ASSESSMENT OF HEAVY METAL CONTENT IN IMPORTED AND LOCAL FISH AND CRUSTACEAN SPECIES OBTAINED WITHIN LAGOS METROPOLIS

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ABSTRACT

Fishes are known for their abilities to concentrate heavy metals in their muscles and since they play important role in human nutrition, they need to be carefully screened to ensure that unnecessary high level of some toxic trace metals are not being transfer to man through their consumption. The study was to evaluate heavy metals (chromium, lead, iron and cadmium) in imported and local species of shrimps, crabs and fish using Atomic Absorption Spectroscopy. The selected imported species were horse mackerel-kote fish (Trachurus trachurus), mackerel - titus (Scomber scrombus), croaker (Pseudotolithus typus), smooth swim crab (Portunus validus) and pink shrimp (Farfantepenaeus notialis) while the local species used were; Sole fish (Cynoglossus senegalensis), Tilapia (Oreochromis niloticus), brackish water catfish (Chrysichthys nigrodigitatus), freshwater catfish (Clarias gariepinus), lagoon crab (Callinectes amnicola) and freshwater prawn (Macrobrachium macrobrachion). It was observed that there was no significant difference in the metals (Cd, Pb and Cr) between the imported and local fish species and between imported and local crustacean species. However, these metals concentrated more in the local fish species, O. niloticus (1.846 ± 1.00 mg/100g). The mean heavy metals concentration occurred in the following decreasing order: Fe > Cd > Pb > Cr for all the samples. The mean concentrations of the analyzed heavy metals in the samples were below the maximum permissible limits as recommended by the International Atomic Energy Agency (IAEA), United Nations Environment Program (UNEP) and Federal Environmental Protection Agency (FEPA) for heavy metals in fish.

Keywords: Fish, Shrimp, Crab, Heavy metal, Chromium, Lead, Iron, Cadmium

INTRODUCTION

There has been a growing interest to determine heavy metals levels in the marine environments over a few decades now and attention was drawn to find contamination level of public food supplies, therefore, marine environments occasionally monitored for heavy metals contamination in water, sediment and aquatic animals (Ashraf, 2005). Aquatic foods are essential delicacies and form an important staple food for daily living of every human being. The ability of heavy metals been accumulated in aquatic animals is of great scientific interest as far as the knowledge of heavy metal is concerned (Kumar and Hema, 2007). Aquatic invertebrates take up and accumulate trace heavy metals which have the potential to cause toxic effects. Decapod crustaceans have the ability to metabolically regulate essential metals like zinc (Zn), copper (Cu) and manganese (Mn) (Rainbow, 1995) and in contrast tend to be effective bioaccumulators of non-essential metals such as lead (Pd) and cadmium (Cd), reflecting environmental levels and serve as bio-indicators of these metals (Rainbow *et al*., 1990; Usese *et al*., 2018).

Heavy metals are intrinsic, natural constituents of our constituents environment, they occur in the environment both as a result of natural processes and as pollutants from human activities (Garcia-Montelongo *et al*., 1994). They are stable and persistent environmental contaminants of aquatic environment, as it is difficult to remove them from the environment once they enter into it, they also move from one compartment to the other within the food chain. Some metals like iron (Fe), Zn, Cu, Mn, which are required for metabolic activity in organisms, lie in the narrow "window" between their essentiality and toxicity (Jordão *et al*., 2002). Other heavy metals like Cd, Pb, mercury (Hg) and chromium (Cr), may exhibit extreme toxicity even at low levels under certain conditions, thus necessitating regular monitoring of the aquatic environments (Fergusson, 1990; Cohen *et al*., 2001). Heavy metals are considered as harmful because of their non-biodegradable nature, long biological half-lives and their potential to accumulate in different parts of the body (Markus *et al*., 2010). Although some heavy metals such as Fe, Mn, Co, Cu, Zn are essential micronutrients for fauna and flora, they are dangerous at high levels (Ochieng *et al*., 2007).

Moreso, heavy metal at different concentrations has been found to impair the swimming pattern, skin colouration, feeding rate and general behavior of fish which suggests that fish can tolerate low concentrations of pollutants with reduced mortality (Dahunsi *et al*., 2011). Metals have the tendency to accumulate in various organs of aquatic organisms especially in fish (Karadede *et al*., 2004). Some contaminants in the sediments are taken up by benthic organisms, and when larger animals feed on these contaminated organisms, the toxin are taken in their bodies, moving up the food chain in increasing concentration in a process known as biomagnification (Abida *et al*., 2009; Lawal-Are and Babaranti, 2014). Bioaccumulation and biomagnification are capable of leading to toxic level of these metals in fish, even when the exposure is low.

