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Comparative Analysis of Heavy Metal Concentrations in Fish Obtained From Anambra River and Different Ponds in Anambra State.

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ABSTRACT

Concentration of heavy metals (Co, Ni, Mn, Cr, Pb Cd, As and Zn) in vital organs (gills, muscles, livers) of catfish (*Claria gariepinus*) obtained from Anambra River, and two other artificial ponds in Anambra state of Nigeria were quantitatively determined. The determination was carried out using Variance AA240 Atomic Absorption Spectrophotometer (AAS). The results obtained showed that there were significant differences in the concentration of heavy metals in the samples obtained from Anambra River, and those obtained from artificial ponds. In Pond 1, all the heavy metal concentrations in the organs were within the acceptable WHO standard, but in the feed, Mn was found to be slightly higher than the limit. Mn, As and Cdwere higher than the acceptable limit in the pond water. In the water from Pond 2, all the heavy metals exceeded their WHO acceptable limit except Co which was not detected. This indicates that the water source of pond 2 is contaminated and not safe for fish farming. This could be seen from the concentration of the metals in the gills of the fish which exceeded the limits. In Anambra River, the water was found to have higher concentrations of Ni, Mn, Cr, and Cd than the acceptable limit set by WHO. This could be due to incessant discharge of untreated effluent water into the river course by surrounding industries. However, only Cr was found to be in the gills of the fish at unacceptable concentration. No trace of Pb, As and Co was found in the water.

Keywords: Heavy metals, concentrations, pollution, environment and pollutants

INTRODUCTION

The pollution of the aquatic environment with heavy metals has become a worldwide problem in recent years, because they are indestructible and most of them have toxic effects on organisms [1]. Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability of bioaccumulate in aquatic ecosystems [2].Most of the sediments in our rivers, lakes, and oceans have been contaminated by pollutants. Some of these pollutants are directly discharged by industrial plants and municipal sewage treatment plants, others come from polluted runoff in urban and agricultural areas, and some are the result of historical contamination [1].In the quest for development, humans in one way or the other pollute the environment. In many developed countries of the world, contamination of water bodies like river, sea, ocean etc. by metals has been a matter and a problem due to activities carried out by man and natural processes which have resulted in degradation of the environment. The attempt to explore the earth to provide a better living condition is also responsible for the pollution of the environment. These activities include; urbanization, industrial activities and modernization of agricultural practices, in terms of the application of fertilizers, pesticides and other chemicals whose end product result to harmful effect in humans. These pollutants eventually find their way into the body of water. Consequently, aquatic organisms like fish, shell fish and freshwater may accumulate hazardous concentration of toxic chemicals such as heavy metals [1].During the past several decades, the increasing usage of heavy metals in industry has led to serious environmental pollution through effluents discharge[3]. Under certain environmental conditions, heavy metals may be accumulated to a toxic concentration [4], and cause ecological damage [5]. Fish accumulates metals directly from water by absorption, assimilation, through food substances (phytoplankton, zooplankton and carnivores). Fish samples can be considered as one of the most significant indicators in freshwater systems for the estimation of metal pollution level [6]. Because a river system drains the surrounding areas, many harmful substances are washed into the aquatic environment; therefore, industrialization and metal pollution of river bodies are positively correlated. The toxicity of these heavy metals depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals. Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority metals that are of public health significance. These metallic elements are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. They are also classified as human carcinogens (known or

probable) according to the U.S. Environmental Protection Agency, and the International Agency for Research on Cancer [7].

This research work aims to determine the concentration of eight heavy metals (Co, Ni, Mn, Cr, Pb Cd, As and Zn) in the vital organs of fish found in two artificial ponds and in Anambra river located in Anambra state of Nigeria. A comparative analysis was done on the concentrations putting into considerations the contribution of the fish feed used in feeding the fishes in the artificial ponds. The results were compared with the WHO standards.

MATERIALS AND METHODS.

Sample Collection, Identification and Preparation:

Fish sample (identified by Ofobeze Tochukwu in the Department of Zoology, Paul University, Awka.) together with water sample were obtained from Anambra river. The same specie of fish together with water and feed were sampled for analysis from two different artificial body of water (pond).

They were collected in polyethylene bags and taken to the laboratory for analysis. The fish sample were dissected using stainless steel scalpels and Teflon forceps using a laminar flow bench, then, the desired parts which are; gills, muscles and the livers were taken out and kept in well labeled containers.

DIGESTION OF FISH SAMPLES

2.0g of each of the desired ground parts of the fish sample was weighed into a digestion flask and 20cm^3 of aqua regia (4cm^3 conc. HNO_3 and 16cm^{3}concHCl) was added. The mixture was heated until a clear digest was obtained. The digest was filtered, made up to 50cm^3 with distilled water. It was then stored in a plastic container for AAS analysis.

