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Full Length Research Paper

Evaluation of Lead, Cadmium and Chromium in Tilapia fish obtained from Makoko and Carter Bridge Rivers in Lagos, Nigeria

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Most of the fresh water fish consumed in Nigeria comes from the Southern part of the country. The major aim of this study was to evaluate the heavy metal concentrations of Tilapia fish (*Tilapia orechromis*) of Makoko and Carter Bridge Rivers, thereby conducting a health risk assessment of these fishes. Heavy metal analyses were carried out by atomic absorption spectrophotometry (AAS). Lead concentrations of tilapia fish from Carter Bridge and Makoko rivers were found to be 0.65 and 0.31 mg/g, respectively. Cadmium concentrations of the fish were found as 0.90 and 0.23 mg/g, respectively. Chromium was detected in all sample groups. Its concentrations were found to be 0.008 and 0.22 mg/g, respectively. The concentrations of all the sample groups were above the maximum permissible limits of the USEPA. The coastal Nigeria population, which consumes larger quantities of fish may be at risk.

Key words: Heavy metals, *Tilapia orechromis*, lead, cadmium, chromium.

INTRODUCTION

Site background

The sites are fishing areas frequented by many people. Fishing is variable and depends on many factors including the location, the fishermen and the type of fishing. Fishing populations ranged from early morning fishermen to individual that rely on sourcing the rivers for food consumption. It is also a notable fact that the sites also serve as food markets, which are visited by a wide range of people.

Heavy metals

The variability in metal concentrations of marine organisms depends on many factors such as, the position of the fish in the food chain, size, age and characteristics kinetics for elements and their biological halftime.

Pollutants accumulated in marine organisms are transferred to main through the food chain (Cogun et al., 2006; Farkas et al., 2000; Naqui et al., 2003; Uluozlu et al., 2007). Marine organisms have been recognized as a useful tool for the monitoring of the environment.

Organisms like mussel feeds through to filter organic material and phytoplankton in water. They can filter the toxic materials simultaneously. Besides their potential employment as biomonitors, several species are included in the diet of coastal inhabitants.

Tilapia is a large cichlid genus that contain more than 100 species. They are naturally found in Africa and in the Middle East. Fish of the genera oreochromis, sarotherodon and Tilapia are commonly known as Tilapias. Tilapias are very important protein source and a popular target for artisanal and commercial fisheries. Heavy metals are refer to as metallic elements that have high density and are toxic or poisonous at low concentrations. They are natural components of the Earth's crust. Heavy metals are dangerous because they tend to bioaccumulate. They can get into riverine bodies from industrial and consumer's wastes or even from the rain.

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Bioaccumulation means an increase in the concentration of chemicals in a biological organism over time, compared to the chemicals concentration in the environment (Australia Food Authority, 1997).

Cadmium derives its toxicological properties from its chemical similarity to zinc, an essential micronutrient for plants, animals and humans. It is biopersistent and once absorbed by an organism can be there for a long time. It is produced as an inevitable by-product of zinc refining and its most significant use is in nickel/cadmium batteries as rechargeable or secondary power sources (Lovei, 1996).

Other uses are as pigments, stabilizers for PVC, in alloys and electronic compounds. It is also present as an impurity in several products, including phosphate fertilezers, detergents and refined petroleum. In the general non-smoking population, the major exposure is through food via the addition of cadmium to agricultural soil/rivers from effluents or fertilizer application (WHO, 1985). Chromium is used in metal alloys and pigments for paints, chrome plating, ceramics, paper, rubber and other materials. It often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high levels of chromium (National Health and Research Council, 1996).

Lead in the environment arises from both natural and anthropogenic sources. Exposure can occur via drinking water, food, air, soil and dust from old paint. Lead is among the most recycled non ferrous metal and its secondary production has therefore grown steadily in spite of its declining prices. It is applied in the manufacturing, construction and chemical industries (Mahaffey, 1983). Lead is easily shaped and malleable. It is used in batteries, alloys, pigments, cable sheathing, ammunition and as petrol additives, which is no longer allowed in the EU, but is still prevalent in developing countries e.g. Nigeria (Gavaghan, 2002).

