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HEAVY METAL CONTENT OF SOLE, *Solea solea* and CROAKER, *Pseudotolithus typus* FROM LAGOS AND DELTA STATES, NIGERIA

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ABSTRACT

This study investigated the levels of lead (Pb), cadmium (Cd), Copper (Cu), Chromium (Cr) and Zinc (Zn) in two common edible fish species, Sole, *Solea solea* and Croaker, *Pseudotolithus typus* from Makoko and Koko in Lagos and Delta states respectively. Heavy metal contents were determined by air-acetylene flame Atomic Absorption Spectrophotometer after wet digestion of dried and milled samples with 1:1 HNO_3: H_2O_2. Results obtained ($\mu g/g$, dry weight) for Sole in Lagos and Delta states were: Pb (0.330 and 0.149), Cd (0.097 and 0.063), Cu (0.869 and 0.434), Cr (1.184 and 0.826), Zn (7.612 and 7.890); and Croaker: Pb (0.163 and 0.045), Cd (0.115 and 0.029), Cu (0.990 and 0.694), Cr (1.008 and 1.038) and Zn (6.756 and 6.168) for the wet season (April-October); and Pb (0.534 and 0.527), Cd (0.373 and 0.410), Cu (0.437 and 0.556), Cr (0.834 and 0.983), Zn (6.764 and 9.343) for sole and Pb (0.210 and 0.213), Cd (0.264 and 0.307), Cu (0.442 and 0.483), Cr (0.577 and 0.597) and Zn (4.783 and 5.924) for croaker in the wet season (July-October). Significant (P□ 0.05) variations were observed in metal content between fish in terms of species, location and season. Generally, sole had higher metal concentrations than croaker; and metal contents were higher in samples from Lagos compared to Delta, probably due to the contribution of more effluents from industrial, commercial and municipal wastes in Lagos state. Cd and Cr levels in the test species were found to exceed international standards. It is recommended that a programme of continuous monitoring and control of the physical and chemical characteristics of components and food products of Nigeria's coastal zone be incorporated as a management tool for this important ecological zone.

Keywords: Heavy metal, *Solea solea*, *Pseudotolithus typus*, Lagos, Delta, seasonal variation

INTRODUCTION

The Nigerian coastal zone sprawls a total of nine states including Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Lagos, Ogun, Ondo and Rivers. Fish, a major product of the zone is a rich source of protein, minerals and other essential nutrients. Sole, *Solea solea* and Croaker, *Pseudotolithus typus* are among the most commonly available and economically important fish species in Nigeria's maritime states and contribute significantly to animal protein intake of the urban population in these states. Lagos and Delta states are important coastal states with a blossoming shipping and freighting industry especially in Lagos state, which doubles as the industrial and commercial centre of Nigeria with the highest number of industries and arguably the largest human population within a state in the country. As the commercial and industrial nerve centre of Nigeria with an estimated population of over 9 million people (National Population Commission, NPC, 2006), environmental concerns are normally focused on Lagos State. Over 60% of Nigeria's industries are cited in the state, each discharging its characteristic range of effluents, often containing heavy metals into the terrestrial and aquatic ecosystems within the state. Water pollutants originate from point and non point sources. Point sources are distinct and confined, and include accidental spills from industrial sites that empty into streams or rivers. On the contrary, non-point sources, such as run-off, are diffuse and intermittent; and influenced by factors such as land use, climate, hydrology, topography, native vegetation and geology. Common urban non point sources include urban run-off from streets or fields and contain all sorts of pollutants from heavy metals to chemicals and sediments. Rural sources of non point pollutants are generally associated with agriculture, mining or forestry. Non point sources are usually difficult to monitor and control (Botkin and Keller, 1998). The hazard presented by a particular water pollutant depends on several factors including the concentration or toxicity of the pollutants in the environment and the degree of exposure to people or other organisms (Pye and Patrick, 1983).

It is estimated that over 80% of coastal pollution originates from land-based sources, including industrial, agricultural, oil and gas production and marine oil transportation activities (Ducrotroy, 1966). Recent works suggest that toxic materials threaten the ocean bottom as well as the entire marine ecosystem. The base of the marine food chain consists of planktonic life which occupies the upper 3mm of the ocean water. The young of most fin and shell fishes also reside in the upper few millimeters of the ocean; and tend to concentrate pollutants such as toxic chemicals and heavy metals. It is reported that concentrations of zinc, lead, and copper in the upper 3mm (or micro layer) is from10 to 1000 times higher than in the deepest waters due to a process referred to as surface film enrichment (Millero, 1996). There is fear that disproportionate pollution of the micro layer will have serious effects on marine organisms (Greig *et. al.*, 1977; Leussen, 1989), resulting in major impacts on people and society as contaminated marine organisms transmit toxic elements or diseases to their consumers (Greig *et. al.*, 1977).

