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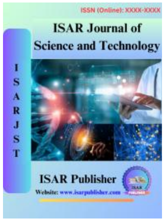

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Heavy Metal Concentrations in Fish from Oguta Lake: Exceedances of Permissible Limits and Public Health Concerns

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Abstract: This study investigated the concentrations of heavy metals—mercury (Hg), lead (Pb), cadmium (Cd), iron (Fe), and copper (Cu)—in five fish species (African Sharptooth Catfish, Mud Fish, Hong Kong Tilapia Fish, and Knife Fish) from Oguta Lake, Owerri, Imo State, Nigeria. The specific objectives were to (1) assess heavy metal concentrations in fish organs (muscle, liver, gills) obtained fom Oguta lakes, (2) compare contamination levels across species, and (3) evaluate potential health risks associated with fish consumption. A stratified random sampling technique was used to collect fish samples, and heavy metal analysis was conducted using Atomic Absorption Spectroscopy (AAS). Data were statistically analyzed using SPSS (version 25.0), with significance set at $p < 0.05$. The results revealed alarming heavy metal contamination, with concentrations exceeding FAO/WHO permissible limits in most cases. Mercury (Hg) was highest in the liver of African Sharptooth Catfish (2.569 mg/kg; limit: 0.5 mg/kg), while cadmium (Cd) peaked in the same species' liver (54.757 mg/kg; limit: 0.1 mg/kg). Lead (Pb) was most concentrated in the muscle of Hong Kong Tilapia Fish (35.882 mg/kg; limit: 0.3 mg/kg), and iron (Fe) levels were highest in the liver of Mud Fish (103.306 mg/kg; limit: 40 mg/kg). Copper (Cu) showed relatively lower contamination, with a maximum of 2.361 mg/kg in Knife Fish gills (limit: 3 mg/kg). Statistical analysis indicated no significant differences ($p > 0.05$) in metal concentrations across species, except for mercury (F-value = 3.444, $p = 0.035$). These findings highlight severe pollution of public health concerns in Oguta Lake, due to environmental contamination, industrial effluents discharge, agricultural runoff, and improper waste disposal. Chronic exposure to such heavy metals through fish consumption poses serious health risks, including neurotoxicity, kidney damage, and carcinogenic effects.

Keywords: Environmental contamination, Fish organs, Heavy metals, Permissible limits, Public health concerns.

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Introduction

After decades of rapid urbanization, population growth, and industrialization, developing countries are now home to many of the world's most critical air, water, and solid waste problems (Tariq et al., 2011). Studies have identified the rise in the pollution of particular heavy metals in freshwater systems around the world, particularly in rivers (Tuzen, 2017; Zhang et al., 2019). Heavy metals contamination in food, especially in fish, has become a growing concern due to its potential health risks to human consumers (Mansour & Sidky, 2012; Vinodhini & Narayanan, 2008). Heavy metals such as lead, mercury, cadmium, and arsenic are toxic even at low concentrations and can accumulate in the human body over time, leading to various health issues including neurological and developmental disorders, kidney damage, and cancer (Mendil et al., 2015; Nriagu, 2018; World Health Organization, 2019). In a study by Shazali et al. (2019), it was found that fish, being a common source of protein for many communities, could be a significant source of heavy metals exposure (Miller et al., 2010; Sadiq et al., 2009). The presence of these contaminants in fish is largely due to anthropogenic activities such as industrial discharges, agricultural runoff, and improper waste disposal, which can contaminate water bodies and subsequently affect aquatic life (Adeyemi et al., 2010; Nriagu & Pacyna, 2008; U.S. EPA, 2020). Owerri, a major city in Nigeria, is known for its vibrant markets where seafood, including fish, is widely consumed. The pollution has mainly been caused by industrial processes and industrial waste, typically from rubber and oil palm mills (Tariq et al., 2011; Agu et al., 2015; Okafor et al., 2016).