These elements get into the riverine bodies through the deposition of effluents from chemical and manufacturing industries into them (WHO, 1992). There they bioaccumulate in aquatic life/organisms and eventually get into the food chain. In some developed countries, dietary lead exposure is well below the provisional tolerable weekly intake recommended by the UN Food and Agricultural Organization, but in Nigeria, such data do not yet exist.

MATERIALS AND METHODS

Tilapia fish was bought from 2 local markets (Makoko and Carter Bridge sites). The fish markets were very close to the rivers. They were immediately taken to the laboratory and stored below 4˚C. The species selected for metal analysis was based on general abundance in the areas and their potential to be consumed by local people.

The fish was washed and dried in the oven after which they were grinded to powered form. 5 g was taken and weighed. It was digested in 5 ml of high purity nitric acid and 100 ml of water for approximately 25 min until digestion is complete. Digests are filtered through filter.

Atomic absorption spectrophotometry was used for the determination of lead, cadmium, chromium, magnesium and manganese. Analytical blanks were run in the same way as the samples and concentration were determined using standard solutions prepared in the same acid matrix. All metal concentrations were quoted as mg/g dry weight.

RESULTS

The concentration of metals and anions in *Tilapia orechromis* is presented in Tables 1, 2 and 3. The data showed that all the fishes caught from Makoko River and Carter Bridge River contained heavy metals higher than the USEPA permissible levels for heavy metals in fish. Magnesium values ranged from 1.74 to 1.80/mg/g in carter Bridge River and Makoko River, respectively. Iron levels were from 10.48 to 18.9 mg/g.

Tilapia fish from Carter Bridge River displayed higher cadmium and lead concentrations in their tissues compared to those of Makoko River. In contrast, Tilapia fish from Makoko River contained chromium level higher than that of Carter Bridge River. It seems that Carter Bridge waters receive more cadmium and lead pollutants from the industrial and domestic sources and Makoko waters contain more chromium pollutants from the surrounding environment. The copper levels recorded in tissues of Tilapia fish from Makoko River were higher than that recorded for Carter Bridge Rivers. Sulphate and nitrite levels were higher in fish obtained from Makoko River than Carter Bridge River.

The potential toxicological impacts of contaminated sea foods can be evaluated on the basis of concentrations in whole body and fish samples (Thompson, 1990).

Concentration of heavy metals can be 200 to 400% greater in organs and other tissues than in muscles (Chan, 1995). Thus, one might expect higher concentrations to be recorded in homogenized whole body samples.

DISCUSSION

From the research works, it was found out that the fish was heavily polluted with cadmium and lead. Cadmium levels ranged from 1.13 to 4.49 mg/g, while lead levels ranged from 1.57 to 3.25 mg/g. These values are indeed exceedingly high. Chromium levels ranged from 0.04 to 0.11 mg/g. These values are above the health based guideline for cadmium, lead and chromium in fish according to USEPA guideline.

It is a notable fact that lots of effluents are being deposited into this site and at the same time, this site stands as a fish market where the general populace buys fish. Apparently, no hazard might exist through moderate consumption of these fishes and if the consumer visits the sites once in a while. Thus, for consumers purchasing

Table 1. Concentration of magnesium, iron and manganese in Tilapia fish from Makoko and Carter Bridge River.

Metals (mg\g)	Rivers		MCL
	Makoko River	Carter Bridge River	
Magnesium	1.87 ± 0.03a	1.74 ± 0.02a	0.05
Iron	18.96 ± 0.14a	10.48 ± 0.04a	0.30
Manganese	0.45 ± 0.01a	0.87 ± 0.01a	0.05
p	< 0.05	< 0.05	

Values are expressed as mean ± S.D in triplicate determinations; values carrying superscripts horizontally are significantly ($p < 0.05$) different.

Table 2. Concentration of cadmium, lead and copper in Tilapia fish from Makoko and Carter Bridge River.

