Innovations

Heavy metals content of some benthopelagic and demersal fish species in selected wetlands in Lagos Nigeria

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Abstract

This study investigated the concentrations of heavy metals in some fish species in wetlands in Lagos for their suitability for local human consumption and for export. It was an ex-post facto research that answered 4 research questions and tested a hypothesis. To achieve these 5 wetlands were randomly selected in Lagos City, and 3 species of fish were sampled from 5 sample sites in each wetland which were bulked and composite drawn and stored in ice-cooled flask kept at -20°C for analysis. The analytical standard adopted was EPA 6020B and instrument of determination deployed is Agilent AAS model 240FSAA. The grand mean results obtained were; Cd; 0.08±0.03mg/kg, Cr; 0.08±0.02mg/kg, Hg; 0.04 mg/kg, As; 0.06±0.01 mg/kg and V; 0.06±0.00 mg/kg. The grand mean results were subjected to test of significance with ANOVA deploying SPSS model 29 at 0.05 level of significance. The p-value was 0.41 thus rejecting Ho. The study concludes that the wetlands are polluted with heavy metals and recommends that: the fishes from the wetlands are not fit for local consumption and are not suitable for export. The wetlands should be remediated and the monitoring agency enjoined to increase their surveillance on the industries operating in Lagos city.

Keywords*: industries, heavy metals, wetlands contamination, fishes bioaccumulation, remediation.*

Introduction

Fish is incontrovertibly one of the most important components of human diet globally that is highly cherished and relished by all classes of humans in different physical and physiological states. Fish is an excellent source of omega 3 it has high protein, and low fat content (Ikundayo *et al*, 2014, Ogwu *et al*., 2022b, Mustafa & Guluzar, 2003). Regular consumption of fish reduces the occurrence or severity of asthma especially in children and also increases their IQ and improves their eye sights (Meche *et al*., 2010, Ogwu, 2021, Ruhman *et al*., 2012). Older people who eat fish regularly are less likely to develop senile dementia, Alzheimer disease and depression (Ogwu *et al*., 2021, Busaide *et al*., 2011, Castro *et al*., 2011, Voegborlo *et al*., 2012). In Ayurvedic medicine, fish is known to be used in the tratemnt of tuberculosis, bronchitis, skin diseases, cough, night blindness and loss of appetite (Zhao *et al*., 2012, Vilmaz *et al*, 2007, Ogwu *et al*., 2020). Fish silage is an important componentin animal nutrition as it contains about 15 percent protein and this makes it very useful in non-ruminant nutrition (Ogwu *et al*., 2021b, Kris-Etherton *et al*., 2002, Moselhy, 2000). Fish flour is a valuable enrichment protein source for breads, cakes and biscuits (Nwaeze *et al*., 2014, Ogwu *et al*., 2022a, Abdallah 2008, Khalid, 2004). Its quano is more effective in soil nutrient status enrichment than poultry dropings and other animal manure (Ogwu *et al*., 2023a, Ogwu *et al*., 2023b, Avenant-Oldewage & Marx, 2000). Glue isinglass are valuable by products of fish (Ogwu 2023C, Abdulhilal & Ismail, 2000, Dhaneesh *et al*., 2012). Ctenopharyngodin idella, Orechromis spp and Puntius gomonotus are useful in the control of weeds in earth ponds (Ogwu, 2023d, Qadir & Malik, 2011, Ahmard *et al*., 2006).

Fish employed 500 million people globally in 2020 as part-time, full time or accoutrement supplier (Ogwu, 2023a, Ogwu *et al*., 2023 b, Gorar *et al*., 2013).

Global fish production in 2022 is 184.6 million metric tons as against 178.1 million metric ton in 2021 (Food and Agricultural Organisation, 2023, World Bank, 2022). Africa contributes 6 percent of global fish production volume(FAO, 2021, WFP, 2022) while Nigeria is the third fish producer in Africa producing 1.1 million metric tons annually (FAO, 2021, African Development Bank, 2021). Lagos State is the highest fish producing state in Nigeria with 174,000 metric tonnes annual production (National Bureau of Statistics, 2020, Ruwani, 2021, Oteriba, 2021).

