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Assessment of Heavy Metals in Fish Ponds

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Abstract: *Aquatic habitats are becoming progressively polluted due to indiscriminate discharge of pollutants generated from various industries, transportation and fossil fuel burning. The main objective of the study is to assess the heavy metals present in three ponds in Oke Osun, Osogbo. A total of 4 litres each of water samples from different points at 20 cm depth of the pond were collected using 250 mL bottles which were pre-washed with 10 % nitric acid and distilled water. Acid preserved water sample (100 mL) was taken in a beaker and 10 mL of nitric acid was added. It was then brought to a slow boil and evaporated on a hot plate to the lowest volume possible of 15mL before precipitation occurred. Atomic Absorption Spectrophotometer was used for the metal determinations which involved the use of Hollow Cathode lamp (HCL) for each of the respective elements. The mean concentrations (mg/L) of the heavy metals determined were: Cd; 0.01±0.006, Pb; 0.15±0.04, Co; 1.93±0.05, Cr; 0.31±0.01 and Ni; 0.03±0.006 mg/L in the order of Co > Cr > Pb > Cd for Pond A. Pond B had Cd; 0.03±0.03, Pb; 0.35±0.08, Co; 0.37±0.03, Cr; 0.42±0.006 and Ni; 0.06±0.0006 mg/L while Cd; 0.01±0.006, Pb; 0.22±0.02, Co; 1.11±0.09, Cr; 0.23±0.02 and Ni; 0.02±0.006 mg/L for pond C The study showed that all the water samples collected from pond contained Cd, Pb, Co, Cr and Ni, with concentration above permissible standards by WHO and SON.*

Keywords: Pond, Heavy metals, Pollution, WHO, Atomic Absorption Spectrophotometer

1. INTRODUCTION

Many geographical and human activities that create industrial and domestic effluents have severely harmed the aquatic environment (Mohnish Pichhode *et al*., 2020). Heavy metals are mainly found in stone and rock formations in distributed form. Heavy metals are becoming more abundant in the biosphere as a result of industrialization, urbanization, and anthropogenic contribution, with the greatest availability in aquatic ecosystems and a lower share in the atmosphere as particulates (Pichhode & Gaherwal 2019a). Heavy metals are a special problem since they are non-biodegradable and have a negative impact on human health. Mohnish Pichhode et al., 2020, found that these heavy metals bioaccumulate rapidly in several organs (such as the liver and kidney) and muscular tissue. Heavy metals are constantly poisoning natural water resources, causing harm to a variety of ecologically vital aquatic animals such as fish and others (Mohnish Pichhode *et al*., 2020). Although the degree of pollution in natural ecosystems is normally much below the threshold that causes death in exposed animals, it may be enough to disrupt tissue function (Pichhode & Nikhil 2015a, b). Contaminants or pollutants of this type disrupt a variety of physiological and biochemical pathways in fish.

Freshwater fish are the greatest sentinels for monitoring and identifying an aquatic ecosystems health. Any contaminant's first harmful effect is only visible at the cellular or tissue level, and thereafter manifests itself in morphological or behavioral abnormalities (Pichhode *et al*., 2020). Various heavy metals, agrochemicals, and industrial operations continuously emit various wastes into natural freshwater sources, causing soil and aquatic biota monitoring to be negatively affected. It is critical to identify and manage these contaminants in order to reduce their negative effects on aquatic ecosystems (Witeska *et al*., 2014).

Phytoplankton and zooplankton are significant natural foods for many fish species and other aquatic creatures, and heavy metal bioaccumulation in these organisms causes heavy metals to accumulate in fish, posing a concern to humans. Fish have a larger potential to accumulate heavy metals in their organs than the surrounding environment, hence heavy metal concentrations in fish are crucial indicators of pollution levels (Mancera *et al*., 2006). The purpose of this study was to determine the levels of heavy metals in three ponds in Oke-Osun, Osogbo.

2. METHODOLOGY

2.1 Sample Collection

Three fish ponds at Oke Osun, Osogbo, Osun State were sampled. Using 250 mL bottles pre-washed with 10% nitric acid and distilled water, a total of 4 litres of water samples were taken at various points at a depth of 20 cm in the pond.

2.2 Preparation of Standard Solutions

Cadmium, Lead, Colbat, Chromium, and Nickel standard solutions were made from their salts using the (APHA, 2005) approach for Atomic absorption spectroscopy. As the stock solution, a metal solution with a known concentration of 1000 mg/L was created. By diluting the stock solutions with deionized water, standards solutions were created.

