ORIGINAL ARTICLE

ASSESSMENT OF BIOACCUMULATION OF SOME HEAVY METALS IN *TILAPIA ZILLI* AND *CLARIAS ANGUILLARIS* FROM WUDIL RIVER, KANO-NIGERIA

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ABSTRACT

Background: Heavy metals are metallic chemical elements with a relatively density and toxic or poisonous to health because they are not degraded by the living body, hence, tends to accumulate over time. **Objectives**: This study was undertaken to determine the levels or concentrations of some heavy metals; Lead (Pb), Nickel (Ni), Cadmium (Cd), Iron (Fe) and Zinc (Zn) in the two (2) fish species; *Tilapia zilli* and *Clarias anguillaris* with weight of 95.00g and 98.98g respectively, obtained from Wudil-river, Kano-Nigeria. **Methods**: The mean concentrations of the heavy metals present were determined using PerkinElmer Analyst 300 Atomic Absorption Spectroscopy (AAS). A calibration plot of absorbance against concentration of each element under investigation was constructed and finally the concentration of each element was determined from calibration curve by extrapolation. **Results**: The results of this work indicated that the concentrations of (Pb) was found to be 0.34 $mgdm^{-3}$, (Ni) 1.15 $mgdm^{-3}$, (Cd) 1.42 $mgdm^{-3}$, (Fe) 1.42 $mgdm^{-3}$, and (Zn) 1.20 $mgdm^{-3}$ in *Tilapia zilli*, while, (Pb) concentrations in *Clarias anguillaris* was found to be 0.30 $mgdm^{-3}$, (Ni) 2.01 $mgdm^{-3}$, (Cd) 1.14 $mgdm^{-3}$, (Fe) 2.42 $mgdm^{-3}$, and (Zn) 1.30 $mgdm^{-3}$ respectively. The concentrations of Pb, Ni, Cd, and Fe in both specie of fishes were above the permissible limits of 0.05mg/dm^3, 0.02mg/dm^3, 0.80mg/dm^3 0.30mg/dm^3 respectively as recorded by United States Environmental Protection Agency (USEPA) and World Health Organization (WHO). However, (Zn) concentrations in two fishes were found to be below the permissible limits of 2.91mg/dm^3 sets for heavy metals by the above named organizations. **Conclusion**: Therefore, the results of this work revealed clearly that the concentration of Pb, Ni, Cd, and Fe accumulated in the two fishes may be toxic or detrimental to health, since above the tolerable or permissible limits.

Keywords: Fish species, Concentrations, Permissible limits, Results, Absorbance, Cadmium

1. INTRODUCTION

A fish is any member of prophylactic group of organisms that consist of all gills bearing craniates aquatic animals that lacks limbs with digits. Most fishes are ectothermic (cold blooded) allowing their body temperatures to vary as ambient temperature change, through some of the largest active swimmers like white shark and tuna can hold a higher core temperature [1]. They are found in most bodies of water and nearly all aquatic environments, from high mountains streams to the abyssal and even hadal depth of the deepest oceans [2]. Fish exhibit greater diversity than any other group of vertebrates. They are important resource for both income and food to humans worldwide.

Heavy metals are natural components of the Earth's crust. They are not usually degraded or destroyed, but, to a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning. Some heavy metals such as Lead, Cadmium (Cd) and Mercury (Hg) usually resulted into impaired kidney function, poor reproduction capacity, hypertension, tumours and hepatic dysfunction [3].

Goodwin et al. (2003) showed that the bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemicals concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted[4].Fishes accumulate toxic chemicals such as heavy metals directly from water and diet, and contaminant residues may ultimately reach concentrations of hundreds or thousands of times above those measured in the water, sediment and the food.

Heavy metals are normal constituents of marine environment that occur as a result of pollution principally due to the discharge of untreated wastes into rivers by many industries and also as a result of some agricultural practices. Bioaccumulation these heavy metals in tissues of marine organisms has been identified as an indirect measure of the abundance and availability of the metals in marine environment [5]. For this reason, monitoring fish's tissue contamination serves an important function as an early warning indicator of sediment contamination or related water quality problem. Therefore, it provides a means of taking appropriate action to protect public health and the environment. Multiple factors including season, physical and chemical properties of water can also play a significant role in heavy metals accumulation in different fish species.

Several studies have also indicated that fishes are able to accumulate and retain heavy metals from their environment depending upon exposure, concentration and duration as well as salinity, temperature, hardness and metabolism of the animals [6]. Adeyeye et al. (1996) reported also that the concentration of heavy metals was a function of fish species as it accumulates more in some fish species than others [7].