Lagos is a city of "aquatic splendor"it has several wetlands, it is also the industrial and commercial centre of Nigeria (Ogwu, 2023a, Olagunju, 2020, Agunbiade, 2020). Wetland contamination and pollution resulting from poor effluents management by industries and households is a attaining a global crisis status (arvind, 2002, Kojadinovic, 2007, Yankesy, 2011). Wetlands pollutants from industrial effluents include detergents, microplastics, polyaromatic hydrocarbon (PAHs), petroleum tar, pesticides, heavy metals (Wilson & Pyatt, 2007, Umoren, 2005). Bioavailability of heavy metals will result in bioaccumulation and biomagnification of the metals in aquatic organisms in wetland ecosystems (Singh & Kamal, 2016, Sharma & Tyagi, 2013, Rizwan *et al*., 2011). Heavy metals in humans above the recommended threshold results in various health complications such as cancer, cardiovascular disease, bone degeneration, memory loss amongst others (Obodai *et al*., 2011, Nkasar *et al*., 2010, Mukherjee *et al*., 2006).

The central focus of this study is the assessment of the heavy metals content of some Ubiquitous fish species in Lagos wetland and these are; *Tilapia zilli, Chana obscura, Clarias* spp for their suitability for human consumption and Codex Alimentanus status. The heavy metals evaluated are Cd, Cr, Hg As and V.

The study was guided by research questions as below;

- what are the contents of Cd, Cr, Hg, As and V in the fish tissues in Lagos wetlands?
- are the concentrations of the heavy metals within the maximum permissible concentration for fish (MPC) as recommended by world Health Organisation.
- are fishes harvested and cropped in the wetlands healthy for human consumption
- Can the fish pass Codex Alimentarius rules for agricultural produce export.

Hypothesis

This study was guided by a hypothesis as below;

H0: there is no significant difference between the concentrations of the heavy metals in the fish species in Lagos wetlands and WHO maximum permissible concentration for heavy metals in fish tissues.

Study Area

Lagos is one of the 36 states of the Federal Republic of Nigeria. It was hitherto the capital of Nigeria until 1991 when Abuja became the capital city. It is a state of aquatic splendor with of its areas being sandwiched by wetlands and is the industrial and commercial hub of Nigeria. Lagos lies within the coordinates of 6°5244' N and 3.3792°E, with a land area of 1,171 km^2(Google Search, 2023) and a population of a 15,946000 inhabitants (Lagos Fact Sheet, 2022). The wetlands are the recipients wastes generated by the clusters of industries that dot Lagos land scape and the high population density.

Materials and Methods

Ethical Statement

The fishes samples for this study were collected from the wild. They were neither threatened nor endangered and the ecosystems were not under protection law prohibiting cropping. Therefore no permit was sought from any authority before the samples were collected.

Sampling

The samples collection were carried within six months, August 2022 to January 2023,with the assistance of 5 artisanal fishermen deploying gillnet, seine and cast nets. The fishes species used were *Tilapia zilli, Chana obsura* and *Clarias* spp because they are ubiquitous in Lagos wetlands. The wetlands sampled for the study are Badagry wetland, Epe, Ijegun, Ikorodu and Ojo wetlands. Each wetland was mapped out into 5 sampling sites. (Adebowale, 2020, Abdulmalik, 2021) and study fish species were collected from each sampling site bulked and composites drawn and stored in Agilent ice-cooled flask at – 20°C and taken to the laboratory for analysis.

Analysis

The analytical laboratory used for this study is National Institute for Oceanography and Marine Research (NIOMR), Victoria Island, Lagos, and the analytical standard adopted is the United States Environmental Protection Agency (USEPA) 2020B as described by (Sivakumar & Xiaoyu, 2018). The fish samples were thawed at room temperature and the scales of *C obscura* and *T. zili* removed with stainless steel scapel and dissected with stainless dissecting knife. 1gm of the tissues consisting of the flesh, gills and opaculum were weight out for analysis. The weighted out quantity of the samples were put into a texplan beaker and $HNO_3$65 percent added into the beaker to reduce the pH and prepare the samples for analysis. Agilent microwave model 11636A was used for the digestion of the samples and this was allowed to cool at room temperature and later diluted with double distilled water to 25 ml. The digested samples were then analyzed 3 times for heavy metals: Cd, Cr, Hg, As and V. using Agilent AAS model 240FSAA. The instruments calibration was done using standard solution prepared by Merck Germany multielement standard solution IV/111355/1000 mg/kg

