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Assessment of Selected Heavy Metals in Water, Sediment and Muscles of Some Edible Finfishes - Schilbe mystus, Sarotherodon galileus, Mormyrus rume and Clarias anguillaris from Ajiwa Irrigation Dam, Katsina State, Nigeria

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Abstract

The freshwater fishes (*Schilbe mystus, Sarotherodon galileus, Mormyrus rume and Clarias anguillaris*) are the most commercially important finfishes in Nigeria. Investigations were made on the accumulation of five (5) heavy metals: Lead (Pb), Chromium (Cr), Iron (Fe), Cadmium (Cd), and Zinc (Zn) collected from water, sediment and *fish organs* (gills, intestines and flesh) inhabiting the Ajiwa dam. Standard methods analyses revealed low accumulation of metals in the water and flesh of the finfishes for both seasons compared to the sediment. The mean concentration of heavy metals decreased in this sequence: Fe>Zn>Pb>Cr>Cd (wet season) and Fe>Zn>Cr>Cd>Pb (dry season) for all sampled fish organs. Fe had the highest mean concentration (106±2.30mg/l) in all the samples while Cd (0.43±0.02mg/l) and Pb (0.22±0.01) had the least mean concentration for the wet and dry seasons respectively. The bio-water accumulation factors showed that the flesh accumulated all the five metals with Fe (>0.5mg/l) as the highest and Zn (≤0.221mg/l) as the least. The bio-sediment accumulation factors in the flesh were ≤2 mg/kg. The results of heavy metals concentrations obtained from the sampled fish organs and water from the dam were within the limit of FAO/WHO recommendation for human consumption and striving of the finfishes.

Key Words: *Ajiwa dam, bioaccumulation, finfish, Mormyrus rume, seasonal*

Introduction

Decades ago, the ability of the aquatic ecosystem to sustain this important aquatic resource (fishes) has come under threat, as a result of increasing contamination of surface water and sediments in the aquatic medium as it accumulates in aquatic organisms (planktons and invertebrates) and invariably, bioaccumulates in humans, the final consumer of the aquatic resources, which now pose a great concern globally (Malik et al., 2010; Aghoghovwia *et al.*, 2016; Hossain *et al.*, 2016; Akinjogunla and Lawal-Are, 2020; Akinjogunla *et al.*, 2023). Water plays a very significant role in the life of human and aquatic organisms. Water with zero content of toxicant is essential for living a healthy life since polluted water can pose humans health at risk through direct or indirect contact with dangerous chemicals (Akinjogunla *et al.*, 2023).

In the recent times, Ajiwa irrigation Dam, Katsina has been subjected to a lot of anthropogenic pollutants capable of impairing the healthy status of the river with the influence of inhabitants and fisherfolks on the dam (Akinjogunla and Shuai'bu, 2022). Aquatic contamination has been increased by industrial revolution, mechanical waste and anthropogenic activities. Significant pollutant discharge into water have resulted to magnanimous hazards to the fresh water ecosystem. Contaminants of aquatic systems with heavy metals is one of the most challenging problems globally now, because of their toxicity, persistency and ability of bioaccumulation (Zeitoun and Mehana, 2014). Metals accumulate in sediment at a considerable amount and finally enters into the food chain through water and plants (Bhuyan and Islam 2017).

Finfishes constitute major sources of animal protein intake of human, (Akinjogunla *et al*., 2021; Akinjogunla and Usman, 2023; Akinjogunla and Shehu, 2024), particularly in developing countries and are consumed or presented in various palatable ways (fresh, cooked, grilled, dried, fried or smoked) depending on individual's taste, preference or socio-economic status (Akinjogunla *et al*., 2017). Fishes are the most important aquatic biota and are susceptible to heavy metals pollution (Akan *et al*. 2012).