Metals (mg\g)	Rivers		MCL
	Makoko River	Carter bridge river	
Cadmium	1.13 ± 0.08a	4.49 ± 0.05a	0.01
Lead	1.57 ± 0.16a	3.25 ± 0.06a	0.05
Copper	2.20 ± 0.05a	1.37 ± 0.06a	0.00
P	< 0.05	< 0.05	

Values are expressed as mean ± S.D in triplicate determinations; values carrying superscripts horizontally are significantly ($p < 0.05$) different.

Table 3. Concentration of chromium, sulphate and nitrite in Tilapia fish from Makoko and Carter Bridge River.

Metals (mg\g)	Rivers		MCL
	Makoko River	Carter Bridge River	
Chromium	0.11 ± 0.01a	0.04 ± 0.05a	0.01
Sulphate	460.31 ± 0.36a	280.00 ± 0.07a	250
Nitrite	0.23 ± 0.02a	0.03 ± 0.05a	1.00
p	< 0.05	<0.05	

Values are expressed as mean ± S.D in triplicate determinations; Values carrying superscripts horizontally are significantly ($p < 0.05$) different.

the products in large quantities on a regularly basis, a public health hazard will definitely exist. In Turkey, it was observed that 5 heavy metals concentrations were present in the liver and muscle tissues of *Mugil auratus.* Chromium concentrations were found below detection limits of 0.05 µg/g dry weight. Cu, Pb and Cd were detected as mg/kg dry weight within the limits 0.49 to 1.30, 0.60 to 1.21 and 0.15 to 0.50 (Filazi et al., 2003). Copper, lead and cadmium levels found for fish in this study were higher than the results of that study.

In a recent study, the average concentrations of heavy metal levels in mussels (*Uno stevenianus*) were found to be as follows: 1.43 mg/kg for lead, 0.09 mg/kg for cadmium and 5.83 mg/kg for copper (Yarsan et al, 2000). Lead, cadmium and copper levels detected in this present study were higher.

In China, Liang et al. (2004) have reported the 6 heavy metals levels investigated in veined rapa whelk. It was found (wet weight) 0.05 to 0.39 mg/kg for cobalt, 0.15 to 30.61 mg/kg for cadmium, 0.09 to 0.75 mg/kg for lead. On the contrary, the lead and cadmium concentrations in this study were determined higher.

On the east coast of the Middle Adriatic, it was investigated that heavy metal concentrations in the soft tissue of *Mytilus galloprovincialis* measured concentrations were found to be 2 to 7 mg/kg for Pb, 1 to 2.9 mg/kg for Cr, 2-13 mg/kg for Mn and 3.7 to 11.1 mg/kg for Cu (Orescanin et al., 2006). Lead copper and chromium concentrations of fish in our study were found higher.

Heavy metal concentrations of marine organisms depend on age, environment and feeding behaviour. Heavy metal concentrations are higher in internal seas than open seas (Filazi et al., 2003; Kayhan et al., 2006).

RECOMMENDATIONS

Children should not eat whole fish from these sites or any metals prepared using fish from these sites. Adults' particularly pregnant women should limit the number of whole fish eaten from these sites (Bolawa et al., 2009). An advisory notice should be made available to the public and posted on the media box and all the areas along those sites.