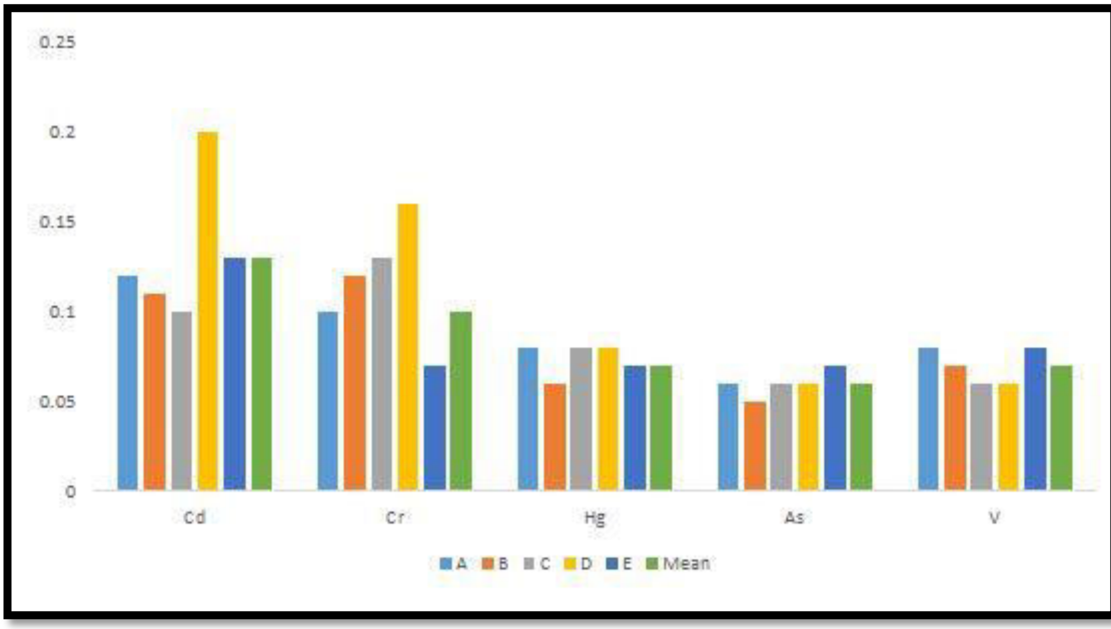
Quality Assurance

Reagents used for the study were of very high quality. Glass wares were soaked in nitric acid for 24 hours and later rinsed with distilled water. They were equally washed in potassium permanganate and again rinsed with distilled water. Occurrences were verified with International Atomic Energy CRM 407 reference material. The result of AAS 240 FSAA in quality control was very satisfactory and gave accurate reading of the metals to the certified grade of 99 to 100 percentage.

