dams. The soil samples were collected at a depth of 0 - 15cm of the major sampling areas. They were thoroughly mixed and transferred into clean and labeled plastic containers for analyses in the laboratory.

The soil samples were oven dried at 105°C to constant weight (Begum *et al.*, 2009). The oven dried material was crushed and sieved through a 20µm plastic mesh from which the representative sample was obtained (Begum *et al.*, 2009).

3.1 RESULTS

Damba and Wanke Road Dams were two of the Dams located in Gusau the Capital of Zamfara State; that were selected for this Study. The bottom sediment, water, surrounding soil and fish samples were collected from each of the Dams and were analysed for various Heavy Metals using Atomic Absorption Spectrophotometer (AAS).

2.3 Sample Preparation for AAS Analysis

Acid used for the Wet Digestion include: Nitric Acid (HNO₃), Hydrogen Peroxide (H₂O₂) and Sulphuric Acid (H₂SO₄)

The samples were prepared by taking 1.0g of each of the oven dried sample in a beaker, followed by the addition of 30cm³ of freshly prepared 1:1 (V/V) HNO₃ and H₂O₂. Each beaker was covered with a watch glass for about an hour to allow the initial reaction to subside. The beakers were heated on a hot plate with the temperature not exceeding 90°C for 30 minutes. The contents were then transferred into 50cm³ volumetric flask and diluted with distilled water to the mark (Douglas and Donald, 1976; Kakulu *et al.*, 1987)

2.4 Procedure for AAS Analysis

The alpha 4 model of atomic absorption spectrophotometer was set according to the manufacturer's instructions with the wavelength corresponding to that of the metal under investigation. Standard solutions prepared from the stock solutions and the blank were used to obtain the calibration curves. The absorbance of each sample was measured in duplicate with an automatic calculation of the average concentration in ppm.

2.5 Data Analysis:

Three analytical determinations were carried out on each independent replication for every parameter. Three independent replicates (n = 3) were obtained from each treatment and the results presented in tables and are reported as means ± standard deviation (SD). Data were analyzed by T-test. Differences were considered significant at an alpha level of 0.05.

The results obtained for heavy metals analysis on sediment, water and soil of the Dams were presented in Table 3.1. While heavy metal analysis of Tilapia and Catfish parts (flesh, gills and bones) caught from Damba and Wanke Road Dams were presented in Tables 3.2 and 3.3, respectively. All the results presented were means of triplicate analyses.

Table 3.1. Concentrations of Heavy Metals in Water, Sediment and Soil Samples of Wanke Road and Damba Dams.

Heavy metal	Pb	Zn	Cr	Mn	Cd	Fe	Cu	Ni
Damba Dam								
Water (mg/l)	ND	184.35±0.11	184.35±0.25	ND	ND	ND	5.45±0.02	ND
Soil(mg/kg)	ND	1877.50±0.16	216.95±0.64	ND	ND	ND	3.70±0.01	ND
Sediment (mg/kg)	ND	3022.50±1.3	188.55±0.26	ND	ND	ND	14.35±0.40	ND
Wanke Road Dam								
Water (mg/l)	ND	3025.00±0.16	114.25±1.09	ND	ND	ND	22.80±0.30	ND
Soil (mg/kg)	ND	2754.50±0.15	272.05±0.76	0.075±0.001	ND	ND	32.25±0.092	ND
Sediment (mg/kg)	ND	2450.00±0.27	320.70±1.4	ND	ND	395.17±1.02	0.85±0.01	ND

Values are reported as mean ± standard deviation, (n = 3).

Table 3.2: Levels of heavy metals in Tilapia and Cat fish samples of Damba Dam – Gusau.

concentrations are expressed in mg/kg								
Heavy metal	Pb	Zn	Cr	Mn	Cd	Fe	Cu	Ni
Tilapia								
Flesh	ND	70.20±0.12	236.30± 0.23	6.25±0.40	ND	ND	14.00±0.50	ND
Bones	ND	57.00±0.60	360.75± 1.02	ND	ND	ND	14.90±0.30	ND
Gills	ND	39.30±1.03	241.30± 0.10	ND	ND	10.20±0.21	14.90±0.30	ND
Catfish								
Flesh	ND	24.20±0.13	236.45±1.20	ND	ND	ND	23.35±0.58	ND
Bones	ND	47.95±.09	436. 40± 0.91	59.55±0.41	ND	ND	29.95± 1.0	ND
Gills	ND	48.95±0.16	108.15±2.10	ND	ND	ND	39.05± 0.46	ND

Values are reported as mean ± standard deviation, (n = 3).