Hence, fish species have been the most popular choice as test organisms for toxic or heavy metals because they are presumably the best understood organisms in the aquatic environment [8], and also due to their importance to man as a protein source. Therefore, this study is undertaken to determine, asses or analyze the bioaccumulation of heavy metals in some fish species.

2. MATERIALS AND METHODS

2.1 Sampling area and sample collection: Five fresh samples each of *Tilapia zilli* and *Clarias anguillaris* were collected from river Wudil in Wudil Local Government Area Kano-Nigeria. The fishes were labeled with an identification number. All Samples of the fish were transported to the laboratory in a polythene bag on the same day for analysis.

2.2 Sample preparation: The samples of each fish were dried in an oven at 65°C and were grounded into powder using porcelain mortar and pestle. Each sample was stored in an air tight container before the analysis. All samples were analyzed in triplicate and the mean values recorded.

2.3 Study site and period of conducted study: The research was conducted in the central laboratory, Bayero University, Kano for the period of thirty days (30 days).

2.4 Procedure: 5.0g portion each of the grounded fish samples were transferred into Kjeldahl flask and 50dm^3 of HNO_3 and 5dm^3 $HClO_4$ mixture was added. The mixture was swirled and the digestion was carried-out in a fume cupboard on a hot plate until the liquor becomes clear after the disappearance of brown fumes of NO_2. All digested liquors or solutions were cooled and filtered using Whatman NO.1 filter paper and diluted with 0.2% HNO_3 [9]. Blank solutions were also prepared. Each solution was analyzed for Lead (Pb), Nickel (Ni), Cadmium (Cd), Iron (Fe) and Zinc (Zn) using PerkinElmer Analyst 300 Atomic Absorption Spectroscopy (AAS). A calibration plot of absorbance against concentration of each element under investigation was constructed and finally the concentration of each element was determined from calibration curve by extrapolation.

2.4 Statistical analysis: Data was presented as mean values of triplicate measurement [10].

3. RESULTS

Assessment of bioaccumulation of some heavy metals was studied in *Tilapia zilli* and *Clarias anguillaris*. High concentrations of Lead (Pb), Nickel (Ni), Cadmium (Cd) and Iron (Fe) which is above tolerable limits was recorded for the two (2) fish species. However, the level of Zinc (Zn) is below the permissible limits in both species. The results were depicted in table 1.

Table 1: The mean concentrations of some heavy metals in *Tilapia zilli* and *Clarias anguillaris.*

	Concentrations of heavy metals (mg/dm^3)				
Fish species	**Lead (Pb)**	**Nickel (Ni)**	**Cadmium (Cd)**	**Iron (Fe)**	**Zinc (Zn)**
Tilapia zilli	0.34	1.15	1.42	1.42	1.20
Clarias anguillaris	0.30	2.01	1.14	2.42	1.30

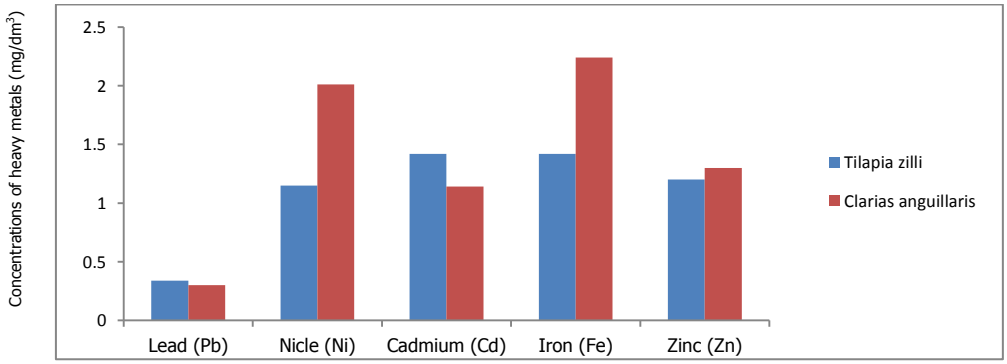

Figure 1: The figure presents the bioaccumulation of heavy metals in *Tilapia zilli and Clarias anguillaris.*

4. DISCUSSION

The study was carried-out to ascertain the bioaccumulation of some heavy metals in *Tilapia zilli* and *Clarias anguillaris.* The mean concentrations of lead (Pb) in the two (2) fish samples analyzed were found to be 0.34mg/dm^3 in *Tilapia zilli* and 0.30mg/dm^3 C*larias anguillaris*. The levels of the Pb in both fish species are above the tolerable limits of 0.05mg/dm^3 estimated by [11]. This may be due to the presence of a higher concentration of lead which usually occurs in the surface soil at depth of 1.5cm, this is in agreement with the finding of [12]. The observed bioaccumulation pattern in all the fish samples analyzed may be due to wide distribution of lead in the earth's crust, as a result of its frequent use in lead acid batteries, solder, rust inhibitors and plastic stabilizers [13]. Lead is classified as one of the most toxic heavy metals. The principle transporter of lead from intestine to various body tissues is the hemoglobin [14]. Acute lead poisoning in man causes severe dysfunction of kidney, reproductive systems, liver, brain and central nervous systems [15]. Thus, samples are not safe for human consumption.