Fishes are known for their abilities to concentrate heavy metals in their muscles and since they play important role in human nutrition, they need to be carefully screened to ensure that unnecessary high level of some toxic trace metals are not being transfer to man through fish consumption (Adeniyi and Yusuf, 2007). The selected imported species for this study were Horse Mackerel- Kote fish (*Trachurus trachurus*), Mackerel- Titus (*Scomber scrombus*), Croaker (*Pseudotolithus typus*), Smooth swim crab (*Portunus validus*) and Pink shrimp (*Farfantepenaeus noitialis*) while the local species used were; Sole fish (*Cynoglossus senegalensis*), Tilapia (*Oreochromis niloticus*), Brackish water catfish (*Chrysichthys nigrodigitatus*), Freshwater catfish (*Clarias gariepinus*), Lagoon crab (*Callinectes amnicola*) and Freshwater prawn (*Macrobrachium macrobrachion*). They were chosen because of their economic importance, acceptability and availability. The aim of this study therefore was to evaluate residue of heavy metals (Cd, Cr, Fe and Pd) in the aforementioned imported and local species of fish and crustacean obtained within Lagos metropolis.

MATERIALS AND METHODS

Sampling: The local fish samples used for the studies were bought from a local fresh fish market (Asejere Fish Market) in Makoko, Lagos State with source from Makoko area of Lagos Lagoon (Figure 1) which has been polluted with refuse, dyes and paints from industries, giving the water a black colour and a foul odour.

Figure 1: Makoko area of Lagos Lagoon

The lagoon is located between Longitudes 3º 23' and 3° 40' E, and Latitudes 6º 22' and 6º 38' N (Figure 2), shallow in most places, usually less than 1.5 m deep (Nwankwo, 1993; Moruf and Lawal-Are, 2015) and receives fresh water from rivers Yewa, Ogun, Ona and Osun.

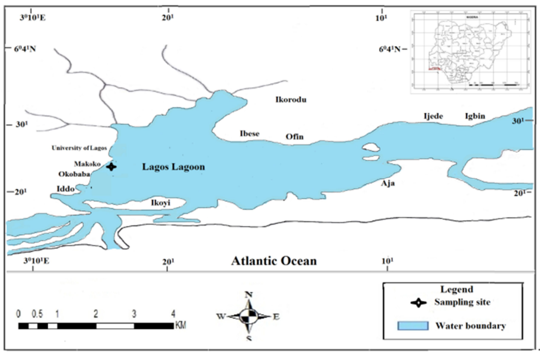


Figure 2: Map of Lagos Lagoon showing Makoko area (Source: Usese *et al.*, 2018)

The area surrounding the Lagos lagoon is probably the most urbanized and industrialized in Nigeria (Okoye *et al.,* 1989). This lagoon plays a significant role for the human community due to the prosperous and massive fishing exploitation and commerce. However, the environment is also very sensitive to the stress exerted by human activities that may affect and damage its ecological equilibrium.

The imported fish species where bought from the popular Ijora Fish Market in Lagos State, all in frozen state. The samples were collected and preserved in a freezer at a temperature of -20°C till the time of analysis.

Determination of Heavy Metals in Biological Samples: The wet method of digestion was used to carry out the sample digestion. The weights of the specimens were taken and 1 g of flesh of each of the sampled fish was weighed into a 100 ml beaker, 10 ml of 3:1 acid mixture was added (nitric acid and perchloric acid). The mixture was then transferred to a hot plate and digested at a temperature of 150°C until total dissolution was achieved and the samples became clear. Atomic Absorption Spectrophotometer (AAS) was used as described by APHA (1995) to determine the level of various heavy metals.

Statistical Analysis: The data obtained were subjected to a one-way Analysis of Variance (ANOVA). Duncan Multiple Test Range was used to test for significant relationship among heavy metals levels in the flesh of the fish and crustacean samples at $p<0.05$.

RESULTS AND DISCUSSION

The results obtained (Tables 1 and 2) indicated the variation of heavy metals present in the selected imported and local fish and crustacean species. All the collected samples contained the metals analyzed for in detectable amounts. It was observed that there were no significant differences ($p>0.05$) in the metals (Cd, Pb and Cr) between the imported and local fish species and between imported and local crustacean species. However, *O. niloticus* had higher concentrations of these metals. According to Elnabris *et al.* (2013), trivalent chromium is believed to play an important role in cholesterol and amino acid metabolism and acts as a cofactor for the hormone insulin, however, high intake beyond the permissible limit is carcinogenic to man and other mammals.