Table 3.3: Level of heavy metals in Fish samples caught from Wanke Road Dam (WRD).

concentrations are expressed in mg/kg								
Heavy metal	Pb	Zn	Cr	Mn	Cd	Fe	Cu	Ni
Tilapia								
Flesh	ND	39.50 ±0.40	342.45±0.07	ND	ND	205.45±1.05	40.40±0.80	ND
Bones	ND	6.25±0.25	180.50±.81	ND	ND	ND	72.10±1.08	ND
Gills	ND	68.60 ±1.20	184.85±0.53	ND	ND	20.80±0.09	63.05±0.32	ND
Catfish								
Flesh	ND	58.85±0.65	343.85 0.24	86.30±0.30	ND	424.20±1.70	18.40±0.07	ND
Bones	ND	72.75±1.03	279.70±0.5	39.35±0.62	ND	ND	89.05±1.52	ND
Gills	ND	47.25±0.13	319.00±1.04	ND	ND	ND	79.40±0.92	ND

Values are reported as mean ± standard deviation, (n = 3).

3.2 DISCUSSION

The increasing concern as regard the roles and fates of Heavy Metals in the Nigerian environment and its effect on Man has necessitated this study. The concentration of eight

Heavy Metals (Pd, Zn, Cr, Mn, Cd, Fe, Cu and Ni) in sediment, soil and water are given in Table 3.1. Pd, Cd and Ni were not detected in all the samples. Mn was detected in the soil of Wanke road Dam only. Zn, Cr, Cu were detected in all the samples.

3.2.1 Heavy Metals Concentration in Water

The concentrations of heavy metals in water from the Damba and Wanke road Dams were presented in Table 3. 1. Zn and Cr have the same concentrations of 184.35 mg/kg while Cu is 5.45 mg/kg in Damba dam. The concentration of these metals in the water samples of Wanke road dam were found to be in the following order of decreasing concentrations as follows Zn > Cr > Cu.

The mean level of Zn in Damba Dam Water was 184.35 ± 0.11 mg/l and 25.50 ± 1.3 mg/l in Wanke road Dam. This is beyond the maximum limit set by WHO (2008) of 5.0mg/l. The concentration of Zn is higher in Wanke Dam than the Damba Dam. The mean level of Cr in the Dam's Water are 184.35 ± 0.25 and 114.25 ± 1.09 mg/l, respectively.

This result showed that the concentration of Cr is higher in the two Dams than the WHO (2008) and USEPA (2011) permissible limit of 0.05 and 1.3mg/l, respectively. However, its accumulation is higher in Damba Dam than Wanke road Dam.

The mean levels of Cu in the Dam's waters were 5.45 ± 0.02 and $22.50.030$ mg/l respectively. The concentration of this metal is also higher than the standard permissible limit set by the WHO (2008) and USEPA (2011) of 0.05 and 0.005mg/l. However, the concentration of Cu is higher in Wanke road Dam compared to the Damba Dam.

3.2.2 Heavy Metals in Soil

Three Heavy Metals were detected in the surrounding soils of the two Dams. These metals include Zn, Cr and Cu.

The mean concentration of Zn in the Soils samples of the surrounding Dams are 1877.50 ± 0.16 and 2754.50 ± 0.15 mg/kg, respectively. This is higher than the maximum permissible limit of 300mg/kg recommended by WHO. This result shows the extent of pollution around these Dams; this also demonstrated the concern on the health problems associated with excess level of Zinc in soils. For example dust from these contaminated sites could also pose great health challenges especially on those people who live close to these contaminated sites (Atiemo *et al.*, 2011).