The mean nickel (Ni) concentrations of 1.15 mg/dm3 in *Tilapia zilli* and 2.01mg/dm3 from C*larias anguillaris* determined were much higher than the tolerable limit value of 0.02mg/dm^3 recorded by [16]. Ni is a skin allergen, it penetrates the skin very slowly and appears distributed to all organs, primarily the heart, kidneys, lungs and liver [17]. The major sources of Ni uptake are from natural source, as well as processed foods. Increased incidence of cancer of the lung and nasal cavity caused by high intake of Ni has been also been reported in workers in Ni smelters. When ingested, it also resulted into reproductive and developmental abnormalities [18].
The mean levels of Cadmium (Cd) were observed to be 1.42mg/dm^3 and 1.14mg/dm^3 in *Tilapia zilli* and *Clarias anguillaris* respectively. The concentrations were above the maximum guideline of 0.80mg /dm^3 [19]. The results obtained were not in agreement with the report of [20]. There is no known nutritive value of Cadmium; high intake of Cadmium can lead to kidney damage [21].Cd toxic level is tenth times higher than that of Pb and mercury, leading to heart diseases (such as hypertension), cancer, diabetes, inhibits methylation of phospholipids (interferes cellular membrane function) and nerve cell damage, particularly the nerve fiber [22].The source of Cd in humans is through food consumption.
The mean Iron (Fe) concentrations revealed to be1.42mg/dm^3 from *tilapia zilli* and 2.42mg/dm^3 in *Clarias anguillaris.* The levels obtained were above the maximum permissible limit of 0.30mg/dm^3 recorded by [10]. Fe is an essential element in human diet. It forms part of hemoglobin, which allows oxygen to be carried from the lungs to the tissues. Severe Fe deficiency causes anemia, hypovolemic shock due to iron potent ability to dilate blood vessels [23].
Mean Zinc levels of 1.20mg/dm^3 realized from *Tilapia zilli* and 1.30mg/dm^3 in *Clarias anguilaris* were below the maximum permissible limit of 2.91mg/dm^3 observed by [15]. Zinc is an essential element; fish do not accumulate levels that are likely to be toxic to animals and humans. This is in comparison with the finding of [24]. Zinc deficiency is very rare in humans and some of its symptoms are retarded growth, bone demineralization and depigmentation of the skin [25].
Figure 1 showed clearly the differences in the concentration of the heavy metals assessed from *Tilapia zilli* and *Clarias anguillaris.* Highest levels of Pb and Cd were recorded in *Tilapia zilli*, while that of Ni and Fe were observed in *Clarias anguillaris*.
Fish species were obtained from only one location in the river and also triplicate measurement was considered during the study instead of a higher measurement, thus, they may be regarded as a the limitations or shortcomings that affect the findings of the research study.

5. CONCLUSION

The assessment for bioaccumulation of the heavy metals in *Tilapia zilli* and *Clarias anguillaris* showed that the concentrations of Pb, Ni, Cd, and Fe were above the permissible or tolerable limits. The accumulated of heavy metals(Pb, Ni, Cd, and Fe) in the two (2) fish species may be as a result of aquatic nature of the environment, industrial effluents, sewages, indiscriminate use of pesticides, fungicides, algaecides and other chemicals used during farming and fishing activities. However, Zn levels in both species of the fish indicated or were below the tolerable limits. Therefore, the results of this research have revealed that; the two (2) fish species (*Tilapia zilli* and *Clarias anguillaris*) accumulated higher levels of Pb, Ni, Cd and Fe which is above tolerable limits. Hence, consuming fishes and other animals from such aquatic body may be toxic to health.

Recommendations: Further analysis should be undertaken on heavy metals with regard to the water and even the vegetables (plants) grown or cultivated by the river sites. Also, awareness and laws should be established against indiscriminate activities such as disposal of sewages and industrial effluents into the water bodies, burning of harmful substances on the water (river) banks and the use of excessive chemicals during fishing and irrigation.

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