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Fish Abundance, Heavy Metal Concentration and Histopathological Profile of Fishes at Okobaba, Lagos State

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ABSTRACT

Potentially dangerous substances such as pesticides, heavy metals, and hydrochemicals are often indiscriminately disposed into the aquatic environment from the anthropogenic activities of man. This study aimed at investigating fish distribution, abundance and evaluate the concentration of heavy metals (lead, copper, zinc, and iron) in water samples from three different points (Okobaba water shore, under third mainland bridge and beyond third mainland bridge) and in the dominant fish (*Sarothredron melantheron*) from the study area. Abundance value ranged between 3 and 220 with the least abundant specie (3) being *Lates niloticu*s, while the most abundant specie (220) was *Sarotherodon melanotheron*. The percentage of abundance of *Sarotherodon melanotheron* is 19.30%, while the percentage abundance of *Lates niloticu*s is 0.26%. Histopathological parameters of the selected fish species were examined. The results were compared to the World Health Organization (WHO) acceptable limit. The concentrations of the heavy metals were analyzed using Perkin Atomic Absorption Spectrophotometer (AAS). *O. mossambicus* had 2.21±0.02, 3.34±0.04, 2.32±0.02, 0.57±0.01 mg kg-1 as the mean concentration of these metals in the tissues of these fishes. The gills have higher concentration of the metals compared to other organs. Each heavy metal mean concentration varied significantly ($p<0.05$) with the fish species. Histological analysis shows vacuolation of hepatocytes, inflammation, and necrosis in the tissues. In the muscle, there was a mild lesion, necrosis, inflammation, and cellular degenerations. The level of tissue and organ degeneration were more pronounced in the gills. The study showed that these metals have detrimental effects on the tissues and organs examined. It can be concluded that Okobaba area of Lagos Lagoon water body and fishes are heavily contaminated with heavy metals**.**

Keywords:
Fish richness, diversity, heavy metals, concentration, physiological profile

Introduction

The aquatic environment is particularly becoming a reservoir of wastes from industries, urbanization and agriculture. Studies shows there has been presence of heavy metal contaminant in aquatic organisms. These metals build up in the food chain causing adverse effects and death in the aquatic organisms. Heavy metals are non-degradable and can remain in aquatic environments and their organisms (Mathias K.K *et al*., 2014). According to WHO, metal occur in less than 1% of the earth's crust, with trace amounts generally found in the environment and when these concentrations exceed a

stipulated limit, they may become toxic to the surrounding environment. Their presence is as a result of natural and anthropogenic activities of humans. Environmentally, coastal areas serve as reservoir of these metals from industrial activities, agricultural runoff, and other anthropic activities. Heavy metals are harmful and their bioaccumulation in the food chain leads to diseases in humans. (Krishna P.V *et al*., 2014).

Inland aquatic fauna is constituted by fishes and are rank very high as a source of proteins. Basic scientific information on biodiversity is vital for sustained exploitation and conservation of fisheries resoirces(Pawar *et al.*,2009). Concerns regarding over-pollution of aquatic ecosystems have caused major health and environmental problems (Ayola and Aina, 2017). Pollutants accumulate at higher amounts in aquatic organisms' tissues than in the environment. When chemicals, particularly parent compounds, are exposed to aquatic creatures, they can create a wide range of issues including loss of biodiversity.

Relative species abundance describes how common or rare a species is in relative to other species in a given community and usually described for single trophic level (Adadu M.O *et al*.,2019). Species richness and relative abundance are a key element of biodiversity. Lawson and Olusanya (2010) reported that species richness relates to the number of different species in a given area and it is the fundamental unit used to access homogeneity of an environment. The declining rate of fisheries resources in Nigeria due to over exploitation and inadequate management of the coastal waters is becoming alarming (Ayamre and Ekelemu 2016). For sustainability of these resources, an adequate knowledge of species composition and its abundance must be understood and actively pursued.
Heavy metal contamination of aquatic environments is of critical concern due to potential detrimental effects both directly within foodwebs of impacted systems, as well as obvious linkages to human health concerns associated with contaminated drinking water and fish supplies. Remediation remains a key challenge due to incomplete understanding of the complex behaviour of metals in aquatic systems. Metals can exist in a variety of forms in water, not all of which are equally toxic, mobile, or bioavailable. Further, metal associations are dynamic and reversible, reflecting changing physico-chemical conditions. Therefore, this study aims to investigate the fish abundance, the distribution and concentration of some heavy metals (Pb, Cu, Zn and Fe) in the tissues of the dominant fish species at the study sites.

Materials and Method

Description of study site

The study was carried out at Okobaba, Lagos Mainland, Lagos, Nigeria, with a geographical coordinates of latitude 6° 29' 43" north and longitude 3° 23' 41" east and it is a developing community located at the foot of the Third Mainland Bridge.Three stations where selected in proximity to the Okobaba community. Okobaba water shore (Nearest to the sawmill) as Station (1), Under Third Mainland bridge as Station (2), Beyond third Mainland Bridge Station 3(Elijah and Elegbede, 2015).