Cr had a mean value of 216.95 ± 0.64 mg/kg and 272.05 ± 0.76 mg/kg in the soils of Damba Dam and Wanke road Dams. However, the accumulation of Cr was higher in the surrounding soils of Wanke road Dam compared to Damba Dam. The WHO maximum permissible value of Cr in soils is 100mg/kg. The result obtained from this study shows higher level of Cr in the soils against the maximum standard sets by the WHO.

The mean concentrations of Cu in the soils of the Dams were 3.70 ± 0.01 mg/kg and 32.25 ± 0.09 mg/kg. The level of accumulation of Cu is higher in Wanke Road Dam as compared to Damba Dam. The Cu values compare to other metals in water, soil and sediment is lower.

3.2.3 Heavy Metals in Sediment

The average concentrations of heavy metals in sediments of the Dams are presented in Table 3.1. The mean values of Zn in the sediment of the two Dams were 3022.50 ± 1.3 and 2450.00 ± 0.27 mg/kg in Damba Dam and Wanke road Dams, respectively. The values were higher than the permissible limits sets by WHO (2010) and ISQG (Interim sediment quantity guideline) 2002 of 121mg/kg and 123mg/kg.

Cr has the mean value of 188.55 ± 0.26 mg/kg and 320.70 ± 1.4 mg/kg in the two

Dams. These values appeared to be higher than the limit sets by WHO and ISQG (2002) of 43.4 and 37.3mg/kg respectively.

The level of Cu in the sediments appeared to be lower than the permissible limit sets by the WHO (2010) and ISQG 2002 of 37.6 and 35.7mg/kg. The mean value obtained in this study is 14.35 ± 0.40 and 0.85 ± 0.01 mg/kg respectively. Trace metals are considered to be major toxicant in contaminated water worldwide and studies indicated that levels of Heavy metals were higher in sediment than in water due to the adsorption of Cations by organic matter present in the sediment layers. The metals interact with organic matter in aqueous phase and settle down resulting in high concentrations in sediments.

From the results of this study, it shows that the environment is highly polluted by these three metals (Zn, Cr, and Cu). Their continuous presence in the water, soil and sediment means bioavailability to the aquatic inhabitant and may lead to subsequent biotoxicity.

Aquatic organisms like fish species accumulate metals in their tissues many times than soil, sediment and water. This bioaccumulation can be a rich source of heavy metals to man.

3.3.4 Heavy Metals Concentration in Fish Tissues (Flesh, Bones and Gills).

The study deals with the metal accumulation in the flesh, bones and gills of Tilapia and Catfish caught from Damba and Wanke road dams in Gusau, Zamfara state Nigeria.

Of the eight heavy metals determined, only five metals were found to be present in the fish organs. These metals include Zn, Cr, Fe, Mn and Cu.

The results of the analysis of the flesh, bones and gills of Tilapia and Catfish caught from Damba and Wanke road dams were presented in Tables 3.2 and 3.3 respectively. The variability observed in the metal levels of different species/organs depends on feeding habits (Watanabe *et al.*, 2003), ecological needs, metabolism (Canlı and

Kalay, 1998), age, size and length of the fish (Al-Yousuf et al., 2000) and their habitats (Canlı and Atli, 2003).

Chromium (Cr)

Chromium (Cr) was the most abundant metal in the studied tissues of all the fish species. The concentration of Cr was higher in the bones compared to the rest of the organs. The highest value of 360 ± 1.02 mg/kg was observed in the bones of Tilapia fish caught from Damba dam while the least value of 180.50 ± 0.81 mg/kg was observed in the bones of Tilapia fish caught from Wanke road dam.

The concentration of Cr in all the parts is higher than the maximum permissible limit of 1.0 mg/kg sets by FAO/WHO (2004).

The concentration of Cr in the organs of Tilapia fish caught from Damba dam was found to be in the following order: bones > gills > flesh. While Cr in the organs of Tilapia fish caught from Wanke road dam is in the following order: flesh > gills > bones. The concentration of the heavy metals observed in Catfish caught from damba and wanke road dams were in the following order: bones > flesh > gills and flesh > gills > bones respectively. From other studies, it was discovered that Chromium does not normally accumulate in fish and hence low concentrations of Cr were reported even from the industrialized parts of the world (Moore and Ramamoorthy, 1984). The concentration of Cr was also significant in all the organs of the fish samples of the two dams compared at $p < 0.05$.