Heavy metal contamination of the aquatic environment has become a worldwide challenge, mainly because heavy metals are indestructible; and most of them have toxic effects on organisms (MacFarlane and Burchett, 2000). Among environmental pollutants, metals are of particular concern, due to their potential toxic effects and ability to bio-accumulate in aquatic ecosystems (Censi *et. al.*, 2006). Heavy metal concentrations in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and biota (Camusso *et. al.*, 1995). Generally metal concentrations are low in water and attain considerably higher concentration in sediments and biota (Namminga and Wilhm, 1976). Heavy metals, including both essential and non-essential elements generally have high significance in eco-toxicology because they are highly persistent and also have the potential to be toxic to living organisms (Storelli *et al.*, 2005). Concerns over heavy metal pollution of the marine environment have been rising due to the human activities that contribute significantly to the release of these metals into the environment. Skejelkvale *et. al.* (2001) reported that heavy metals in the environment are brought about primarily by anthropogenic sources. Though heavy metals are a part of the natural environment and provide numerous benefits to society, those that get deposited in most water bodies result from coal and oil combustion, internal combustion engines, local point sources, and direct deposition from air pollution, bedrock geology and soils (Skejelkvale *et. al.*, 2001).

The concern posed by heavy metals in the environment creates an immense threat to the existence of organisms thriving in the area and the ecological integrity of the habitat, particularly as heavy metals may enter the food chains, persist in the environment, bio-accumulate and bio-magnify, then increase exposure of consumers of aquatic products to serious health risks.

MATERIALS AND METHODS

Two species of fish *Pseudotolithus spp* (croaker) and *Solea solea* (sole) which are lenthic and benthic fishes respectively were used for the study. Sampling was done six times in May, July, September (Wet season) and November, January, and March (Dry season) at Makoko, Lagos State and Koko, Delta State. Fish samples were bought fresh from fishermen at landing sites in the locations; and preserved by cooling in ice buckets till they were transferred into deep freezers in the laboratory and kept frozen until analysis.

For analysis, frozen fish samples were allowed to defrost at room temperatures about two (2) hours. The thawed fish samples were then oven dried at 105^0C for about 12hours until constant weight. Thereafter dried fish samples were homogenized using a ceramic mortar and pestle.

The samples were prepared with utmost care to avoid contamination. Hand-gloves were worn throughout the analytical procedures, and precautions were taken to carry out all preparations under strict sanitary laboratory conditions. Where drying was not completed in one day, samples were kept in desiccators and oven-drying was continued the following day.

Glass wares used were washed and rinsed severally with distilled water; then washed in 10% HCl before use.

Samples were digested according to the wet digestion procedure of Asegbeloyin *et al.* (2010), by digesting 10.00 g of dried sample in 60 ml of freshly prepared 1:1 HNO_3/H_2O_2 solution at 160^0C on a hot plate for about one hour until the volume of contents was reduced to about 5.00 ml. Contents were then filtered and the filtrate transferred to a standard flask and made up to 25.00 ml with distilled de-ionized water. This was stored in plastic bottles and the concentrations of Pb, Cr, Cu, Cd and Zn were evaluated using air-acetylene flame AAS (AAnalyst 200, Perkin Elmer).

Data obtained were subjected to one-way Analysis of Variance (ANOVA) according to the procedure of Steel and Torrie (1980). Significantly different means were separated using the methods of Duncan. The values obtained were presented as Least Significance Differences (LSD) of means at ($p<0.05$).

Results and Discussion

Metal (Pb, Cd, Cu, Cr and Zn) concentrations in the two fish species and sampling locations were compared with international standards. As expected, the metals were more concentrated in sole (a benthic fish) fish than croaker, a pelagic fish; except for Cu where the concentrations in croaker were higher than in sole and Cd where concentrations found in Croaker for Lagos State was higher than those found in Sole.

As shown in figure 1, the obtained result for lead concentrations showed that only sole from Lagos (LS) with $0.330\mu g/g$ was higher than the standard of $0.2\mu g/g$ (EC, 2005).

In general, lead values obtained in this study were similar with those reported in previous studies (Eletta *et al.*, 2002). Lead is known to exert its most significant effects on the nervous system, the hematopriotic system and the kidney. It has effects on the nervous system including motor disturbances.