Results

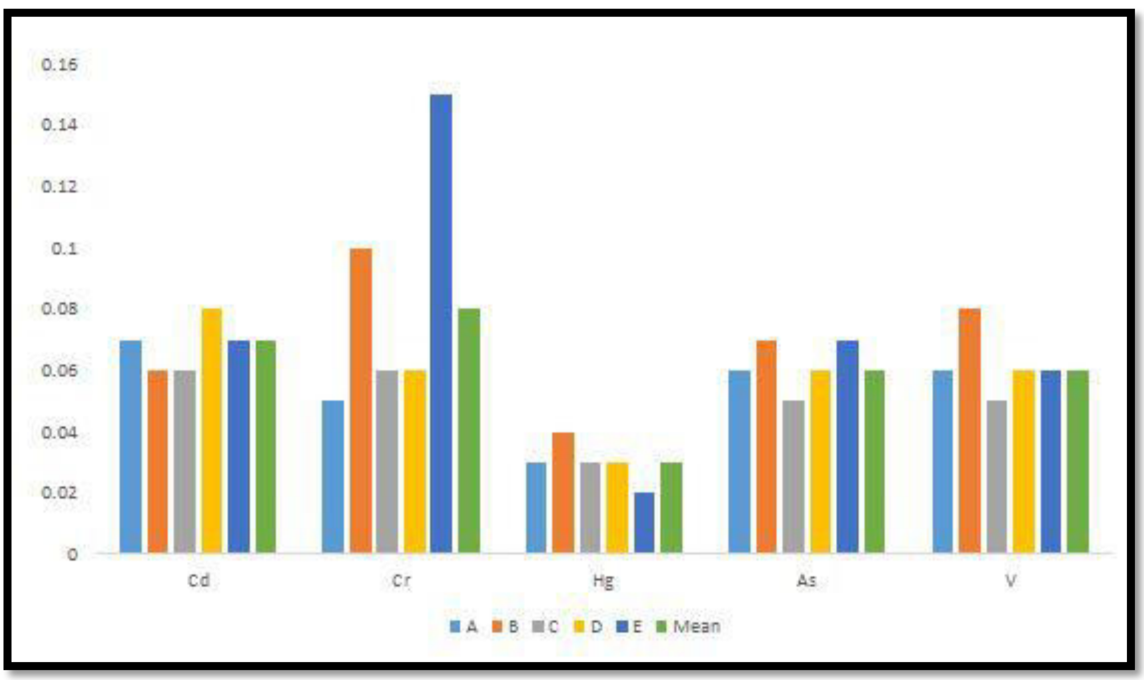
The results of the heavy metals in the fishes species in wetlands in Lagos are as in Figures 2-6 and grand mean concentration of the heavy metals in fishes species in wetlands in Lagos in Figure 7.
Result of heavy metals content of fish species in Badagry are as in Figure 2.

Figure 2: Heavy metals content in fishes species in Badagry wetlands and WHO maximum permissible concentration in mg/kg



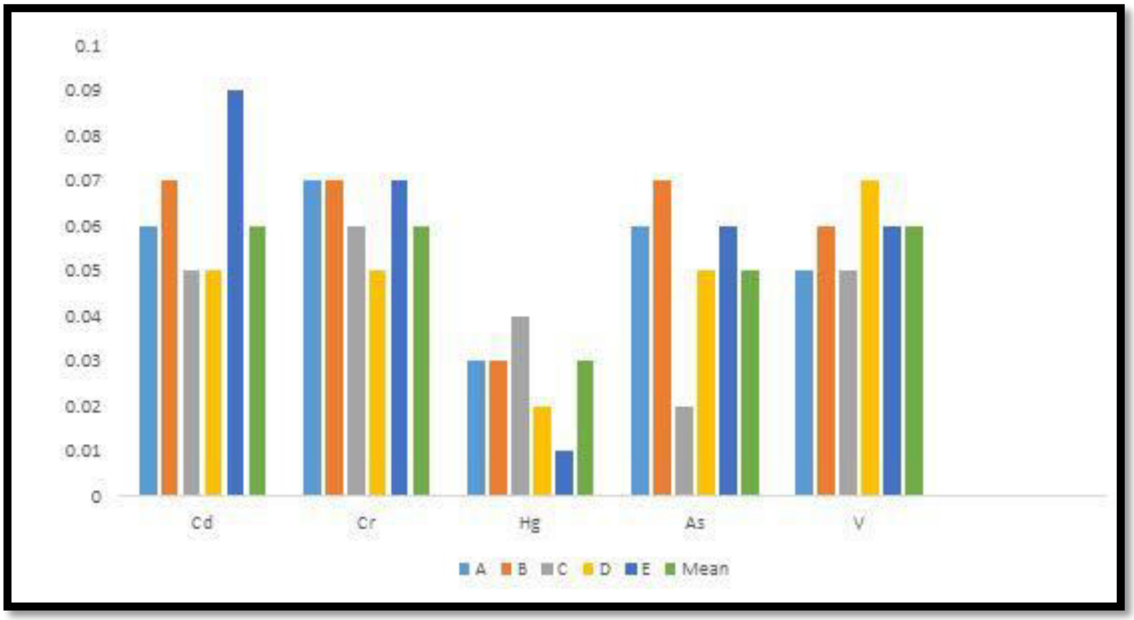
Results of heavy metals content in fish species in Epe wetland are as in Figure 3