Zinc (Zn)

The highest concentration of 72.75 ± 1.03 mg/kg of Zn in the present study was observed in the flesh of Catfish caught from Wanke road dam. While the least value of 6.25 ± 0.25 mg/kg was observed in the bones of Tilapia fish caught from Wanke road dam. The concentration of Cr in all the parts is higher than the maximum permissible limit of 1.0 mg/kg sets by FAO/WHO (2004).

The concentration of Zn in the organs Tilapia fish caught from Damba dam was

found to be in the following order: bones > gills > flesh. While Zn in the organs of Tilapia fish caught from Wanke road dam is in the following order: flesh > gills > bones. The concentration of the heavy metals observed in Catfish caught from damba and wanke road dams were in the following order: gills > bones > flesh and bones > flesh > gills respectively. Other workers have also reported the highest concentration of Zn in the gills of *Labeo dyocheilus*, *Wallago attu* and in liver of *C. punctatus* (Murugan et al., 2008). However highest accumulation was seen in other organs such as gills of *C. punctatus* (Vineeta et al., 2007), testis of *O. niloticus* and *L. niloticus* (Charbonneau and Nash, 1993).

The permissible limits for Zn set by FAO/WHO / (1989) is 50 mg/kg which is a bit higher than most of the values observed during this study. Zinc was detected in all the fish organs. Fish can accumulate zinc from both the surrounding water and from their diet (Eisler, 1993). Among all metals, zinc is the least toxic and an essential element in human diet as it is required to maintain the functioning of the immune system. Zinc deficiency in the diet may be highly detrimental to human health. Zinc deficiency in the human diet may be due to inadequate dietary intake, impaired absorption, excessive excretion or inherited defects. The recommended dietary allowance for zinc is 15 mg/day for men and 12 mg/day for women, but high concentration of zinc in fish may cause vomiting, renal damage and cramps (Jarup, 2003). Although zinc is an essential element, at high concentrations, it can be toxic to fish, cause mortality, growth retardation and reproductive impairment (Sorenson, 1991). Zinc is capable of interacting with other elements and producing antagonistic, additive or synergistic effects (Baumann and May, 1984). Zinc does not appear to be a threat to the fishes within these dams. The concentration of Zn was also significant in all the organs of the fish samples of the two dams compared at $p < 0.05$.

Manganese (Mn)

The result of this study showed that Mn was detected only in the flesh of Tilapia fish and the bones of catfish caught from Damba dam. Also it was found in the flesh and bones of catfish caught from Wanke road dam.

The highest value of 86.30 ± 0.30 mg/kg of Mn in the studied tissues was observed in flesh of Catfish caught from wanke road dam. While the least value of 6.25 ± 0.40 mg/kg was observed in the flesh of Tilapia fish caught from Damba dam. It was observed that Manganese (Mn) in Catfish was higher compared to Tilapia fish of the two dams.

In the present study the observation that was made in flesh and bones of Tilapia and Catfish is higher than observed in Nile Tilapia (Mulu et al., 2012). The permissible limit for Mn set by WHO (1989) and FEPA (2003) is 0.5 mg/kg while IAEA (2003) put it at 3.50 mg/kg. Mn appeared to present hazard to some fish organs within the dam's biotic habitat. The concentration of Mn was also significant in all the organs of the fish samples of the two dams compared at $p < 0.05$.

Iron (Fe)

Iron was only detected in the gills of Catfish among the fish organs studied of the fish samples caught from Damba dam. For Wanke road dam Fe was found in the gills and flesh of Tilapia and the flesh of Catfish only.

The highest value of 424.20 ± 1.70 mg/kg was observed in the flesh of Catfish caught from Wanke road dam while the least value of 0.220 mg/kg was observed in the gills of Catfish caught from Wanke road dam.

The concentration of Fe in two of the fish parts (Tilapia and catfish flesh) from Wanke road dam is higher than the maximum permissible limit of 100.0 mg/kg sets by FEPA (2003)/WHO (1985) and 146 mg/kg sets by IAEA-407 (2003), respectively.