Heavy metals in marine systems are a global problem, since continuous exposure of marine organisms to their low concentrations may result in bioaccumulation, and subsequent transfer to man through the food web (Mendil et al., 2015). Heavy metal pollution in rivers gives threat to public water supplies and also to consumers of fishery sources (Terra et al., 2018; Agu et al., 2014; Agu et al., 2023). Heavy metals constitute a core group of aquatic pollutants via their bio-accumulative and non-biodegradable properties in food (Kazim et al., 2018; Borgmann, 2011). Humans may be contaminated by organic and inorganic pollutants associated with aquatic systems by consumption of contaminated fish and other aquatic foods from this environment (Aderinola et al., 2019; Asuquo et al., 2014). Fish play key roles in ecosystems because they are vertebrates, which are at the top of the food chain (Zaikov et al., 2017). Heavy metals in the marine environment may originate from either natural or anthropogenic sources. Although trace metals are normal constituents of the marine environment, and some of them are essential to marine organisms, all metals are toxic above some threshold level (Kljaković-Gašpić et al., 2010; Bishop, 2020; U.S. EPA, 2018). Heavy metals represent the most dangerous type of pollution as it has been well documented that heavy metals, such as arsenic, cadmium, chromium, lead, and copper are highly toxic to human cells (Gugala, 2018; Zhang et al., 2021).

Heavy metals can be classified as potentially toxic (arsenic, cadmium, lead, mercury, nickel, etc.), probably essential (vanadium, cobalt), and essentials (copper, zinc, iron, manganese, selenium) (Tuzen & Soylak, 2017). Fishes are good indicators for the long-term monitoring of metal accumulation in the marine environment (Türkmen & Tepe, 2017). Studies on bioaccumulation of pollutants in fish are important in determining different content of trace metal in fish species from bio-magnifications of food chains, metabolic capability, and feeding habits (Asuquo et al., 2014; Yilmaz et al., 2010). The accumulation of metal is a tool for identifying the impact of metal in aquatic ecosystem, and therefore shows an adverse effect in organism (Borgmann, 2011). The accumulation of heavy metals in fish is an important issue because many fish species are consumed as a source of protein by a large section of the population, especially those who live near rivers (Agu et al., 2013). The low saturated fat and sufficient omega fatty acids in fish are also important in supporting good human health. The levels of heavy metal accumulation in fish depend on the growth rate, metabolism, feeding pattern, and ecological requirements of a given fish species (Yilmaz et al., 2010).

The increasing industrialization and urbanization have led to elevated levels of heavy metal contamination in aquatic environments, posing significant risks to fish populations and consequently, to human health through the consumption of contaminated seafood. Heavy metals such as lead (Pb), mercury (Hg), cadmium (Cd), and arsenic (As) are toxic and can accumulate in the tissues of fish, resulting in **bioaccumulation** and **biomagnification** within the food chain. Despite existing regulatory measures, the monitoring of heavy metal concentrations in fish remains insufficient, leading to potential health hazards for consumers, particularly vulnerable populations such as pregnant women and children. Moreover, there is a lack of comprehensive data regarding the specific levels of heavy metals in various fish species from local water bodies, which hampers risk assessment and public health initiatives.

This project aims to systematically investigate the levels of heavy metals in selected fishes from specific marketplace, evaluate the potential health impacts on consumers, and provide recommendations for regulatory policies and public health awareness campaigns to mitigate risks associated with heavy metal exposure through fish consumption. The general objective of the research paper is to determine the levels of heavy metals in fishes sourced from Oguta Lake in Owerri and assess the potential health risk on human health.

Methodology

Research design

This study adopted a cross-sectional quantitative design to determine the heavy metals in fish samples and the overall effects on human health living in the study sites.