WATER SAMPLE

The water sample was thoroughly mixed by proper shaking. 100cm^3 of the sample was measured into a beaker, 1-cm^3 of conc HNO_3 was added, the solution was heated to boiling, and it was brought down and allowed to cool in a desiccator. It was filtered and stored in a reagent bottle for AAS analysis. The same procedure was used for all the water samples from the ponds and the river.

FEED SAMPLE

0.5g of the feed sample was weighed into a crucible and transferred into a muffle furnace at the temperature of 550^{o}c for 1hr. After which it was brought out and allowed to cool. It was transferred into a 250cm^3 beaker containing 20cm^3 of 20%

sulphuric acid and heated on a water bath at 65°C for 30 minutes. It was brought down and allowed to cool in a dessicator, thereafter; the volume of the beaker was made up to 100cm^3 with distilled water, filtered with the aid of a filter paper and stored in a reagent bottle for AAS analysis.

Atomic Absorption Spectrophotometer (AAS) Analysis

Heavy Metal analysis

Heavy metal analysis was conducted using Varian AA240 Atomic Absorption Spectrophotometer according to the method of APHA 1995 (American Public Health Association).

RESULTS AND DISCUSSION

The results of the ASS analysis of heavy metals in the samples are shown below in Table 1 – 3.

RESULTS

Table 1: Heavy Metals Concentrations(ppm)on Fish Sample Collected from Pond 1

Parameters	Muscle	Liver	Gills	WHO Ref std (fish)
Cobalt	0.000	0.000	0.000	0.050
Nickel	0.358	0.142	0.204	0.600
Manganese	0.259	0.223	0.327	0.500
Chromium	0.000	0.000	0.000	0.150
Cadmium	0.042	0.001	0.021	7.000
Lead	0.000	0.000	0.000	0.200
Arsenic	0.127	0.00	0.321	5.000
Zinc	0.203	0.322	0.539	10.75

Table 2: Metal Concentrations (ppm) on Fish Sample Collected From Pond 2

Parameters	Muscle	Liver	Gills	WHO Ref std (fish)
Cobalt	0.002	0.055	0.325	0.050
Nickel	0.258	0.568	0.670	0.600
Manganese	0.214	0.383	0.667	0.500
Chromium	0.056	0.068	0.238	0.150
Cadmium	0.450	0.931	3.713	7.000
Lead	0.000	0.000	0.612	0.200
Arsenic	0.278	0.098	0.238	5.000
Zinc	3.381	0.093	2.629	10.75

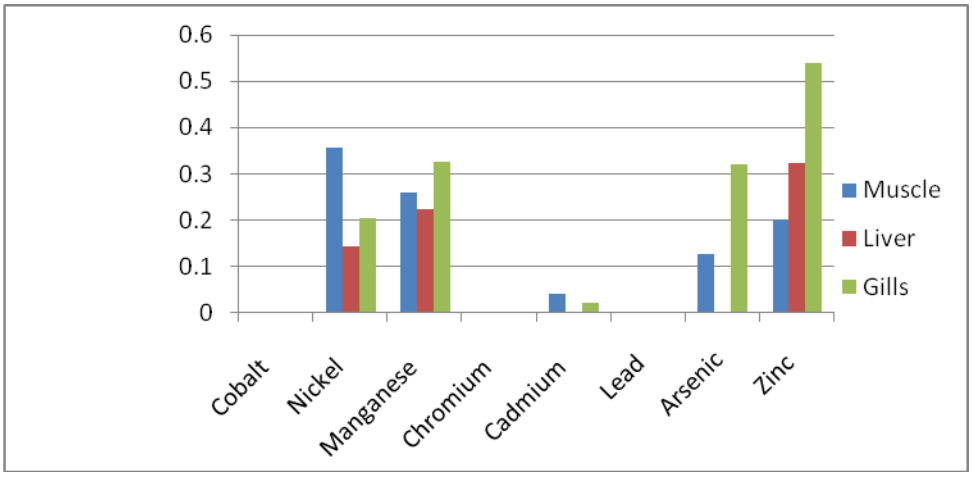
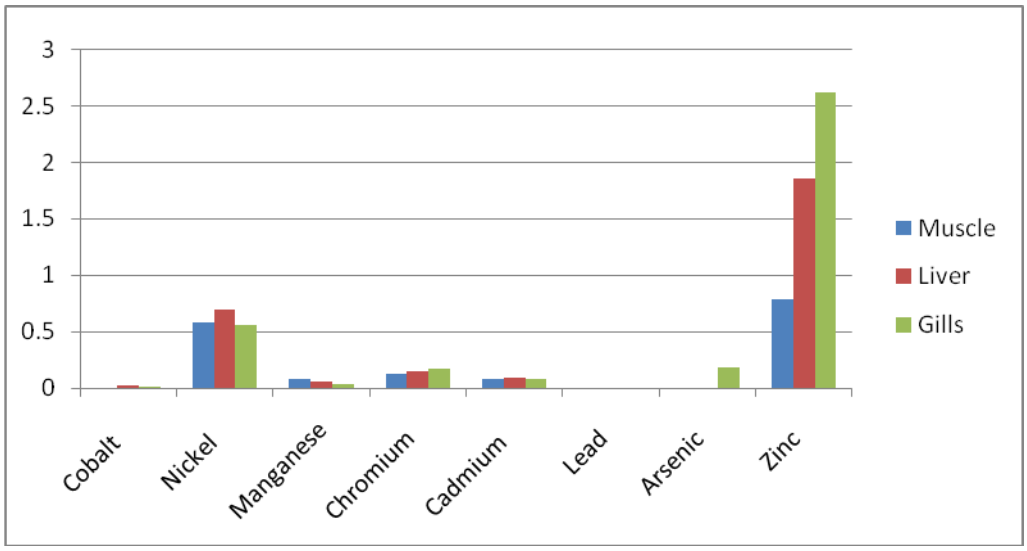