2.3 Metals Quantification in Water Samples

In a beaker, a 100 mL acid preserved water sample was mixed with 10 mL nitric acid. Before precipitation, it was slowly brought to a boil and evaporated on a hot plate to the smallest volume feasible of 15mL. The heating process was continued with the addition of strong nitric acid until digestion was complete, resulting in a light-colored clear solution. During digestion, great care was taken not to let the material dry out. The inside of the beaker was rinsed with distilled water, and the capacity was increased to 100 mL by adding more distilled water (Mutuku, 2010). After that, the sample was filtered, and the filtrate was collected for examination with a Thermo Scientific SOLAAR S series atomic absorption spectrometer.

2.4 Samples Analysis by Atomic Absorption Spectroscopy

Atomic Absorption is a term that refers to the process of The metal determinations were done with a spectrophotometer, which used a Hollow Cathode Lamp (HCL) for each of the elements. The examination was carried out at the Advanced Chemical Laboratory of the Sheda Science and Technology Complex (SHESTCO), using a Thermo Scientific SOLAAR S spectrometer. The actual metal content in each sample was calculated using the equation below, based on the results of the spectrometry study.

$$\text{Metal content (mg/g)} = \frac{\text{Concentration in solution from AAS result (mg/L)} \times \text{vol of dilution (L)}}{\text{Weight of sample (g)} \times 1000}$$

3. RESULT

3.1 Result

3.1.1 Concentration of Cadmium in Fish ponds

The water samples collected from the ponds (Pond A, B, C) at Ilesha reveal that pond B had highest concentration of cadmium (0.003±0.03mg/kg) while pond A and C had the same concentration of cadmium (0.01±0.06mg/kg) (Figure 1).

3.1.2 Concentration of Lead in Fish ponds

The concentration of lead in these fish ponds, shows that pond B had high concentration (0.35 mg/kg), follow by pond C with 0.22±0.02 mg/kg while pond A had least concentration (0.15±0.04 mg/kg) of lead (Figure 2).

3.1.3 Concentration of Cobalt in Fish ponds

Sample of water collected from three ponds at Ilesha had different concentration of cobalt. The concentration found in pond A is highest (1.93±0.05 mg/kg), this was preceded by concentration of 1.11±0.09 mg/kg observed in pond C. Pond B had the least concentration of Cobalt (Figure 3).

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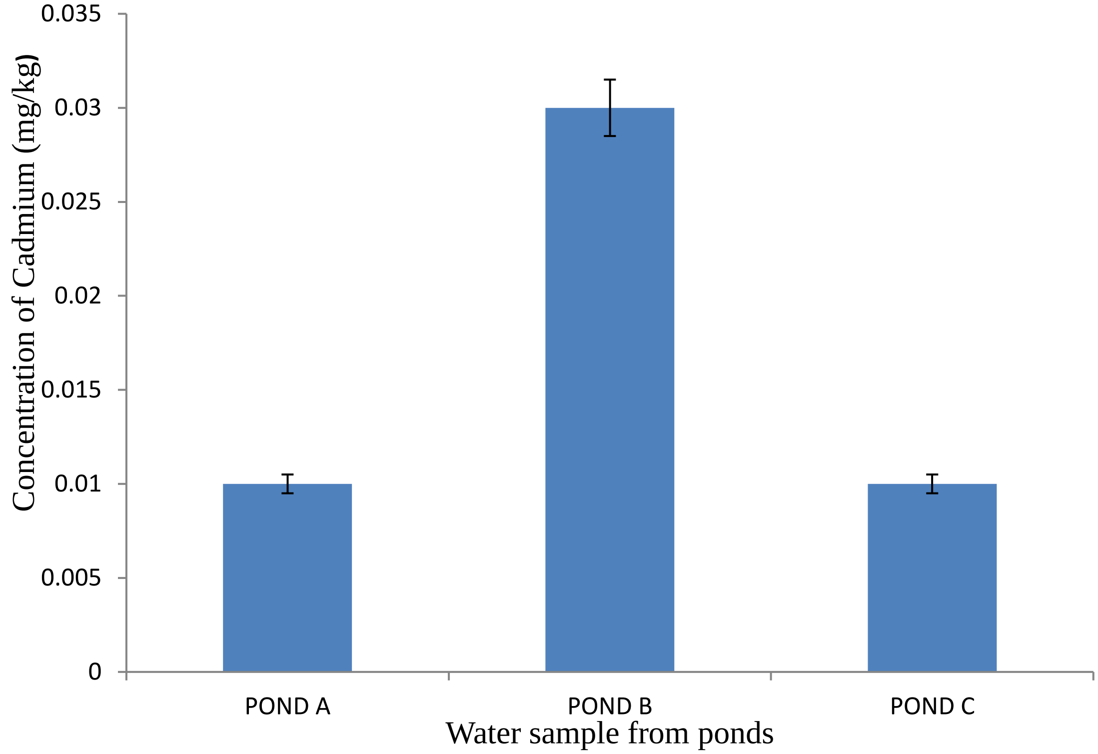