Area of Study

Owerri is the capital city of Imo State in Nigeria, set in the heart of Igboland. It is also the state's largest city, followed by Orlu, Okigwe and Ohaji/Egbema. Owerri consists of three Local Government Areas including Owerri Municipal, Owerri North and Owerri West, it has an estimated population of 1,401,873 as of 2016 and is approximately 100 square kilometres (40 sq mi) in area. Oguta Lake is a lean 'finger lake' formed by the damming of the lower Njaba River with alluvium. it is the largest natural lake in Imo State, Southeastern Nigeria; within the equatorial rainforest region of Niger Delta. Oguta Lake's catchment area comprises the drainage area of the NjabaRiver and a part of the River Niger floodplain in the region south of Onitsha. The lake is situated in Oguta about 50 kilometres (30 mi) from the junction of the Ndoni and Orashi River. It is about eight kilometres (5 mi) long from east to west and 2.5 kilometres (1+1⁄2 mi)wide. The lake is 5:41-5:44N, 6:41-6:50E; <50 m above sea level.

Population of study

Fish samples was gotten from Oguta Lake in Imo State.

Sample size determination

To determine the heavy metals in fish samples from Oguta Lake at, Imo State, Nigeria, a sample size of five[5] fishes were selected for analysis. In the Lake, five [5] different species of fish was selected, African Sharptooth Catfish, Mud Fish, Hong Kong Tilapia Fish and Knife Fish. This approach allows for evaluation of fish samples for heavy metals from different species of fishes.

Sampling technique

The research employed a stratified random sampling technique to ensure the selection of representative fish samples from Oguta Lake in Imo state. This technique divides the lake into distinct strata based on specific characteristics such as depth, habitat types (e.g., shallow areas, open water, or vegetation-dense zones), or zones of human activity. Fish species tend to have habitat preferences, so stratifying the lake ensures all zones are represented. Within each stratum, fish can then be selected randomly for analysis.

This technique will maximize representation and balances variability while accommodating the smaller sample size constraint.

Validity and reliability of instrument

The instruments was validated by the supervisor and laboratory specialist. Reliability was carried with 10% of the sample size been tested and result were reliable at alpha cronbach of 0.8

Method of data collection

Preparation of the sample collection process was by assembling the necessary equipment, which included, Laboratory coat, Hair net, Nose mask, labels, gloves, reagents, cooler, ice pack, and beaker. Samples was collected from Oguta Lake select for fish samples.

Method of data analysis

Heavy Metal Analysis

Principles of Atomic Absorption Spectrophotometer

Working principles: Atomic absorption spectrometer's working principles is based on the sample being aspirated into flame and atomized when the AAS's light beam is directed through the flame into monochromator, and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristic absorption wave length a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Method: Emission Spectroscopy (AAS)

Apparatus

- AAS model: FS 240 Varian atomic absorption spectrophotometer
- Nitrous oxidant gas
- Acetylene gas
- Air oxidant gas
- Distilled water
- 250 ml Conical flask

Preparation of Sub-Stock or working solution of each metals

For each of the above metals a working solution of 100 mg/l was prepared using dilution factor formulae $C_1V_1 = C_2V_2$

WHERE

C_1 = Conc. of the stock solution (1000 mg/l)

C_2 = Conc. of the working solution (100 mg/l)

V_1 =Volume of the stock (unknown)

V_2 = Volume of the working Solution (100 ml)

For example: working solution of any of the metals

$C_1V_1 = C_2V_2$

Hence, 10 ml of each of the stock solution was diluted to mark in a 100 ml Volumetric flask, respectively

Preparation of five (5) different standards of each of the metals from the 100mg/l working solution for standard calibration curve, using dilution factor formula;

$C_1V_1 = C_2V_2$

$V_1 = 0.5$ ml

Standards:

S/N	Conc. mg/L	Vol ml H_2O	Vol ml Std	Total Vol ml
1	5.00	9.5	0.5	10.0
2	10.00	9.0	1.0	10.0
3	15.00	8.5	1.5	10.0
4	20.00	8.0	2.0	10.0
5	25.00	7.5	2.5	10.0

Fish Digestion for Heavy Metal Analysis

5g of fish sample was digested in 250 ml conical flask by adding 10 ml of aqua-regia (conc. HNO_3, HCl, HF in ratio 3:2:1), and heated on a hot plate until volume remains about 7-12 ml. The digest was filtered using what-man filter paper into a 50 ml volumetric flask and the volume made up to the mark using distilled de-ionized water, and was then stored in a plastic container for AAS analysis.