Fig.1:Chart of Metal Concentration on Fish Sample Collected from Pond 1

Table 3: Metal Concentrations (ppm) on Fish Sample Collected from River

Parameters	Muscle	Liver	Gills	WHO Ref std(fish)
Cobalt	0.000	0.018	0.014	0.050
Nickel	0.578	0.694	0.559	0.600
Manganese	0.085	0.056	0.032	0.500
Chromium	0.128	0.146	0.169	0.150
Cadmium	0.077	0.094	0.079	7.000
Lead	0.000	0.000	0.000	0.200
Arsenic	0.000	0.000	0.186	5.000
Zinc	0.788	1.860	2.625	10.75

Fig.2: Chart of Metal Concentrations on Fish Sample Collected from Anambra River



DISCUSSION

Water pollution has been linked majorly to the presence of heavy metals which can be very detrimental to the aquatic habitat. Many different sources contribute heavy metals to the environment which include natural and anthropogenic sources. Some natural sources include leaching of rocks and forest fires. Anthropogenic sources include industrial effluents, fumes, run- off and many other sources. All these eventually end up in different water bodies.

In this research, it was observed that the trend of heavy metals accumulation varied in different organs of fishes. In pond 1 (Table 1), the presence of Co, Cr and Pb were not detected in the tested parts. Ar was absent in the liver whereas the rest of the metals, Ni, Mn, Cd and Zn were detected but they are within WHO recommended standard. In pond 2 (table 2), Apart from Pb which was which was not detected in the muscle, liver or the gills of the fish, the rest of the heavy metals were detected with the concentration of Co, Ni, Mn, Cr and Pb in some parts exceeding the WHO recommended limit: Co in the liver and gills, Ni in the gills,Mn in the gills, Cr in the gills and Pb in the gills. In table 3, Analysis shows that Co was not detected in the muscle of the fish, Pb was not detected was not detected in any of the three parts, while Ar was not detected in both the muscle and the liver. The rest of the metals were detected to be within the recommended limit apart from the concentration of Ni in the liver of the fish.

Table 1-3 suggest that the sources of water for pond 1and pond 2 were contaminated and therefore not good enough for fish farming. Also, the level of Ni, Mn, Cr and Cd in the river water are significantly higher than the recommended limit. Fishes obtained from it could pose a risk to human health.

The differences in the accumulation levels in different organs of the fish depend on the differences in the physiological role of each organ. Other parameters like behaviour, regulatory ability and feeding habits may play an important role in the accumulation differences in the various organs [8, 9]. The results of many researches indicated that metals exhibit various affinities to different organs. Irrespective of the uptake route, liver accumulates high level of metals and is often used as a good water pollution monitor. In the liver, metal levels rapidly rise during exposure and it remains high for a long time. Concentrations of metal in the kidneys increase slower than in liver and it prevalently reaches slightly lower values; hence the kidneys might be considered as a good pollution indicator too. In purification period, levels of kidney metal remain high or may even rise for some time, which is due to kidney's role as organ of excretion [10]. Accumulation of metals in fish depends on contamination and it may be different for various fish species living in the same water [12]. Overall, the higher the concentration of metals in the environment, the more they might be taken up and accumulated by fish. Relationship between concentrations of metal in water and in the fish was reported in many studies [3, 5, 13, 15]. It is thought that the soluble form of heavy metals is more harmful because it is more readily available to aquatic organism and more easily transported. The data comparison about metal concentration in fish from different lakes shows that the cadmium and lead concentrations, but not zinc, are significantly higher in the fish of acidified lakes [6, 8, 16, 17].

CONCLUSION

In conclusion, heavy metals accumulate in various tissues of fish in different concentrations. Generally, accumulation of metals in muscle was lower than liver, gills and kidney. The results present new information on the distribution of these metals in liver, gills, kidney and muscle of *cat fish*. This research showed that concentrations of heavy metal in the Anambra liver is lower than the maximum permissible concentration for various countries. According to the fish samples analyses, concentrations of heavy metal in fish species tissues were well within the limits set by the FAO/World Health Organization (WHO) [19] recommendations and showed that the fish from investigated river and ponds are safe for consumption.

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