Figure 1: Concentration of Cadmium in water samples collected from fish ponds in Oke-Osun, Osogbo, Osun State

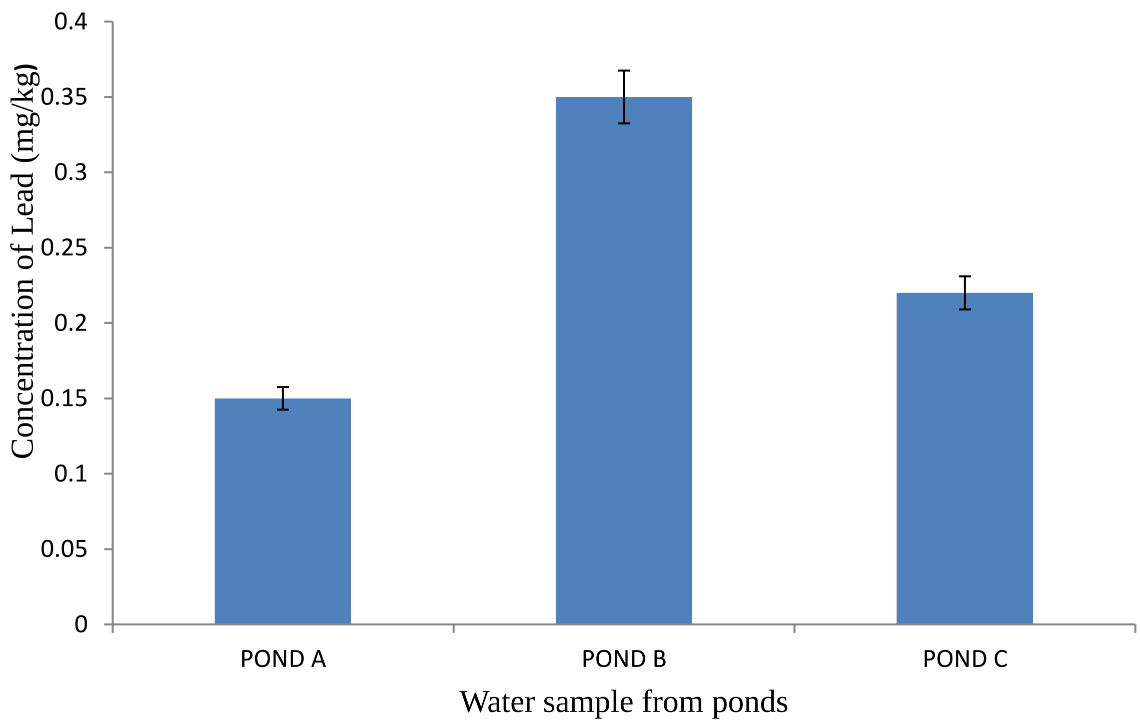

Figure 2: Concentration of Lead in water samples collected from fish ponds in Oke-Osun, Osogbo, Osun State