Procedure:

The sample (digested) was thoroughly mixed by shaking and 50 ml of it was transferred into a glass beaker of 250 ml volume. The sample was aspirated into the oxidizing air-acetylene flame or nitrous oxide acetylene flame of the AAS. When the aqueous sample was aspirated, the sensitivity for 1% absorption was observed. The absorbance of the sample was correlated to obtain the concentration of metal in the sample from the standard calibration curve plotted by the AAS.

Preparation of 1000pm Stock AA Standards

Cadmium

Dissolve 1.000g. of cadmium metal in 20ml. of 5M.hydrochloric acid and 2 drops of conc. nitric acid. Dilute to 1 liter with deionized water.

Dissolve 2.0360g. of cadmium chloride in 250 ml deionized water. Dilute to 1 liter in a volumetric flask.

Dissolve 2.1032g. of cadmium nitrate in 250ml.of deionized water. Dilute to1 liter in a volumetric flask.

Copper

Dissolve 1.000g. of copper metal in 50ml. of 5M nitric acid. Dilute to 1 litre in a volumetric flask with deionized water. Or

Dissolve 3.7980g. of $(Cu(NO3)_2.3H2O$ in 250ml. of deionized water. Dilute to 1 litre in a volumetric flask with deionized water.

Iron

Dissolve 1.000g. of iron wire or granules in 20ml. of 5M hydrochloric acid Dilute to 1 liter in a volumetric flask with deionized water. or

Dissolve 4.8400g. of iron (111) chloride ($FeCl_3.6H2O$) in 200ml. of deionized water. Dilute to 1 liter in a volumetric flask with deionized. water

Lead

Dissolve 1.000g.of lead metal in 50ml. of 2M nitric acid. Dilute to 1 liter in a volumetric flask with deionized water.

Dissolve1.5980g. of lead nitrate ($Pb(NO_3)_2$) in 100ml. of deionized water. Dilute to 1 liter in a volumetric flask with deionized water.

Mercury

Dissolve 1.000g. of mercury metal in20ml. of 5M nitric acid. Dilute to 1 liter in a volumetric flask with deionized water. Or

Dissolve 1.3520g. of mercury (11) chloride ($HgCl_2$) in 250ml. of deionized water. Dilute to 1 liter in a volumetric flask with deionized water. Or

Dissolve 1 .0800g. of mercury (11) oxide (HgO) in 20ml. of 5M hydrochloric acid. Dilute to 1 liter in a volumetric flask with deionized water.

Data collected was presented using frequency distribution tables and analyzed using simple percentage approach. With the aid of computer through the application of statistical package for social sciences (SPSS) software analysis, version 23. The level of significance was set at P<0.0

Result

Concentration of Heavy Metals in Different Organs in the Fish Samples

Table 4.1 Showing the concentrations of heavy metals (Mercury, Lead, Cadmium, Iron, and Copper) in different organs of fish samples, including African Sharptooth Catfish, Knife Fish, Hong Kong Tilapia Fish, and Mud Fish, show significant variability. Mercury levels were highest in the liver of African Sharptooth Catfish (2.569 mg/kg), while it was undetectable in Mud Fish. Lead was most concentrated in the muscle of Hong Kong Tilapia Fish (35.882 mg/kg) and the liver of Mud Fish (25.780 mg/kg). Cadmium levels peaked in the liver of African Sharptooth Catfish (54.757 mg/kg), with the intestines also exhibiting notable concentrations. Iron concentrations were highest in the liver of Mud Fish (103.306 mg/kg), whereas Copper was generally low across all fish, with a maximum in the gills of Knife Fish (2.361 mg/kg). Statistical analysis revealed no significant differences in metal concentrations across organs (f-value and p-value indicate non-significance).