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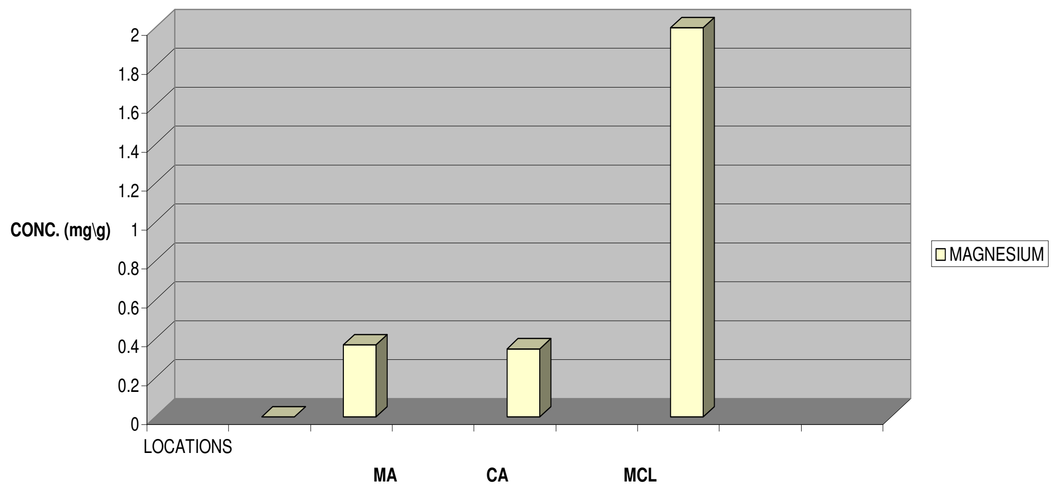
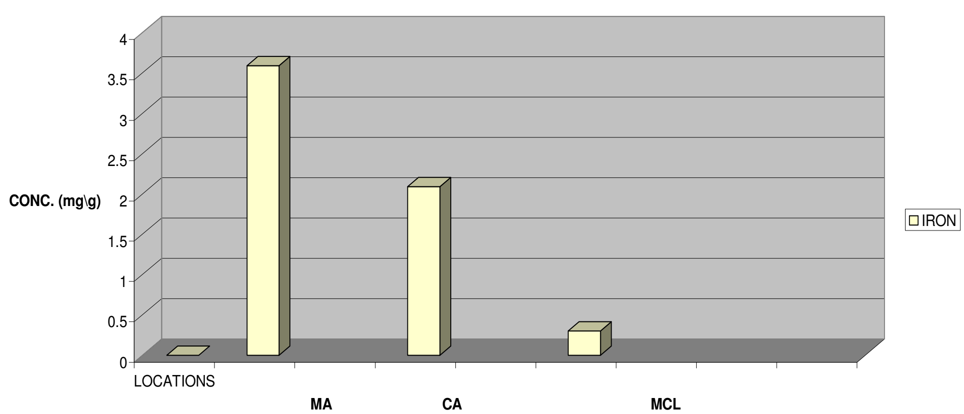
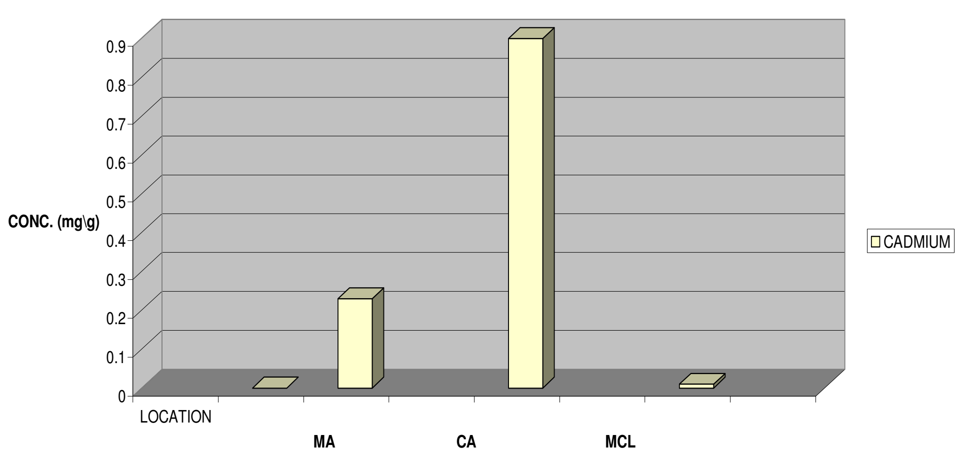
Appendix