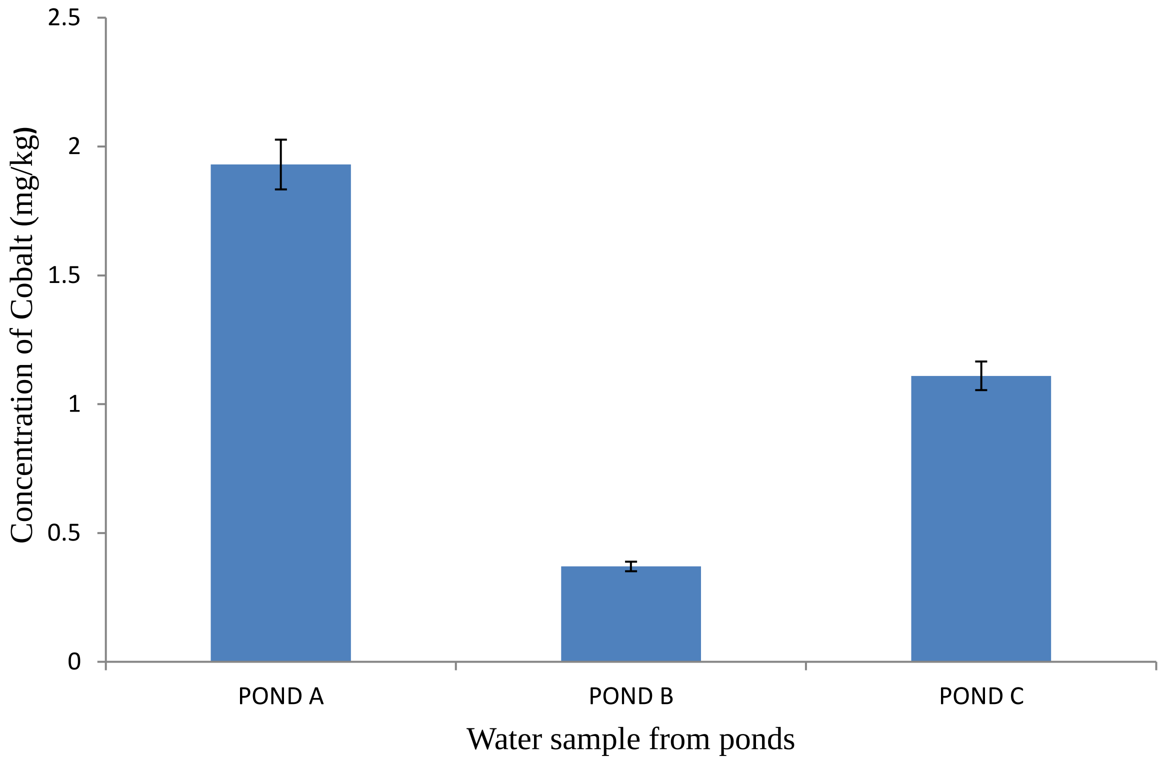

Figure 3: Concentration of Cobalt in water samples collected from fish ponds in Oke-Osun, Osogbo, Osun State

3.1.4 Concentration of Chromium in Fish ponds

The highest concentration of chromium was found in Pond C (0.42±0.06 mg/kg), next is Pond A with chromium concentration of 0.31±0.01 mg/kg while the least concentration was found in 0.23±0.02 mg/kg (Figure 4).

3.1.5 Concentration of Nickel in Fish ponds

The concentration of Nickel in Pond C is highest (0.06±0.006 mg/kg), pond B had 0.03±0.006 mg/kg while low concentration of 0.02±0.006 mg/kg was found in pond B (Figure 5).