Collections of fish sample: The fish samples used for the study were obtained from fishermen operating along Okobaba area of the lagoon. The fish samples were transported to the laboratory in ice boxes and stored at -20ºC for analysis.

Collection of water samples: Water samples were collected between 09.00 to 11.00 am over a period of six months at each of the three stations. Water sample were collected in plastic bottle. The plastic containers were labelled appropriately and transported to the laboratory for analysis. Temperature and pH were recorded in situ at the time of sample collection using Horiba-U.

Determination of Fish Abundance and Diversity at the study site

(i) **Margalef's Diversity Index (d):** $d = S - 1/LnN$

Where: d = Species richness index S = Number of species in a population N = Total number of individuals in S species. (Clifford and Stephenson 1975)

(ii) **Shannon-Wiener Diversity Index (H′):**

$$H' = -\sum(Ni/N) \times \ln(Ni/N)$$

(iii) Where Ni = number of individuals or quantity of each species (the i th species) N = total number of individuals for the site.(Magurran, 2004)

Heavy metals: The heavy metals were determined on Principle of operation of Atomic Absorption Spectrometer using flame ionization dectector (FID). A series of standard solutions for each metal ions was prepared using deionized distilled water and stock solutions (1000mg/kg).The Buck Scientific Atomic Absorption spectrometer Model 210 VGP was use for this analysis.

Histopathology: The fish samples dissected and muscle, liver, kidney and gills were collected and fixed in 10% formalin for the histopathology analysis.

Statistical analysis: Data were analyzed with SPSS 20.0 for windows. The data were analyzed by t-test for significance difference in the concentrations of the selected heavy metals for the six months (April- September) while one-way analysis of variance (ANOVA)was used to test for significance differences in the concentrations of heavy metals between different sampling sites ($P < 0.05$).

Results

Physicochemical parameters

Table 1: Mean and standard deviation values for physicochemical parameters of the surface water at Okobaba water shore (Station 1), Under Third Mainland bridge as Station (2), Beyond third Mainland Bridge Station (3) in Lagos lagoon (April -September 2021).

PARAMETERS	MEAN	STANDARD DEVIATION
Air Temperature(°C)	28.03	0.81
Water temperature(°C)	29.1	2.17
Transparency(cm)	98.51	29.70

PH	6.69	0.54
Conductivity (µS/cm)	13.4	4.15
Total Dissolved Solids mg/L	1	0.00
Salinity (ppt ‰)	10.98	3.96
Copper(mg/kg)	0.03	0.01
Iron(mg/kg)	0.02	0.O2
Lead (mg/kg)	0.02	0.01
Zinc(mg/kg)	0.09	0.03

Heavy metals

Table 2. Fish species, Abundance, Abundance percentage (%), Biomass (%) and Biomass percentage(%) values of Okobaba water in Lagos lagoon (April -September).

Family	Species	Abundance	% Abundance	Biomass (g)	% Biomass
Bagridae	*Chrysicthys nigroditatus*	129	11.32	18585	8.81
Carangidae	*Tranchinotus goreensis*	15	1.32	1795	0.85
Centropomidae	*Lates niloticus*	3	0.26		0.00
Characidea	*Alestes fasciatus*	25	2.19	2310	1.10
	Alestes baremos	19	1.67	475	0.23
Cichlid	*Hermichromis fasciatus*	30	2.63	5820	2.76
	Sarotherodon melanotheron	220	19.30	4285	2.03
Cluoeidae	*Ethmalosa fimbriata*	93	8.16	5915	2.81
Cynogglossidae	*Cynoglossus senegalensis*	50	4.39	7415	3.52
Drepanidae	*Drepane Africana*	18	1.75	715	0.34
Gymnarchidae	*Gymnarchus*	20	1.75	26315	12.48
	Hepsetus odoe	26	2.28	3630	1.72
Hepsetidae	*Papyrocranus afer*	12	1.05	5200	2.47
Haemulidae	*Brachydeuterus auritus*	69	6.05	8115	0.34
Lutjanidae	*Lutjnus goreensis*	9	0.79	4820	2.29
Malapteridae	*malapterurus electricus*	17	1.49	915	0.43

Mochokidea	*Synodontis niloticus*	74	6.49	6430	3.05
	Synodontis membranous	86	7.54	7120	3.38
	Synodontis Claris	5	0.44	215	0.10
Mulgilidae	*Mugil cephalus*	58	5.09	4550	2.16
Osteodlossidae	*Heterotis niloticus*	32	1.75	15350	7.28
Pomadasydae	*Papyrocranus afer*	20	1.75	5200	2.47
Sphyaenidae	*Sphyraena piscatorium*	98	8.60	74320	35.25
Trichiuridae	*Trichiurus lepturus*	12	1.05	1350	0.64

Histopathology

The concentration of copper in the organs of tilapia fish are higher in gill in order of 0.71>0.66>0.60>0.35 (gill>liver>kidney>muscle). The concentration of lead in the organs of tilapia fish are higher in gill in order of 1.21>0.90>0.62>0.28 (gill>kidney>liver>muscle). The concentration of zinc in the organs of tilapia fish are higher in gill in order of 2.96>2.41>1.60>0.97 (gill>kidney>liver>muscle). The concentration of Iron in the organs of tilapia fish are higher in gill in order of 1.12>0.62>0.46>0.32 (gill>kidney>liver>muscle).