Heavy metal toxic waste is considered as a major ecological disaster because of its inability to breakdown to smaller harmless pieces and so, they regenerate to survive in the environment and also in the aquatic organisms (Ayangbenro and Babalola 2017). In aquatic system, the ambient environment (water and sediment) is usually the medium and receiving point of these metal pollutants (Gilbert &Avenant-Oldewage 2014). Pollution appraisal in an environment based on water analyses only is not a comprehensive and precise method of identifying contaminants in aquatic systems (Ismail *et al*. 2016) while metal concentration in sediment is also an indispensable tool in water quality evaluation (Abdel-Khalek *et al.* 2016). The biotic and abiotic properties of the aquatic environment differ from one habitat or ecosystem (marine, estuarine or freshwater) to another. Human activities (domestic or industrial) that can result in the alteration of the waterbeds, presence or absence of fauna (preys or predators), support or impeding of aquatic growths etc. can lead to degradation of water quality (Verma *et al.*, 2012).

The concentration of metals becomes toxic to both the fish and the final consumer (human and animals) when it exceeds the permissible level (Abdallah et al., 2012; Adaka *et al.*, 2017; Akinjogunla and Lawal-Are, 2020; Okunade *et al*., 2021; Akinjogunla *et al*., 2023). This threshold limit varies not only between different metals but also among different species. Metals become toxic when the metabolic activities of the organism fail to detoxify them (Mansour and Sidky, 2002). Exposure to heavy metals could eventually lead to health hazards or threats connected with the ingestion of contaminated / polluted fish by man. All these sources of pollution affect the physiochemical characteristics of the water, sediment and biological components (Akinjogunla et al., 2023), and thus the quality and quantity of fish stocks (Mantovani, *et al.*, 2005; Singh, *et al.*, 2006).

Schilbe mystus, *Sarotherodon galileus, Mormyrus rume and Clarias anguillaris* are freshwater fishes that are of great commercial importance and in abundance in the study area (Akinjogunla and Shuaibu, 2022). Fish and other aquatic food are capable of concentrating heavy metals in their tissues (Akinjogunla and Lawal-are, 2020; Akinjogunla et al., 2023) and for the fact that they play a vital role in human nutrition, they need to be checked properly to ensure that unnecessary high level of some organic and inorganic pollutant is not being transferred to human through consumption.

To the best of our knowledge, from literature survey, no work has been reported on the assessment of heavy metals in fishes, sediments and water of the Ajiwa Irrigation Dam. Therefore, in this study we accessed the concentration levels of selected heavy metals such as Cadmium (Cd), Lead (Pb), Chromium (Cr), Zinc (Zn) and Iron (Fe) in the four commonly consumed finfishes (*Schilbe mystus*, *Sarotherodon galileus, Mormyrus rume and Clarias anguillaris)* tissues (gills, intestine, flesh) of the Ajiwa irrigation Dam.

Materials and Method

Sampling Area

Ajiwa Irrigation dam / reservoir (Figure1) is located at Batagarawa Local Government Area of Katsina State (Akinjogunla and Shuai'bu, 2022) with its primary purpose of suppling water but as time goes on, fishing activities was added (Akinjogunla and Usman, 2023).