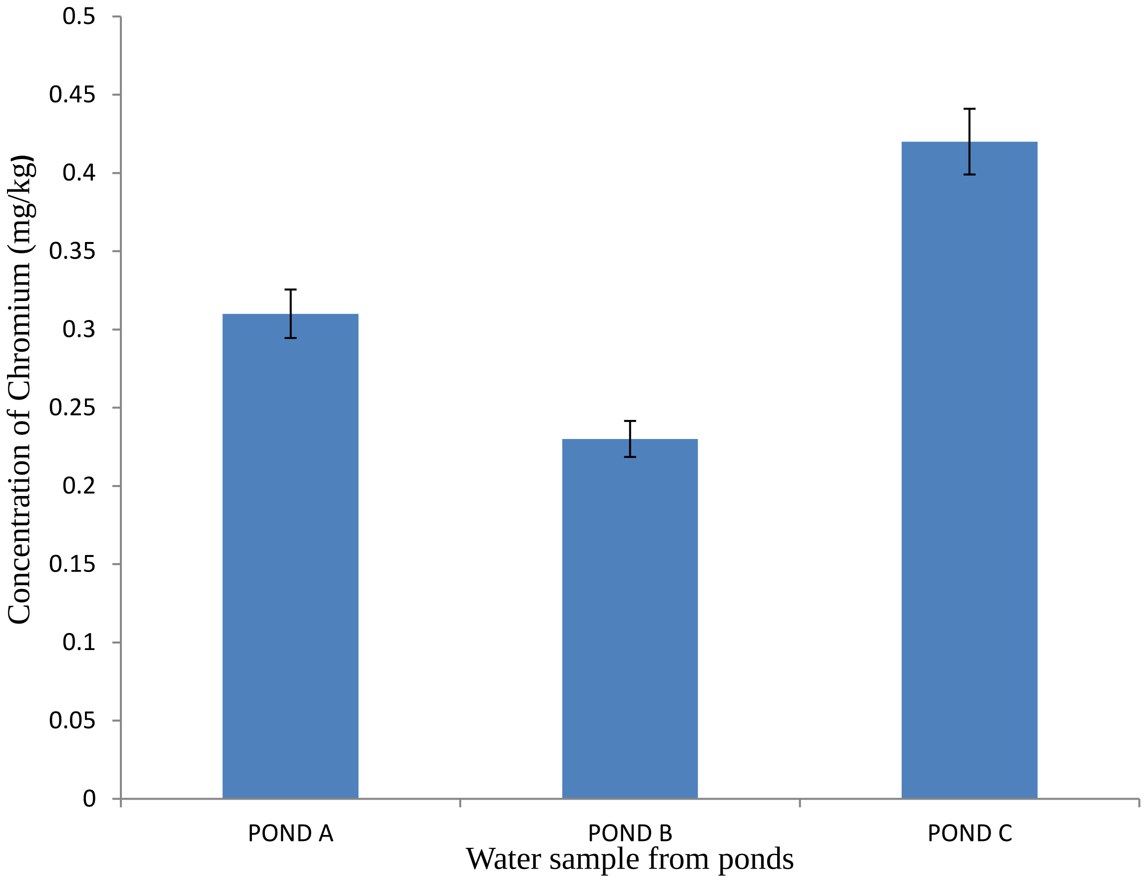

Figure 4: Concentration of Chromium in water samples collected from fish ponds in Oke-Osun, Osogbo, Osun State

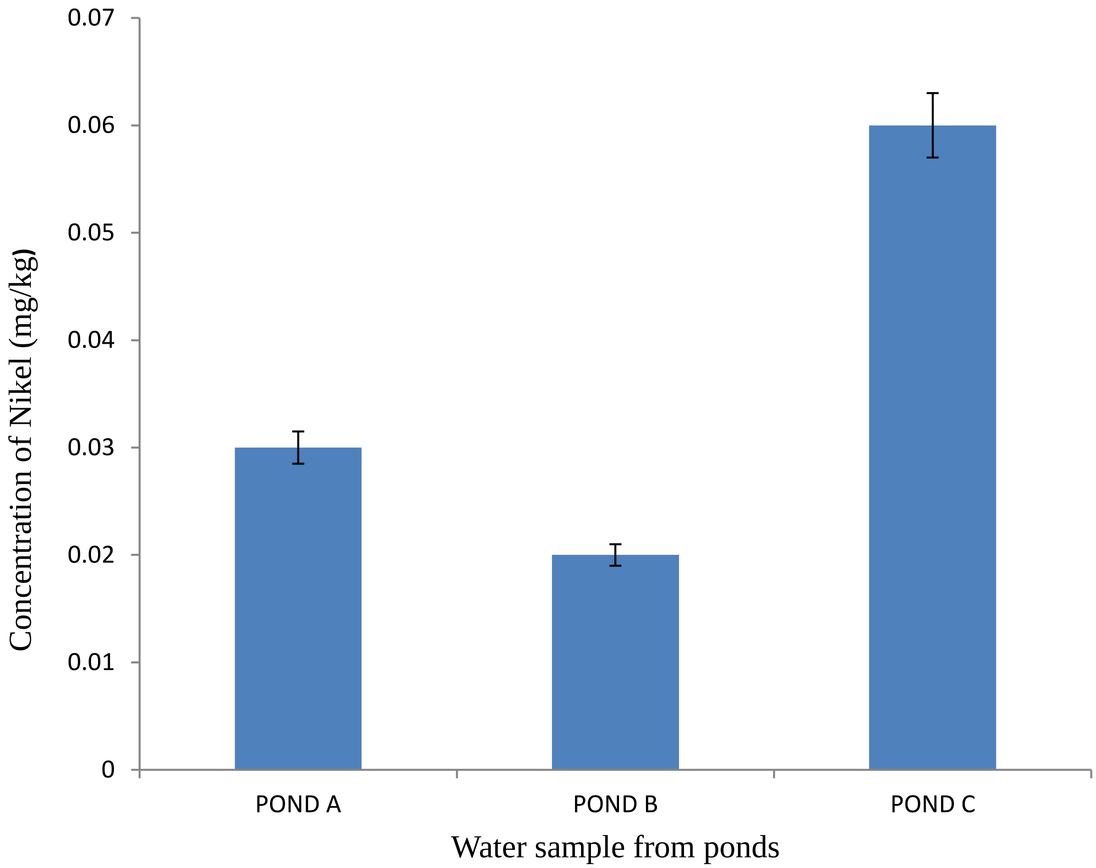

Figure 5: Concentration of Nickel in water samples collected from fish ponds in Oke-Osun, Osogbo, Osun State