Table 4.1: Concentration of heavy metals in different organs in the fish samples

Parameter Tested	Organ	African Sharptath Catfish	Knife Fish	Hong Kong	Tilapia Fish	Mud fish	Total	f-value	p-value
Mercury (mg/kg)	Intestine	1.075	0.570	0.747	0.930	0.00	0.664		
	Muscle	0.235	0.570	0.655	0.00	0.00	0.292		
	Liver	2.569	1.883	0.645	0.078	0.00	1.035	1.068	0.390
	Gills	1.240	0.908	0.208	0.00	0.00	0.471		
Lead (mg/kg)	Intestine	3.110	3.625	10.178	6.345	8.211	6.294		
	Muscle	3.610	3.300	35.882	5.954	3.710	10.491		
	Liver	13.684	10.580	4.095	7.237	25.780	12.275	0.415	0.745
	Gills	3.210	14.694	13.021	7.030	11.130	9.817		
Cadmium (mg/kg)	Intestine	26.015	4.720	11.953	4.080	6.984	10.750		
	Muscle	9.165	4.400	33.572	4.397	3.660	11.039		
	Liver	54.757	13.432	4.650	4.199	17.978	19.003	0.681	0.606
	Gills	6.510	14.250	8.871	3.820	7.540	8.198		

Iron (mg/kg)	Intestine	8.700	29.105	32.603	50.120	3.268	24.759		
	Muscle	3.105	3.515	24.987	56.844	2.270	18.144		
	Liver	26.458	45.610	8.565	11.754	103.306	39.139	0.542	0.661
	Gills	5.805	32.938	15.007	59.195	10.992	24.787		
Copper (mg/kg)	Intestine	0.775	1.100	0.947	2.100	0.00	0.984		
	Muscle	0.290	0.00	0.231	0.00	0.00	0.104		
	Liver	1.137	0.014	0.360	0.219	0.00	0.346	1.548	0.241
	Gills	0.240	2.361	0.005	0.300	0.00	0.581		

Concentration of Heavy Metals in the Different Fish Samples

Table 4.2 shows the concentrations of heavy metals (Mercury, Lead, Cadmium, Iron, and Copper) across the different fish species. Mercury levels were highest in African Sharptooth Catfish (1.281 ± 0.966 mg/kg) and lowest in Mud Fish (0.000 mg/kg), with a statistically significant difference (f-value = 3.444, p-value = 0.035). Lead concentrations were highest in Hong Kong Tilapia Fish (15.794 ± 13.899 mg/kg), but no significant differences were observed among fish species (p-value = 0.428). Cadmium levels peaked in African Sharptooth Catfish (24.112 ± 22.181 mg/kg), though the differences were not statistically significant (p-value = 0.225). Iron levels were highest in Tilapia Fish (44.478 ± 22.153 mg/kg), while Copper concentrations were low across all species, with Knife Fish showing the highest value (0.869 ± 1.120 mg/kg). Overall, most metal variations were not statistically significant, except for Mercury.

Table 4.2: Concentration of heavy metals in the different fish samples

Parameter Tested	African Sharptooth Catfish	Knife Fish	Hong Kong	Tilapia Fish	Mud fish	f-value	p-value
Mercury (mg/kg)	1.281±0.966	0.983±0.621	0.564±0.241	0.252±0.454	0.000±0.000	3.444	0.035
Lead (mg/kg)	5.904±5.192	8.051±5.558	15.794±13.899	6.642±0.596	12.208±9.549	1.020	0.428
Cadmium (mg/kg)	24.112±22.181	9.201±5.370	14.762±12.893	4.124±0.241	9.041±6.199	1.603	0.225
Iron (mg/kg)	11.017±10.545	27.792±17.655	20.291±10.631	44.478±22.153	29.959±49.053	0.896	0.491
Copper (mg/kg)	0.611±0.426	0.869±1.120	0.386±0.402	0.655±0.972	0.000±0.000	0.856	0.512