Figure 3: heavy metals content in fish in Epe wetland and WHO MPC in mg/kg



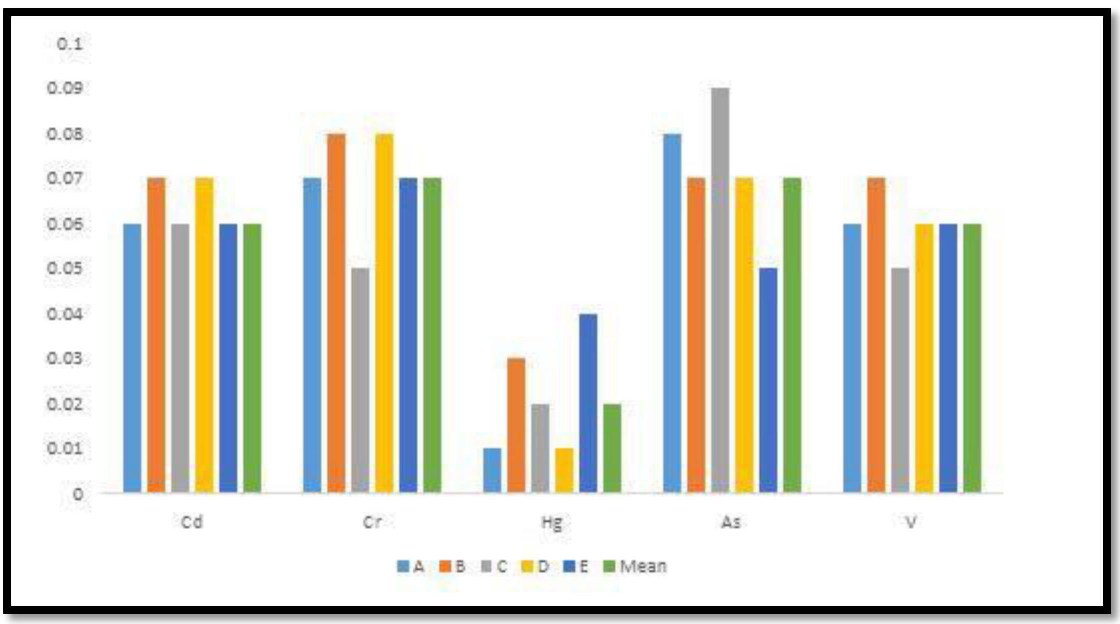
Results of heavy metals content of fish species in Ijegun wetland are as in Figure 4

Figure 4: results of the heavy metals content of fishes species in Ijegun wetland and WHO MPC in mg/kg



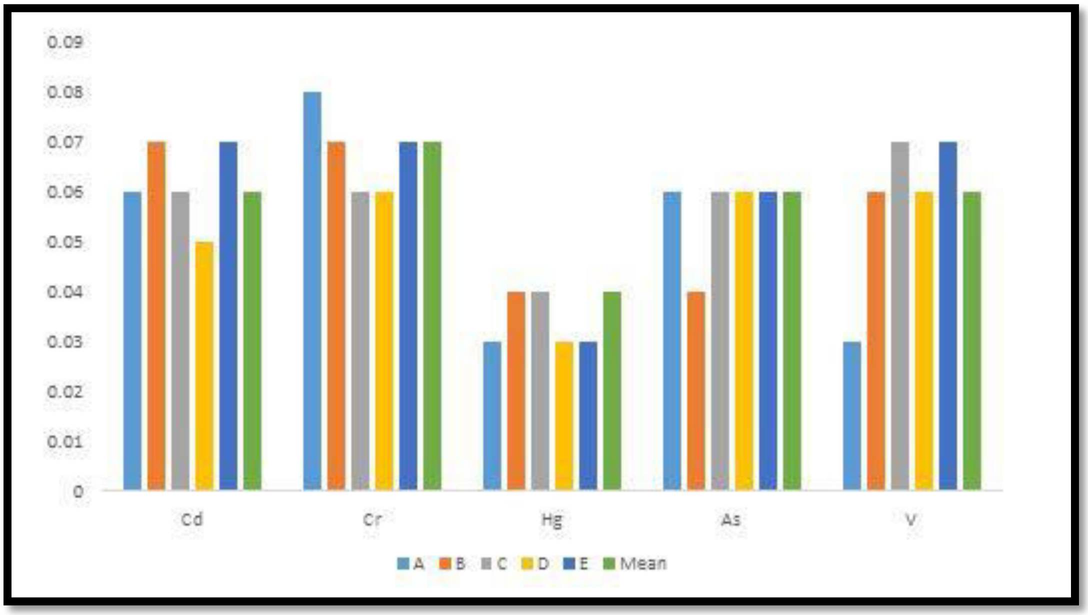
Result of the heavy metals content of fish species in Ikorodu wetlandare as in Figure 5