3.2 Discussion

Anthropogenic heavy metal inputs into water bodies come from a variety of sources, including domestic sewage, combustion emissions, mining operations, metallurgical activities, and industrial effluents, and heavy metals like lead, cadmium, chromium, and nickel are released as a result of these processes (Chinni and Yallapragda, 2000). Heavy metals such as aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc are known to damage many water bodies in Nigeria as a result of increased industrial and agricultural operations (Svobodova *et al*., 1993).

As a result, multiple attempts have been made in recent decades to assess the presence of heavy metals in diverse water bodies in Nigeria and elsewhere. The concentration of heavy metals in water samples from three fish ponds in Oke-Osun, Osogbo, Osun State, was determined in this study. The following heavy metals had mean concentrations (mg/L): For Pond A, the concentrations of Cadmium, Pb, Cobalt, 1.930.05, Cr, 0.310.01, and Nickel were 0.030.006 mg/L in the sequence Cobalt > Chromium > Lead > Cadmium. Cadmium; 0.030.03, Lead; 0.350.08, Co; 0.370.03, Chromium; 0.420.006, and Nickel; 0.060.0006 mg/L were found in Pond B, whereas Cadmium; 0.010.006, Lead; 0.220.02, Cobalt; 1.110.09, Chromium; 0.230.02, and Nickel; 0.020.006 mg/L were found in Pond C.

In comparison to WHO and SON's allowed levels, the figure recorded for heavy metals in this study is extremely high. Except for 0.030.03 mg/L in Pond B, the cadmium levels measured met WHO and SON's permissible standards (0.01 mg/L). The lead levels found in all samples are higher than WHO and SON's recommended standard of 0.05 mg/L. All cobalt concentrations in the three ponds studied above the WHO and SON's recommended guideline of 0.05 mg/L. Pond A and Pond C also have results that are higher than the allowable level (0.02 mg/L), although Pond C meets the acceptable standard.

In a similar vein, Obasohan et al., (2008) measured heavy metal concentrations in the Ikpoba River in Benin City, finding that lead concentrations were higher than the WHO recommended level in drinking water. However, Ozturk et al., (2008) measured the amounts of Cadmium, Chromium, Nickel, and Lead in Turkey's Avsar Dam Lake and found that they were 0.001, 0.006, 0.01, 0.9, 0.006, and 0.005 mg/L, which are lower than the values recorded in this study.

Background levels of heavy metals in natural freshwaters, according to DWAF (1996), are typically very low, ranging from 0.0 to 0.13 ppb (0.00013 mg/L). Different maximum permissible concentrations have been advised by different authors for the preservation

of aquatic life, particularly fish, depending on the species of fish and the physico-chemical state of the water (Svobodova,1993). In freshwater, DWAF (1996) recommended cadmium concentrations of 0.0002–0.0018 mg/L, copper concentrations of 0.005 mg/L, chromium concentrations of 0.02 mg/L, lead concentrations of 0.001 mg/L, and zinc concentrations of 0.005 mg/L.
The relatively high concentration of Lead in the pond may be as a result of the direct release of public waste including sewage into the lake, anthropogenic activities around the lake and vehicular emissions

4. CONCLUSION

The findings of this study revealed that consuming fish from three selected fish ponds in Oke-Osun, Osogbo, Osun State may be harmful to consumers in the long run because some observed heavy metal values in the water samples were above the FAO/WHO permissible limits and can easily be absorbed by the fish due to the strong correlation among all the samples unless proper measures are taken to mitigate the presence of heavy metals found in the water samples.
The heavy metal analysis revealed a public health hazard because the quality of fish grown in such water did not meet the standards levels recommended by WHO, USEPA, and ANZECC. As a result of the current findings, it can be concluded that conditions at industrial drainage, sewage wastewater, and agriculture drainage fish are not safe for human consumption. If the effluent is appropriately treated, any negative health impacts from this application could be prevented.

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