There was significant difference ($p<0.05$) in the concentration of Fe between the imported and local fish species and between imported and local crustacean species. The local fish species contained more Fe than the imported species; however, imported crustaceans (*P. validus* and *F. noitialis* were iron richer than the local crustaceans sampled (*C. amnicola* and *M. macrobrachion*). This result was in agreement with the study of Zhang and Cheng (2007) on fishes from Pahang estuary. According to Tuzen and Yilmaz (2001), the variations in the concentrations of heavy metals in different fish species may be due to ecological demands, metabolism and eating behaviour and body size. The mean concentrations of the analyzed heavy metals in the samples were below the UNEP, IAEA and FEPA maximum permissible limits of heavy metals in fish as reported by Ekeanyanwu *et al.* (2011).

The results on Figures 3 and 4 showed that the mean heavy metals concentration occurred in the following decreasing order: Fe > Cd > Pb > Cr for all the samples which was similar to the report of Jumbo *et al.* (2015) on the heavy metal concentrations of some fin and

Table 1: Heavy metal content in imported and local fish species obtained within Lagos metropolis

Metal (mg/kg)	Imported fish species			
	Scomber scrombus	*Trachurus trachurus*	*Pseudotolithus typus*	
Cadmium	0.027 ± 0.00	0.025 ± 0.00	0.028 ± 0.00	
Iron	0.584 ± 0.06 ^{a}	0.462 ± 0.07^{a}	0.591 ± 0.05^{a}	
Lead	0.018 ± 0.00	0.018 ± 0.00	0.0211 ± 0.00	
Chromium	0.002 ± 0.00	0.001 ± 0.00	0.002 ± 0.00	
	Local fish species			
	Cynoglossus senegalensis	*Oreochromis niloticus*	*Chrysichthys nigrodigitatus*	*Clarias gariepinus*
Cadmium	0.029 ± 0.00	0.036 ± 0.00	0.028 ± 0.01	0.033 ± 0.01
Iron	0.573 ± 0.11^{a}	1.846 ± 1.00 ^{b}	0.672 ± 0.03 ^{c}	0.633 ± 0.03 ^{c}
Lead	0.020 ± 0.00	0.023 ± 0.00	0.020 ± 0.01	0.018 ± 0.00
Chromium	0.002 ± 0.00	0.004 ± 0.00	0.002 ± 0.00	0.002 ± 0.00

Mean ± standard error of mean (SEM) of three replicates, (n=3). Values with different superscript in the same row are significantly different at the 0.05 levels while values without superscript within a row are not significantly different (p< 0.05)

Table 2: Heavy metal content in imported and local crustacean species obtained within Lagos metropolis

Metal (mg/kg)	Imported crustacean species		Local crustacean species	
	Portunus validus	*Farfantepenaeus noitialis*	*Callinectes amnicola*	*Macrobrachium macrobrachion*
Cadmium	0.023 ± 0.01	0.027 ± 0.01	0.015 ± 0.00	0.023 ± 0.00
Iron	0.661 ± 0.01^{a}	0.597 ± 0.1^{a}	0.329 ± 0.01^{b}	0.451 ± 0.1^{c}
Lead	0.012 ± 0.00	0.015 ± 0.00	0.010 ± 0.00	0.010 ± 0.00
Chromium	0.001 ± 0.00	0.002 ± 0.00	0.001 ± 0.00	0.001 ± 0.00

Mean ± standard error of mean (SEM) of three replicates, (n=3). Values with different superscript in the same row are significantly different at the 0.05 levels while values without superscript within a row are not significantly different (p< 0.05)