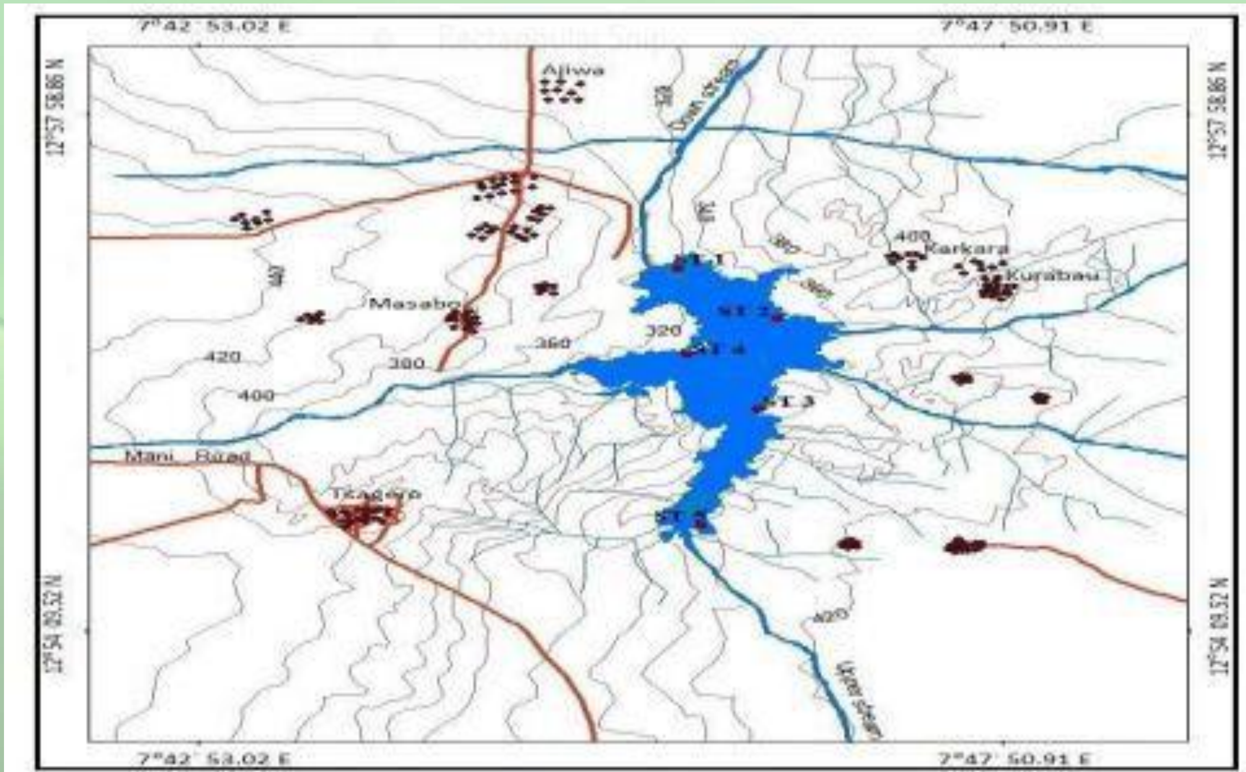

Figure 1. Ajiwa Irrigation dam
Source: Akinjogunla and Shuai'bu, 2022

Sampling stations

Along the river, three (3) sampling stations were selected and named as sampling station A, B, C across the Dam area, with particular reference to areas where there are continuous human interactions and discharge of wastewater.

Water sample collection

Water samples were collected at each sampling station (Station A, B, C) for a period of six (6) months. Water sampling was done by immersing sampling bottles at about 10cm below the water surface. A volume of 500 ml of water sample was collected from each sampling station.

Sediment Sample Collection

Sediment from each study station was collected using hand trowel into pre-cleaned polythene bag for the period of six (6) months between July (which marked the peak of rainy season) to December, 2023 which marked the peak of dry season. All the samples were collected under the same condition. The sediment samples collected were kept in polyethylene bags and preserved under a freezing condition (< -20 °C) before laboratory analysis.

Fish Samples Collection and Identification

Four (4) fish species (*Schilbe mystus, Sarotherodon galileus, Mormyrus rume and Clarias anguillaris*) were collected monthly for a period of six months at the fish landing site of the dam. The fishes were washed using the dam water and preserved in an ice cooler and transported to the Department of Biochemistry laboratory, Gombe State University, Gombe State.

Samples Preparation and Analysis

Water sample

Raw water was subjected to wet digestion. 100ml unfiltered water was measured into a 250ml beaker and 20ml "Analar" nitric acid solution plus 10ml of 50% hydrochloric acid solution was added. The acidified water was evaporated to almost dryness on a hot plate and 5ml of 50% hydrochloric acid was again added and heated for 15 minutes. The beaker was removed and cooled to room temperature before transferring the contents into a 100ml volumetric flask and made up to the mark with distilled water (Wufem *et al*., 2009). The digested water was filtered and analyzed for the levels of heavy metals using AA6800 (Shimadzu Japan). Atomic Absorption Spectrophotometer (AAS).