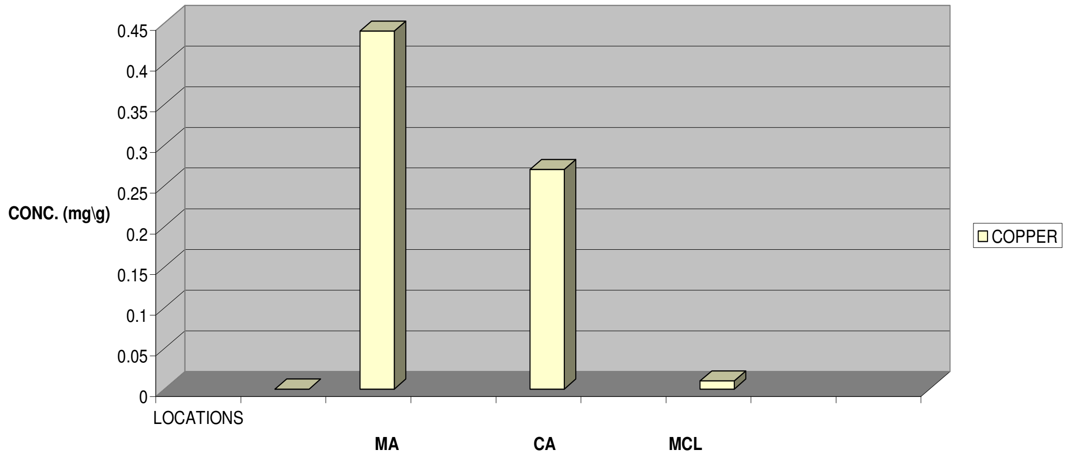
Level of Mg in Tilapia from Makoko (MA) and Carter (CA) Rivers.



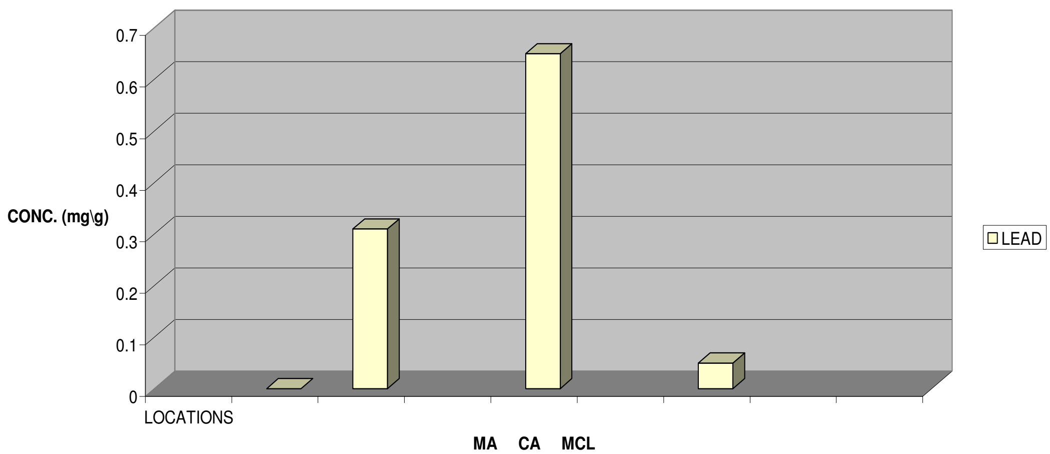
Level of Fe in Tilapia from Makoko (MA) and Carter (CA) Rivers.