Figure 5: Results of heavy metals content in fish species in Ikorodu wetland and WHO MPC in mg/kg



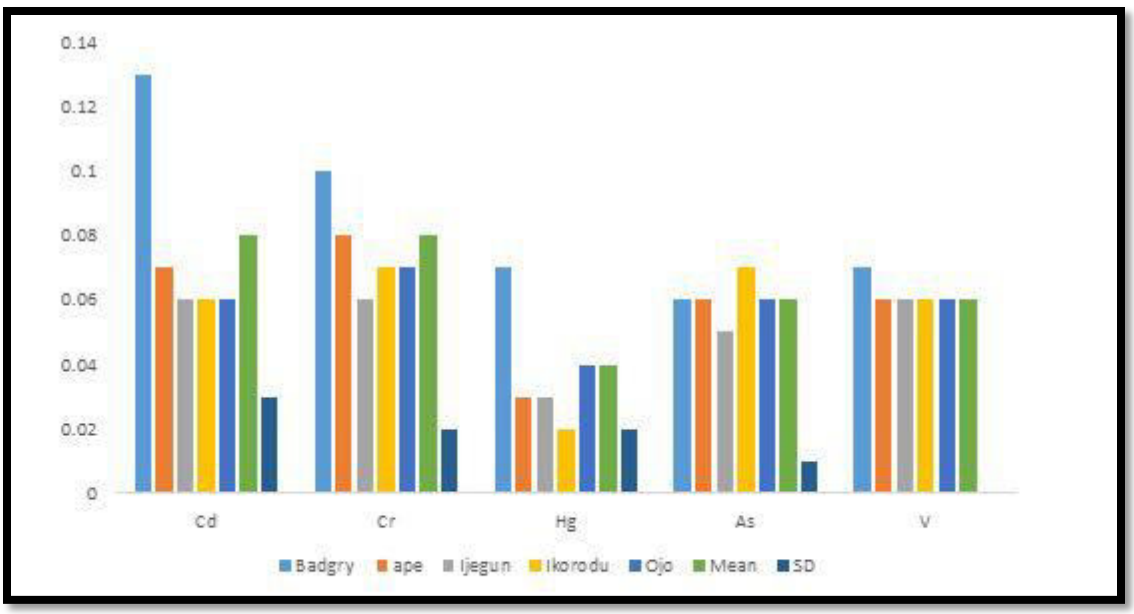
Result of the heavy metals content of fish species in Ojo wetlands are as in Figure 6.

Figure 6: results of heavy metals content of fishes species in Ojo wetland and WHO MPC in mg/kg



The grand mean results of the heavy metals in fishes species investigated are as in Figure 7.

Figure 7: Grand mean of heavy metals in fish species in wetlands in Lagos and WHO MPC in mg/kg



Discussion

The analysis of 3 fish species in wetlands in Lagos presented varying mean concentrations of the heavy metals investigated.

The mean concentrations of Cd in the wetlands are between 0.06mg/kg in Ijegun, Ikorodu and Ojo wetland to 0.13 mg/kg in Badagry with a grand mean of 0.08mg/kg .The critical limit for Cd in fish tissue as stipulated by WHO 2014 is 0.05mg/kg. This elevated mean content of Cd in the fish species are concomitant effects of bioavailability of Cd in the wetlands which are anthropogenic. High content of Cd in fish tissues was in the reports of (Adjei-Kyereme *et al*., 2014);effects of Cd in human system leads to health complications of kidney diseases, damage to lungs and death (Balakryshnan & Ramu, 2016, Boateng *et al*., 2015, Chiamasathit, *et al*., 2020).