Fish samples

The fish organs (gills, intestines and flesh) were eviscerated and then transferred into electric oven at 40^{0}C. They were dried in the oven at this temperature for 24 hours and then pulverized in a clean dry porcelain mortar (Ahmed *et al*., 2010). The pulverized samples were dried further for 1hour at a reduced temperature of 20^{0}C and put into clean dried bottles. 3.0g of the dried fish samples was weighed into a silica crucible and ashed in a muffle furnace at a temperature of 600^{0}C for 5 hours (Adeniyi *et al*., 2005). The ashes were cooled to room temperature and sieved to remove particles and then transferred into a 250ml conical flask. Thereafter, 20ml of concentrated HNO_3 was added and diluted to 50ml with deionized water and swirled gently after which the volume was made up to 100ml with deionized water and analyzed for heavy metals as with the water.

Sediment

Sediment Samples were dried, ground and sieved with 200mm mesh screen. For each sample, 5.0g of sediment was measured into 150ml flasks. 50ml of 0.1M HCl was added and the flasks was agitated for 30 mins at 200 rev/min. The mixture was filtered into 50ml flask and made up to the mark with deionized water (Ahmed *et al*., 2010).

Chemical Analysis

Flame atomic absorption spectrophotometry (FAAS) AA6800 (Shimadzu Japan) supplied with ASC-6100 auto sampler and air acetylene atomization gas mixture with elements specific hollow cathode lamp was used for the determination of the targeted heavy metals at Department of Biochemistry laboratory Gombe State University, Gombe State. Analytical grade standards of each target heavy metals were used.

Determination of Bioaccumulation Factors

The bioaccumulation factors of the heavy metals in the organs, water and sediment were determined using the method adopted to gauge the bioaccumulation of trace metals as advocated by the FEPA (2003) in the tissues of commonly consumed fish.

$$BWAF = \frac{Heavy\ metal\ concentration\ in\ organs}{Heavy\ metal\ concentration\ in\ water}$$

$$BSAF = \frac{Heavy\ metal\ concentration\ in\ organs}{Heavy\ metal\ concentration\ in\ sediment}$$

Statistical Analysis

Data generated from this study were analyzed as mean ± standard error using Microsoft Excel 2010. All means recorded were determined considering a level of significance less than 5% ($p < 0.05$) at 95%. It was used to test for significant relationship among heavy metals levels in muscle, water and sediment of the sampling site.

Results

The mean concentration of Cadmium (Cd), Lead (Pb), Chromium (Cr), Zinc (Zn) and Iron (Fe) in the various tissues (gills, intestines and flesh) of common edible fishes (*Schilbe mystus – S. mystus*, *Sarotherodon galileus – S. galileus*, *Mormyrus rume – M. rume* and *Clarias anguillaris – C. anguillaris*), sediment and water from three (3) sampling points at the Ajiwa Irrigation Dam in Kastina State during the wet and dry seasons is reported in Table 1.

Table 1. The concentration (Mean ± SD, in mg/kg) of metals in tissues of fish samples obtained from Ajiwa irrigation Dam, Katsina during both wet and dry seasons.