Determination of Potential Health Risk by Comparing To FAO/WHO Permissible Level

The potential health risks posed by heavy metal concentrations in different fish were assessed by comparing the levels to FAO/WHO permissible limits. Mercury concentrations in the intestine, muscle, and gills of most fish species were below the permissible level (0.5 mg/kg), except for the liver, where levels in African Sharptooth Catfish (2.569 mg/kg) and Knife Fish (1.883 mg/kg) exceeded the limit. Lead concentrations consistently exceeded the permissible level (0.4 mg/kg) across all organs in most fish species, with the highest levels observed in the liver of Mud Fish (25.780 mg/kg). Cadmium concentrations also surpassed the permissible limit (0.1 mg/kg) in all organs, with African Sharptooth Catfish showing the highest levels in the liver (54.757 mg/kg). Iron exceeded the permissible level (0.5 mg/kg) in all organs across all species, with Mud Fish recording the highest level in the liver (103.306 mg/kg). Copper levels generally remained within permissible limits, except in some liver samples, such as African Sharptooth Catfish (1.137 mg/kg). The findings indicate significant health risks from heavy metal contamination in fish, with all organs across species showing values above permissible limits for several metals.

Determination of potential health risk by comparing to FAO/WHO permissible level

Fish species	Organ	Mercury (mg/kg)	Lead (mg/kg)	Cadmium (mg/kg)	Iron (mg/kg)	Copper (mg/kg)
African Sharptooth Catfish	Intestine	1.075	3.110	26.015	8.700	0.775
	Muscle	0.235	3.610	9.165	3.105	0.290
	Liver	2.569	13.684	54.757	26.458	1.137
	Gills	1.240	3.210	6.510	5.805	0.240
	Total	1.279	5.904	24.112	11.012	0.610

Knife Fish	Intestine	0.570	3.625	4.720	29.105	1.100
	Muscle	0.570	3.300	4.400	3.515	0.00
	Liver	1.883	10.580	13.432	45.610	0.014
	Gills	0.908	14.694	14.250	32.938	2.361
	Total	0.983	8.049	9.201	27.792	0.868
Hong Kong	Intestine	0.747	10.178	11.953	32.603	0.947
	Muscle	0.655	35.882	33.572	24.987	0.231
	Liver	0.645	4.095	4.650	8.565	0.360
	Gills	0.208	13.021	8.871	15.007	0.005
	Total	0.564	15.794	14.762	20.291	0.385
Tilapia Fish	Intestine	0.930	6.345	4.080	50.120	2.100
	Muscle	0.00	5.954	4.397	56.844	0.00
	Liver	0.078	7.237	4.199	11.754	0.219
	Gills	0.00	7.030	3.820	59.195	0.300
	Total	0.252	6.642	4.124	44.478	0.654
Mud fish	Intestine	0.00	8.211	6.984	3.268	0.00
	Muscle	0.00	3.710	3.660	2.270	0.00
	Liver	0.00	25.780	17.978	103.306	0.00
	Gills	0.00	11.130	7.540	10.992	0.00
	Total	0.000	12.208	9.041	29.959	0.00
FAO/WHO permissible level (mg/kg)		0.5	0.40	0.1	0.5	0.4

Discussion

The analysis of heavy metal concentrations in various fish species, reveals significant insights into the bioaccumulation of these contaminants in aquatic ecosystems. The highest, mercury concentration was found in the liver of African Sharptooth Catfish (2.569 mg/kg), while it was undetectable in Mud Fish. This finding correlates with existing literature that indicates certain fish species, particularly those higher in the food chain and with longer lifespans, tend to bioaccumulate heavy metals more efficiently due to their feeding habits and metabolic processes (Mansour &Sidky, 2012). In this research, the liver serves as a primary organ for detoxification, accumulating contaminants over time, thereby presenting the highest concentrations.

The study revealed that lead was most concentrated in the muscle of Hong Kong, Tilapia Fish (35.882 mg/kg) and the liver of Mud Fish (25.780 mg/kg). Lead exposure in aquatic organisms typically originates from anthropogenic sources, such as industrial discharge and urban runoff (Miller et al., 2010). Elevated lead levels are indicative of industrial effluent discharge into aquatic systems, as also supported by the findings of Vinodhini and Narayanan (2008). The muscle tissues being the highest in concentration may pose a significant risk to human health upon consumption, as this is the primary edible part of the fish. The elevated levels of lead in these species underscore the necessity of monitoring local water bodies for pollutants to mitigate human exposure.