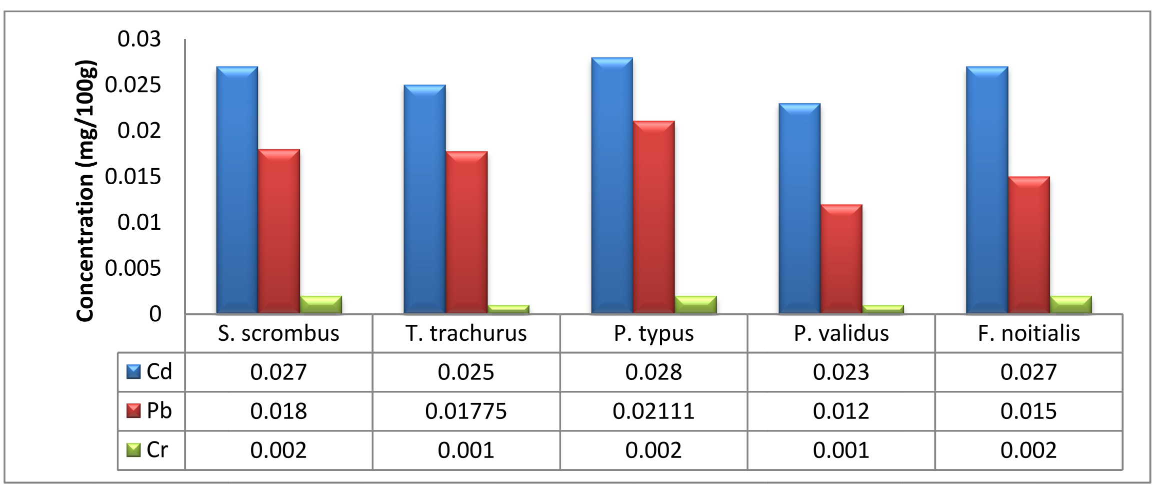
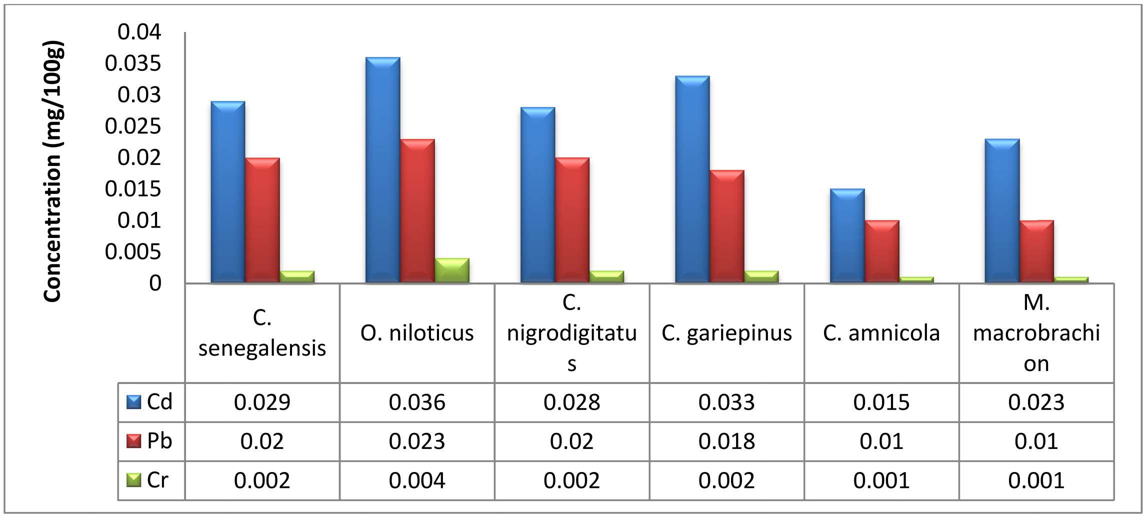


Figure 3: Heavy metal concentration in imported fish and crustacean species obtained within Lagos metropolis



	C. senegalensis	O. niloticus	C. nigrodigitatus	C. gariepinus	C. amnicola	M. macrobrachion
Cd	0.029	0.036	0.028	0.033	0.015	0.023
Pb	0.02	0.023	0.02	0.018	0.01	0.01
Cr	0.002	0.004	0.002	0.002	0.001	0.001

Figure 4: Heavy metal concentration in local fish and crustacean species obtained within Lagos metropolis

shell fish from Ogoniland, southern Nigeria. The report of the present study shows that the concentration of iron is highest for all samples; however, it was not above the FEPA (2003) maximum permissible limit.

Conclusion: The results of this finding present a valuable baseline data on the heavy metals in the various fish and shellfish species market within Lagos State, Nigeria. It was observed that the concentrations of heavy metals recorded in samples were below the UNEP, IAEA and FEPA maximum permissible limits of heavy metals in fish. However, the fact that some level of toxic metal bioaccumulations (Cd and Pb) was found in the local fish samples is a cause for constant monitoring of the source (Makoko area of Lagos Lagoon).

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