	S. mystus			*C. anguillaris*		
M	Gills	Intestine	Flesh	Gills	Intestine	Flesh
Wet Season						
Cd	1.16 ± 0.04	1.45±0.05	1.40± 0.01	0.43± 0.02	0.48±0.01	0.44±0.01
Pb	2.11±0.02	1.21±0.15	1.28±0.20	1.57± 0.01	1.58±0.01	2.00±0.01
Cr	1.47± 0.02	1.48±0.02	1.35± 0.03	0.51±0.03	0.51±0.02	0.49± 0.01
Zn	3.20± 0.14	3.14±0.01	2.23± 0.15	8.85±0.05	8.55±0.04	8.30±0.03
Fe	106± 2.30	98± 2.23	105 ± 2.33	33.0 ±0.05	13.68±0.40	10.20± 0.10
Dry Season						
Cd	0.47 ± 0.02	0.43±0.02	0.34± 0.01	0.60± 0.02	0.60±0.02	0.31±0.01
Pb	0.44±0.02	0.34±0.02	0.22±0.01	0.53± 0.03	0.52±0.02	0.28±0.01
Cr	0.81± 0.02	1.00±0.02	0.98± 0.01	0.79±0.02	0.79±0.02	0.40± 0.01
Zn	36.6± 0.14	30.0± 0.06	36.6± 0.15	35.00±0.02	35.01±0.01	34.00±0.03
Fe	60.6± 0.21	60.5± 0.22	63.6 ± 0.21	53.00 ±0.05	53.00±0.05	52.01± 0.04
	M. rume			*S. galileus*		
M	Gills	Intestine	Flesh	Gills	Intestine	Flesh
Wet Season						
Cd	1.28±0.02	1.10±0.05	1.10 ±0.01	1.02±0.03	1.24±0.02	1.18±0.01
Pb	2.62±0.17	2.55±0.14	2.18±0.16	2.47±0.01	2.38±0.01	2.43±0.02
Cr	1.29±0.11	1.20±0.12	1.23±0.01	1.33±0.02	1.28± 0.02	1.35± 0.01
Zn	2.83±0.21	3.44±0.21	2.33±0.19	2.98±0.02	1.98±0.02	2.60± 0.01
Fe	100±1.52	101±1.82	99±1.72	94.7± 1.53	16.14±0.23	19.12±0.19
Dry Season						
Cd	0.39±0.02	0.49±0.02	0.48 ±0.01	0.60±0.01	0.31±0.02	0.30±0.01
Pb	0.25±0.03	0.46±0.02	0.45±0.03	0.40±0.01	0.22±0.01	0.26±0.02
Cr	0.76±0.03	0.76±0.02	0.77±0.03	1.76±0.02	0.75± 0.02	1.76± 0.01
Zn	37.6±0.23	37.6±0.23	38.00±0.21	35.2±0.02	34.22±0.02	34.20± 0.01
Fe	55.5±3.07	55.44±3.07	54.50± 3.03	54.1± 0.15	54.10±0.16	53.11±0.14

Keys: M: Metals (Mg/kg); Cadmium (Cd); Lead (Pb); Chromium (Cr); Zinc (Zn); Iron (Fe); *Schilbe mystus – S. mystus; Sarotherodon galileus – S. galileus; Mormyrus rume – M. rume* and *Clarias anguillaris – C. anguillaris*

The mean concentration of heavy metals in the fish tissues decreased in the following sequence: Fe>Zn>Pb>Cr>Cd in wet season and Fe>Zn>Cr>Cd>Pb in dry season for all sampled fish organs. There were no significant differences ($p>0.05$) of these metals observed between the sampled fish tissues, water and sediment and seasons. Fe recorded the highest mean values in both seasons (106±2.30mg/kg for wet season and 63.6±0.21mg/kg for dry season). Cd concentration has the lowest value (0.43±0.02mg/kg) in the gills of *C. anguillaris* in wet season while Pb had the lowest value (0.22±0.01mg/kg) in the flesh of *S. mystus* and intestines of *C. anguillaris* in the dry season.

In this study, the gills and flesh of *S. mystus* were recorded to contain the highest levels of Fe for the wet and dry seasons respectively while its intestines were recorded to have the highest value of Cd during the wet season only. The flesh of C. *anguillaris* recorded the lowest value of Fe for both seasons while its gills were recorded to have the lowest value of Cd during the wet season. During the dry season, the intestines of *M. rume* had the highest value of Pb while the intestines of *S. galileus* and *S. mystus* had the lowest levels of Pb.

Table 2. The concentration (Mean ± SD, in mg/l metals in water samples for both Wet and dry seasons obtained from Ajiwa irrigation Dam, Katsina.

Heavy Metals						
Season	Parameters	Cd	Pb	Cr	Zn	Fe
Wet	Water (mg/l)	0.44± 0.02	0.27 ± 0.02	0.07 ± 0.03	69.00±0.36	2.29±0.02
	Sediment (mg/kg)	0.63± 0.15	0.30 ± 0.02	0.60 ± 0.05	69.9±0.31	2.35±0.03
Dry	Water (mg/l)	1.21± 0.03	2.60 ± 0.02	1.56± 0.05	72.10±0.31	90.66±0.03
	Sediment (mg/kg)	1.35± 0.04	2.77 ± 0.03	1.44 ± 0.03	72.2±0.26	106.0±2.57
WHO (2011) tolerance limit	Water (ppm)	0.001– 0.005	0.1	0. 1	0.10	5.00
	Sediment (ppm)	0.l	5.00	0.03 - 0.3		5.00