Cadmium concentrations peaked in the liver of African Sharptooth Catfish (54.757 mg/kg), which aligns with previous studies indicating that cadmium tends to accumulate in the liver and kidneys of fish (Sadiq et al., 2009). The notable concentrations in the intestines also highlight the potential for uptake through dietary sources.

Iron concentrations were highest in the liver of Mud Fish (103.306 mg/kg), suggesting that this species may be particularly involved in the pedogenesis of iron in aquatic environments. Excessive iron levels in aquatic systems often result from agricultural runoff and industrial discharges, as described by Adeyemi et al. (2010). Interestingly, the low levels of copper across all fish, with a maximum of 2.361 mg/kg in the gills of Knife Fish, may indicate a lower bioavailability of this metal in the local ecosystem or effective regulation mechanisms within fish species to manage copper levels (Nriagu&Pacyna, 2008). Despite being an essential trace element, elevated copper concentrations can disrupt aquatic life and cause gastrointestinal distress in humans (USEPA, 2018).

The statistical analysis revealing no significant differences in metal concentrations across organs suggests a uniform distribution of metals throughout the fish tissues, rather than a specific organ holding more concentrated levels. Such findings are important for understanding the overall burden of heavy metals.

This study into the heavy metal concentrations in various fish species elucidates significant health concerns for both consumers and ecosystems. By comparing the concentrations of mercury, lead, cadmium, iron, and copper in fish to the permissible limits established by the FAO/WHO, it becomes evident that a substantial number of fish species pose potential health risks.

Mercury concentrations in the intestine, muscle, and gills of most species remained below the permissible limit of 0.5 mg/kg. However, the alarming levels detected in the liver of African Sharptooth Catfish (2.569 mg/kg) and Knife Fish (1.883 mg/kg) signify an accumulation of mercury in a critical organ. The liver's function in detoxification raises concerns about its capacity to handle such levels of mercury, as chronic exposure could resonate with serious health conditions, including neurological disorders (Zhang et al., 2021). Lead concentrations presented an even more pressing issue, consistently exceeding the permissible level of 0.4 mg/kg across nearly all fish species examined. The particularly high lead concentration in the liver of Mud Fish (25.780 mg/kg) is alarming. Chronic exposure to lead has been documented to adversely affect various physiological systems in humans, including the nervous and renal systems, and is known to pose substantial developmental risks in children (World Health Organization, 2019). Similarly, cadmium concentrations surpassed permissible limits in all organs for all species analyzed. The exceptionally high levels found in the liver of African Sharptooth Catfish (54.757 mg/kg) illustrate an urgent risk, as cadmium is a known carcinogen and can lead to kidney damage and bone disease (Nriagu, 2018). Given that cadmium bioaccumulates in organisms and is persistent in the environment, this is a serious concern for both aquatic life and human health. Iron levels also raised questions regarding health implications, with concentrations exceeding the permissible level of 0.5 mg/kg in all organs across the fish species studied. Given that excess iron can lead to conditions such as hemochromatosis and other iron overload syndromes (Bishop et al., 2020), the findings prompt scrutiny into dietary recommendations and consumption patterns of fish, particularly for populations reliant on these protein sources.

Conclusion

In conclusion, this is a research on determining heavy metals in fishes from Oguta Lake in Imo state. This study assessed the concentration of heavy metals mercury, lead, cadmium, iron, and copper in various organs of five [5] fish species (African Sharptooth Catfish, Mud Fish, Hong Kong, Tilapia Fish and Knife Fish) collected from the lake, indicating potential contamination that could arise from industrial activities, agricultural runoff, and inadequate waste disposal. These metals are known to pose significant health risks, including neurotoxicity, renal failure, and various cancers, underscoring the urgent need for public health awareness and intervention.

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