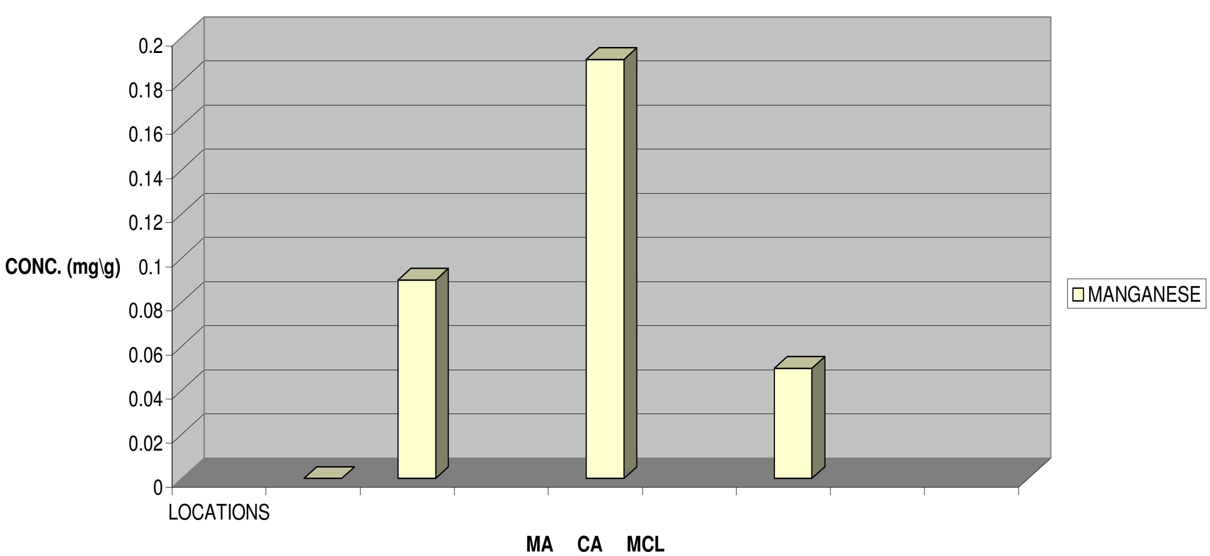
Level of Cd in Tilapia from Makoko (MA) and Carter (CA) Rivers.



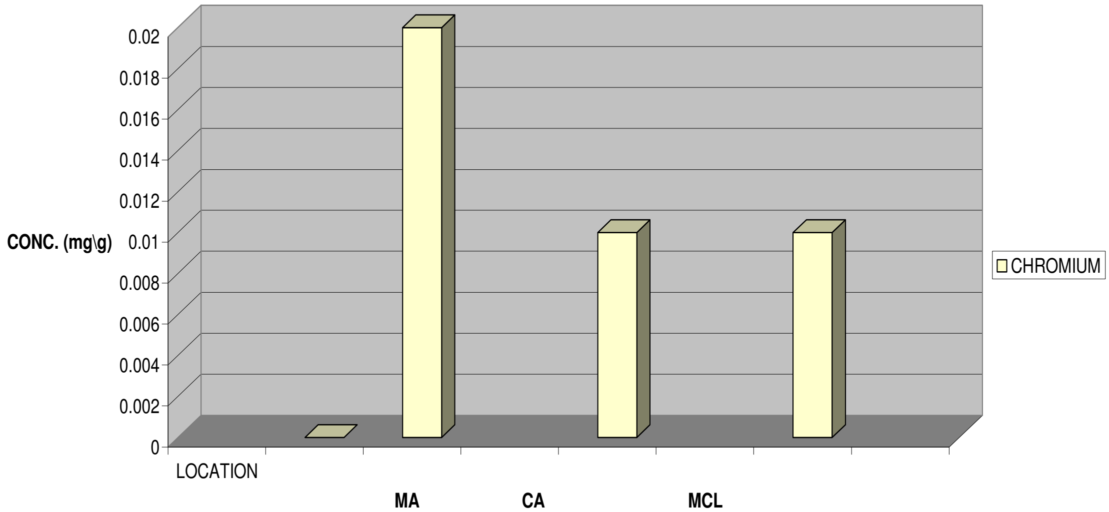
Level of Cu in Tilapia from Makoko (MA) and Carter (CA) Rivers.



Level of Pb in Tilapia from Makoko (MA) and Carter (CA) Rivers.



Level of Mn in Tilapia from Makoko (MA) and Carter (CA) Rivers.



Level of Cr in Tilapia from Makoko (MA) and Carter (CA) Rivers.

MCL	0.05	MCL	0.05

Concentration of Chromium in Tilapia	
Locations	**Cr**
Makoko River	0.02
Carter Bridge River	0.01
MCL	0.01