Keys: Cadmium (Cd); Lead (Pb); Chromium (Cr); Zinc (Zn); Iron (Fe)

Table 2 below shows the mean concentration of these heavy metals (Cd, Pb, Cr, Zn and Fe) in the sampled water and sediments from the Ajiwa Irrigation dam. The highest metal accumulated was Fe (90.66±0.03mg/l and 106.0±2.57mg/kg) for both water and sediment samples respectively during the dry season while the lowest metal accumulated was Cr (0.07 ± 0.03mg/l and 0.60 ± 0.05 mg/kg) for water and sediment samples respectively for the wet season

The values recorded for Cd exceeded the tolerance limits for both sediment and water samples for both wet and dry seasons while values of Pb obtained in this study were within range for the sediment samples for both seasons but the values obtained for the water samples exceeded the WHO limits.

The values recorded for Cr during this study exceeded the tolerance limits for sediment samples for both seasons and water samples for the dry season only. Zn values exceeded the tolerance limits for both water and sediment samples for both the wet and dry seasons while Fe values recorded during the wet seasons for both water and sediment samples were within the limits but values obtained for both water and sediment samples for the dry season exceeded the acceptable tolerance values.

In Table 3, the bioaccumulation factor of fish tissues to water (BWAF) is presented. Cd values ranged between 0.503 in the gills of *C. anguillaris* to 1.661 in the flesh of *S. mystus* while Pb values were between 0.731 in the gills and intestines of *C. anguillaris* to 1.348 in the gills of *S. galileus*. Cr values ranged between 0.552 (in the gills and intestines of *C. anguillaris*) and 1.932 (in the intestines of *S. mystus*). Lowest to the highest values for Zn ranged from 0.221 in the intestines of *S. mystus* to 0.310 in the gills of *C. anguillaris*. The highest and lowest values of Fe (0.775 and1.813) were recorded for intestines of *S. galileus* and the flesh of *S. mystus* respectively. The least recorded values of Fe, Cr and Cd were found in sampled organs of *C. anguillaris* while least values for Zn and Pb were alternated between sampled organs of *S. galileus* and *S. mystus* respectively.

Table 4 shows the bioaccumulation factor between the fish tissues and sediments (BSAF) collected from the Ajiwa Irrigation dam, Katsina. Cd values recorded ranged across the sampled fish organs (gills, intestines and flesh) of the four selected fish samples from 0.410 (in the gills of *C. anguillaris*) to 1.380 (in the flesh of *S. mystus*). Pb values ranged between 0.537 in the intestines of *S. mystus* to 1.800 in the gills of *M. rume*. The values of Cr recorded was between 0.593 (flesh of *C. anguillaris*) and 2.093 (intestines of *S. mystus*) while the values for Zn recorded ranged from 0.219 in the intestines of *S. mystus* to 0.494 in the intestines of *S. galileus*.

The recorded values for Fe were between 0.523 from the intestines of *C. anguillaris* to 1.537 from the gills of *S. mystus*. Sampled tissues of *C. anguillaris* accumulated the least values of all the heavy metals examined while the highest values accumulated rotates between *S. mystus, M. rume* and *S. galileus*.

Table 3. Mean concentration of the bioaccumulation factor of fish tissues to Water (BWAF).

SAMPLE	TISSUES	Cd	Pb	Cr	Zn	Fe
S. mystus	Gill	0.987	0.993	1.398	0.275	1.792
	Intestine	1.078	0.574	1.932	0.221	1.705
	Flesh	1.661	0.592	1.429	0.275	1.813
M. rume	Gill	1.012	1.069	1.196	0.284	1.672
	Intestine	1.151	1.048	1.202	0.283	1.673
	Flesh	0.896	0.986	1.220	0.285	1.651
S. galileus	Gill	1.152	1.348	1.282	0.263	1.601
	Intestine	1.545	1.324	1.245	0.263	0.755
	Flesh	0.896	1.344	1.294	0.256	0.777
C. anguillaris	Gill	0.503	0.731	0.552	0.310	0.925
	Intestine	0.533	0.731	0.552	0.308	0.609
	Flesh	0.515	0.874	0.546	0.299	0.669

Keys: Cadmium (Cd); Lead (Pb); Chromium (Cr); Zinc (Zn); Iron (Fe); *Schilbe mystus – S. mystus; Sarotherodon galileus – S. galileus; Mormyrus rume – M. rume* and *Clarias anguillaris – C. anguillaris*

Table 4. Mean concentration of the bioaccumulation factor of fish tissues to Sediments.