Table 3: Mean and standard deviation values for Histopatological profile fishes for Tilapia fishes (*Sarotherodon melanotheron*) caught from okobaba water (April -September).

	GILLS	**KIDNEY**	**LIVER**	**MUSCLE**
Lead	2.51±0.02	0.64±0.02	0.60±0.01	0.10±0.01
Zinc	3.47±0.04	2.77±0.02	1.20±0.06	0.72±0.04
Copper	0.71±0.01	0.68±0.01	0.42±0.03	0.46±0.10
Iron	55.52±60.53	199.61±91.03	90.82±120.25	150.98±90.35

Discussion

Wastes from numerous activities surrounding the study site, such as fishing, saw milling and burning of wood wastes are extensively contaminating Okobaba area of the Lagos Lagoon. The physical and chemical analysis of water is a significant aspect in determining the water's quality. The result revealed that the dissolved oxygen levels were low at the sites, particularly at Okobaba lake shore, which is directly adjacent to the saw mill. This graphic depicts the level of contamination produced by the discharge of wood waste in this lagoon area. It is safe to presume that there will be decline in the population and variesties of aerobic life in this area of the water body based. Low dissolved oxygen

concentration is recognized as a major cause of stress, poor appetite, slow growth, disease susceptibility and mortality in aquaculture animals (Boyd and Terry 2010). When the DO concentration gets below 5-6 mg/L in fresh water, then the required level of an aquatic organism gets in hypoxic condition (Dong et al., 2011). The Anoxia and hypoxia are known to be a primary cause of stress, poor appetite, slow growth, illness susceptibility, and mortality (Timmons et al., 2001) can create a large reduction in abundance, diversity and harvest of fishes within affected water (Breitburg, 2002).

The fish with the highest species distribution and abundance in the three stations was *Sarotherodon melanotheron* with the index of 220 and *Lates niloticus* having the least index of 3. The high occurrence of *Sarotherodon melanotheron* could be due to their ability to remove accumulated copper and zinc in their chair as they grow and become bigger as its was observed by Arthur *et al*..,2015.
Heavy metals were found in significant concentrations in water and fish samples obtained from the study area. According to Ayoola and Aina (2017), the amounts of heavy metals in the samples were well associated with the concentrations of metals seen in the water samples, and the findings of the analyses offered significant quantitative information. Heavy metal and its derivatives are the most widely dispersed. Long-term exposure to very toxic pollutant compounds, even at low concentrations, has been linked to a variety of health problems (Omogoriola and Ayoola, 2017).

This work introduces crucial Okobaba pollution indicators since it clearly exposes the stress exposure of the fish that reside there and appears to fully explain the preponderance of lesions identified, which are linked to detected heavy metal levels as told in the Ologe, Ayoola and Aina Lagoon (2017).
The concentration of copper in the organs of tilapia fish are higher in gill in order of 0.71>0.66>0.60>0.35 (gill>liver>kidney>muscle). The concentration of lead in the organs of tilapia fish are higher in gill in order of 1.21>0.90>0.62>0.28 (gill>kidney>liver>muscle). The concentration of zinc in the organs of tilapia fish are higher in gill in order of 2.96>2.41>1.60>0.97 (gill>kidney>liver>muscle). The concentration of Iron in the organs of tilapia fish are higher in gill in order of 1.12>0.62>0.46>0.32 (gill>kidney>liver>muscle). Metal concentrations in muscle are low, but liver and gill concentrations are relatively higher, which can combine with other contaminants like ammonia and mercury to cause addictive effects in fish, as Cengiz and Unlu (2002) demonstrated in histopathological changes in the gills of different species of fish exposed to pollutants.

The histological analysis of fish tissues and organs (gill, muscle and liver) demonstrated a harmful effect. In the histological examination of tissues, there was vacuolation of hepatocytes, inflammation, and necrosis. In the muscle, there was a tiny lesion, necrosis, inflammation, and cell degeneration. The severity of tissue and organ degeneration in gills, on the other hand, is greater. Brad's (2002) findings are in line with this. Histopathological abnormalities in the gills and liver, such as those identified in this and other studies might cause serious physiological problems in the fish, leading to death. According to histopathological results, the gills are the primary target tissues for contaminants.

Conclusion

In this study, heavy metal concentrations were below the maximum levels recommended by regulatory agencies and, depending on daily intake by consumers, might represent no risk for human health. Finally, it is recommended that a long-term continuous monitoring to check metals pollution, in order to control of metal in water and fish, control and assessment of the metal content in water of coastal

zones area which are supplied by pollution from industrial activities, agricultural runoff, and other anthropic activities.

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