The analysis of the fish species in wetlands in Lagos revealed that the mean concnetrations of Cr is between 0.06 mg/kg in Ijegun wetland to 0.10 mg/kg in Badagry wetlands with agrand mean of 0.08mg/kg . The WHO MPC for Cr in fish is 0.05 mg/kg. This increased level of Cr is the effect of industrial waste input into the environment. Increased content of Cr in fish was reported by (Den *et al*., 2014, Duruibe *et al*., 2007, Eldaw *et al*., 2020). Heath effects of Cr in human include skin ulcers, cancer of the sinus, nasal cavity and lungs (Garg *et al*., 2007, He *et al*., 2005).

The analysis of fish species in the wetlands in Lagos showed that the mean content of Hg in their tissues is between 0.02 mg/kg in Ikorodu wetlands to 0.07 mg/kg in Badagry with agrand mean of 0.04 mg/kg . The critical point stipulated for Hg in fish for human consumption is 0.001 mg/kg . High content of Hg in fish species are the results of poor effluents disposal by the industries located in Lagos. High concentrations of Hg was in the reports of (Hsu & Lean, 2002, Koffi *et al*., 2014). Human effects of Hg include weight loss, cough, headache, difficulty in breathing (Gyamfi *et al*., 2012, Ogwu, 2023d, Kim, 2002).

Analysis of fish species in the wetlands in Lagos state presented varying mean concentrations of As which ISbetween 0.05 mg/kg in Ijegun to 0.07 mg/kg in Ikorodu with an grand mean concentration of 0.06mg/kg . The WHO MPC recommended for As in fish is 0.05 mg/kg. This increased content of As is the after effect of poor wastes management by the industries operating in Lagos. High content of As in fish was contained in the reports of (Maskoni *et al*., 2020, Ogwu *et al*., 2023b, Ogwu *et al*., 2023c). Effects of As in man include (Skin lesion), cardiovascular diseases and cancer (Milivorevic *et al*., 2016, Miza *et al*., 2020, Khorghed, 2020).

The analysis of fish from wetlands in Lagos presented mean contents of V which range is from 0.06 mg/kg in Epe, Ijegun, Ikorodu and Ojo to 0.07 mg/kg in Badagry with agrand mean content of 0.06 mg/kg. The maximum permissible concentration for V as stipulated by WHO 2014 is 0.005 mg/kg.Increased content of V in fish species was in the reports of (Mohamed & Zahir, 2013, Mukherjee *et al*., 2006, Nkansi *et al*., 2010, Oluyemi *et al*., 2010). Health effects of V in human include bone problems, lung cancer, cardiovascular diseases (Singh & Kamal, 2016, Sharma & Tyagi, 2013).

Conclusion and Recommendations

Wetland is a very valuable ecosystem that provides man with varying ecosystem services ranging from protection of the higher ground from erosion, to cooling of the temperature of the higher ground, carrying out redox reaction, recharging the aquifers, provision of brooding places for fishes and other aquatic organism. It is therefore imperative that wetlands should be protected against degradation from anthropogenic activities especially contamination from pollutant such as pesticides, furams, dioxins, detergents, heavy metals, to avoid bioaccumulation of the contaminants in aquatic organisms making them unhealthy for human consumption.

The analysis of selected fish species from some wetlands in Lagos revealed that the fishes are contaminated with heavy metals investigated as the concentration were higher than the stipulated thresholds allowable for heavy metals in fish.

Against these backdrops, the study recommends as follows:

- The concentrations of the heavy metals investigated are higher than the recommended maximum permissible limit so the fishes in the wetland should not be consumed.
- The produce are also not fit for export because they did not meet Codex Alimentarius standards.
- Remediation of the impacted wetlands is highly recommended.
- The agency responsible for environmental standard compliance, monitoring and enforcement should increase ITS surveillance and enforcement to ensure compliance by the industries and citizens.

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