SAMPLE	TISSUES	Cd	Pb	Cr	Zn	Fe
S. mystus	Gill	0.823	0.928	1.520	0.273	1.537
	Intestine	0.898	0.537	2.093	0.219	1.462
	Flesh	1.38	0.553	1.553	0.273	1.555
M. rume	Gill	0.843	1.800	1.300	0.282	1.435
	Intestine	0.959	0.980	1.306	0.281	1.443
	Flesh	0.747	0.921	1.333	0.283	1.416
S. galileus	Gill	0.959	1.260	1.393	0.261	1.373
	Intestine	1.287	1.237	1.353	0.494	0.648
	Flesh	0.747	1.253	1.406	0.254	0.667
C. anguillaris	Gill	0.419	0.684	0.600	0.308	0.790
	Intestine	0.444	0.686	0.600	0.306	0.523
	Flesh	0.429	0.817	0.593	0.297	0.574

Keys: Cadmium (Cd); Lead (Pb); Chromium (Cr); Zinc (Zn); Iron (Fe); *Schilbe mystus – S. mystus; Sarotherodon galileus – S. galileus; Mormyrus rume – M. rume* and *Clarias anguillaris – C. anguillaris*

Discussion

This study revealed that all the heavy metals analyzed were found in water, sediment and fish samples of Ajiwa irrigation Dam, Katsina. The results obtained showed that the water samples were lower in heavy metals concentration in line with reference values for USEPA, (2010). However, the sediments accumulated more heavy metal than the water and fish samples, these have also been observed by numerous researchers (Moruf and Akinjogunla, 2019; Akinjogunla and Lawal-Are, 2020; Akinjogunla et al, 2023) in some study areas. Sediment has been known to be the major depository of metals, holding more than 99% of total amount of a metal present in the aquatic system (Ozturk *et al*., 2009). According to Brady *et al*. (2015), these metal toxins act together with the sediment, to escalate to sequestration. Thus, excessive dilutions of these heavy metal contaminants are detected in sediment which now serves as a reservoir to these metallic ions (Brady *et al*. 2015; Bai *et al*. 2018).

The high levels of metals at surface water observed at wet season could be attributed to the combined effects of the effluents from the use of herbicides, and the mining products depots, which were discharged into the river close to that station; similar conclusion was drawn by Obasohan and Oronsaye (2000). Presence of zinc in water bodies such as Ajiwa dam could be associated with human activities such as the use of chemicals and zinc-based fertilizers by farmers (Egila and Nimyel, 2002). The levels of Zinc, Chromium and Cadmium recorded at all the stations during this investigation were lower than the maximum acceptable limits for aquatic life as recommended by WHO (2011). The presence of Lead may be due to surface runoffs and municipal waste discharges into the water bodies. The values obtained for Pb, Cr and Cd in the flesh, gills and intestine of the finfishes are in line with values reported by Wokoma (2011), where concentration of lead in tissue of *Psuedotolithus elongatus*, *Mugil cephalus* and *Chrisichthyes nigrodigitatus* from Sombreiro River located in Rivers State was 0.23mg/kg, 0.17mg/kg and 0.21 mg/kg respectively while Sambo *et al* (2014) reported the concentration of lead in the flesh of *Oreochromics niloticus* from Ibrahim Adamu Lake, Jigawa state, Nigeria as 0.27mg/kg and the level in the river sample as 0.81mg/l. Opaluwa *et al* (2012) reported the concentration of lead and cadmium from Uke Stream, Nasarawa State, Nigeria from different tissues of *Synodontis schall* respectively as 0.021mg/g and 0.005mg/g (head), 0.014mg.g and 0.015mg/g (gills), 0.011 mg/g and 0.026 mg/g (intestine) and 0.012 and 0.001 mg/g (flesh), while in *Clarias gariepinus*, the levels of lead and cadmium were respectively recorded as 0.031 mg/g and 0.005mg/g (head), 0.022 mg/g and 0.016mg/g (gills), 0.012mg/g and 0.025mg/g (intestine) and 0.013 mg/g and 0.001mg/g (flesh) and the corresponding water and sediment concentration were respectively recorded as 0.040mg/l and 0.095mg/g (lead) and 0.023 and 0.035mg/g (Cadmium).