The concentration of Fe in the organs of Tilapia fish caught from Damba dam was found to be in the gills only. While Fe in the organs of Tilapia fish caught from Wanke

road dam is in the following order: flesh > gills.

However in other studies the highest accumulation was observed in the organs of gills in the fishes *O. niloticus*, *L. niloticus* (Mohammad, 2008) *O. mossambicus* (Jenny and Avenant, 2006). Accumulation levels reported in the present study for flesh and gills corroborates to the findings in *O. niloticus* and *L. niloticus* (Mohammad, 2008).

Earlier reports showed Fe to be normally highest in gills (Philips, 1976) or in the liver (Charbonneau and Nash, 1993). The concentration of Fe was also significant in all the organs of the fish samples of the two dams compared at $p < 0.05$.

Copper (Cu)

Copper reveals its maximum accumulation in the bones of Catfish caught from Wanke road dam, while gills of Tilapia fish caught from damba dam shows the least level of 7.70 ± 0.17 ; this is in disagreements with the findings in *Carassius auratus* (DeBoeck, 2004). The concentration of Cu in the organs Tilapia fish caught from Damba dam was found to be in the following order: bones > flesh > gills. While Cu in the organs of Tilapia fish caught from Wanke road dam is in the following order: bones > gills > flesh. The concentration of the heavy metals observed in Catfish caught from Damba and Wanke road Dams were in the same order, gills > bones > flesh.

Effects of high concentrations of copper on fish are not well established; however, there is evidence that high concentrations in fish can experience toxicity (Woodward et al., 1994). Copper can combine with other contaminants such as ammonia, mercury and zinc to produce an additive toxic effect on fish (Rompala et al., 1984). The permissible limit for Cu set by WHO (1985) is 3.0 mg/kg, FEPA (2003) 1.3 mg/kg and IAEA-407, (2003), 3.5 mg/kg which are less than the accumulation levels obtained in the present study.

The concentration of Cu was also significant in all the organs of the fish samples of the two dams compared at $p < 0.05$.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

The soil, water and sediment mean heavy metals concentrations in the two Dam's area were generally very high and above standard limit sets by the WHO/ FAO. However, Pb, Ni, and Cd were not detected. The research findings made it clear that the contamination of this water body with these heavy metals was primarily due to the anthropogenic activities. People may suffer from disease through the drinking of the water with higher concentration of heavy metals. They may have physiological effects as on kidney, digestive system, circulatory system, nervous system and various other organs and systems of the body.

The presence and concentrations of the heavy metals analyzed have indicated the suitability of using fish as a biomarker in monitoring heavy metal pollution in water bodies and their surroundings. However a number of intrinsic and extrinsic factors can affect the interpretation of the data obtained. Specific variations in heavy metals observed may be related to size, maturity and proximity to areas with high concentration. High accumulation of trace metals such as Fe, Zn, Cr, and Cu in the fish species examined could be related to the Industrialization and anthropogenic activities in Dam's Area. From the results, it is quite evident that the fishes were highly contaminated by heavy metals and condition may get worse if precautions are not taken. The metal contamination of edible part of the fish was found to be beyond the WHO permissible limit for human consumption. It is very serious issue that aquatic life is being threaten by toxic heavy metals, which are then passed up the food chain posing threat

to the life of human consumer. Thus, it is important to balance the beneficial effects of consumption of fish and detrimental effects of the Heavy metals.

4.2 RECOMMENDATIONS

Damba and Wanke road Dams serve as major fishing, drinking and irrigation water resources for people living in the Capital City of Zamfara State, Nigeria. Apparently anthropogenic activities threaten the sustainability of this resource, hence the need for proper monitoring and enforcement of water resource management regulations.

Based on the results and the above observations, the following are hereby recommended.

1. Fish from the two dams could be used as a source of animal protein, lipid, carbohydrate and macro nutrients in human.
2. Human activities such as washing of motor cars, motor cycles, laundry and dumping of refuse around the dam's site should be controlled.
3. The use of heavy metals in the manufacture of agricultural chemicals should be minimized.
4. Analysis of the crops cultivated on soil surrounding the dams should be carried out to ascertain the levels of heavy metals in them.
5. There should be synergy among regulatory bodies on the implementation of the outcomes of empirical research work.

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