The slight variation of values for the water and sediments between the findings in this study and those of previous reports could be attributed to the type of anthropogenic activities around the rivers studied, type of wastes deposited into the surface water and /or leached into the aquatic ecosystem through soil erosion.

The bioaccumulation potentials of different fish species as well as their level of tolerance could be a possible factor for the low concentration of these metals in the flesh of these species studied suggested that there may be little or no potential health hazard arising from their consumption with regard to Cadmium and Lead

The bio-accumulation factor (BWAF) values of the heavy metals analyzed in this study showed that bioaccumulation has occurred in the fish but not at an alarming rate as at the time of this study. Even though the fish samples are benthic feeder, their constant contact with the sediment does not affect its food intake to a great extent probably as a result of rapid remobilization of the adsorbed metals back into the surface waters through changes in some physicochemical parameters such as temperature, pH, and redox potentials. Also, the phenomenon that different metals are accumulated at different concentrations in the various organs of fish was observed in this study. The variance in the level of deposits in the different organs and/or tissues of a fish can predominantly be accredited to the variations in the biological role of each organ, its comportment, regulatory ability, and feeding habits (Van der Oost et al., 2003).

For the fish organs examined, the gills have the highest concentration of all the metals, while the flesh recorded the least value and is thus the least preferred site for bioaccumulation. The high concentration of the metals in the gills could be due to element complexion with the mucus coverings in the gills which cannot be completely removed from the gill lamellae before analysis (Figueiredo-Fernandes et al., 2007). Another important influence in the total metal concentrations in the gills is the fact that metals get adsorbed onto the gills surface as the first target or point of contact for pollutants in water.

The concentrations of these heavy metals may be attributed to accumulation from the run-off of fertilizers and pesticides as well as runoff from the residential area and oil spillages from boats and canoes used at the dam (Chitou *et al*., 2021). The levels of metal in water bodies (lakes, rivers, lagoons) are mostly manipulated in the wet season by stormwater run- off from the environs on the water bodies' catchment and this ordinarily leads to a buildup in the metals. Islam *et al*. (2015) reported that metal concentration is expected to be low during the wet season due to the dilution effect on heavy metals but some site-specific activities and sources of metal contamination could lead to an exception to this general trend. Different trends of seasonal effects on heavy metal levels in water and sediments have been reported (Islam *et al*., 2015; Edokpayi *et al*., 2017; Le *et al*., 2020).

The results obtained from the assessment of these trace metals suggest that they may pose a potential toxicity problem due to the high clay content of the sediments which reduces drainage and increases the reduction of the metals. The continuous and regular intake of these finfishes collected from the Irrigation dam may likely induce health risks with regards to Cr, Pb and Cd intoxication. Although, WHO did not establish guidelines for Fe and Zn because they are not of health concern at levels found in drinking water, while Cr is an essential element that enhances the metabolism of carbohydrates, lipids and protein in humans (Udiba *et al*., 2020).

Conclusion

The study confirms that there was a significant presence of heavy metals in the commercially important finfishes collected from the Ajiwa irrigation dam. The bioaccumulation of some of these metals in the tissues of the finishes and water samples from the dam was within permissible/tolerable limits, indicating they are safe for consumption. The results obtained also revealed that the sediments accumulated metals at concentrations higher than the permissible limits. Continuous exposure of the dam to sources of these metals may pose a hazard to the end consumers (humans), as these finfishes will eventually absorb some of these metals into their edible tissue which is the main part of consumption for humans. Therefore, there is a need to regularly monitor organisms collected from these areas for metals accumulation.

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