The concentration of Cadmium in all the experimental fish were higher than the EC, 2005 limit of $0.05\mu g/g$, except in Delta croaker with a concentration of $0.029\mu g/g$. Cadmium concentrations in this study were higher than those reported earlier by Edem *et al.* (2009). Adverse effects of excessive chronic cadmium exposure may include chronic renal failure, kidney stones, liver damage (rare), lung cancer, osteomalacia, possibly hypertension, prostatic cancer, and proteinuria. Chronic cadmium exposure has been reported to cause mild anemia, skeletal lesions, Itai-itai disease, anosmia, and yellowing of teeth. Cadmium is a cumulative toxin. Its levels in the body increase over time because of its slow elimination. It accumulates chiefly in the liver and kidneys. However, it also accumulates in muscle and bone.

Chromium concentrations in this study were lower than previously reported by Burger and Gochfeld (2005) but higher than the standard for chromium 0.730μg/g (International Atomic Energy Agency, IAEA-407). Reported health effects of chromium toxicity include haemolysis, renal and liver failure, cancer and damage to circulatory and nervous tissues.

Mean concentrations of zinc in this study were lower than the reported standard of 3.280ppm (IAEA-407). Zinc deficiency has been associated with dermatitis, anorexia, growth retardation; poor wound healing, hypogonadism with impaired reproductive capacity.

Also, the study showed more heavy metals' pollution in Lagos lagoon fish samples than in Koko lagoon except for Zn, where the concentrations in Delta were more than those of Lagos state. The concentrations of Zinc were much lower than the tolerable values stated in the standard.

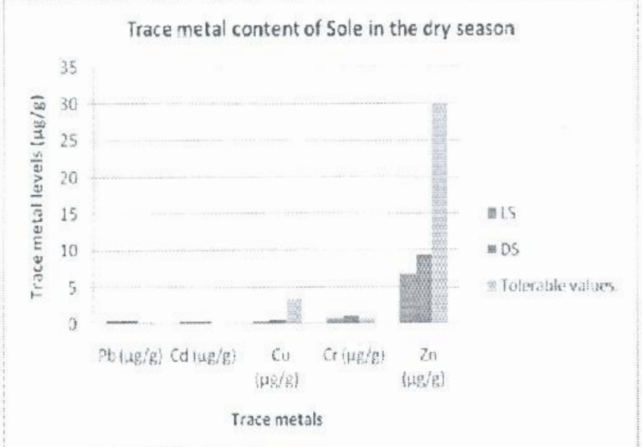

Fig.1: Trace metal content of sole in dry season (Nov. –March)

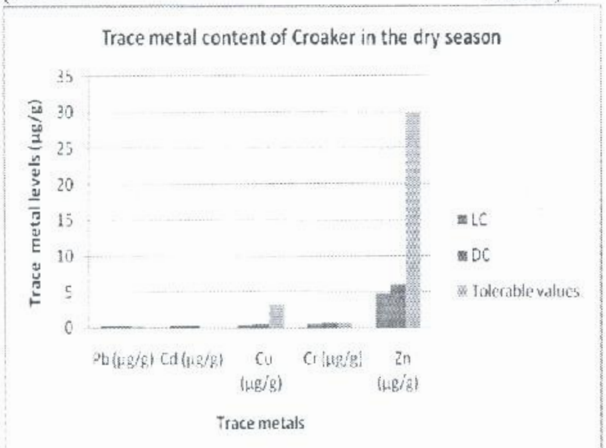

Figure 2: Trace metal content of croaker in the dry season (November – March)

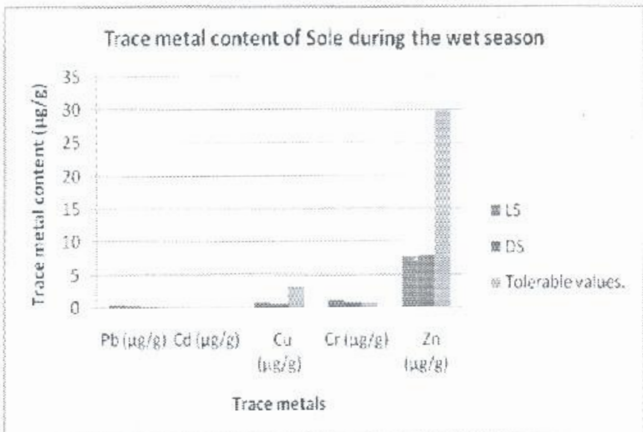

Figure 3: Trace metal content of sole during wet season (May – September)

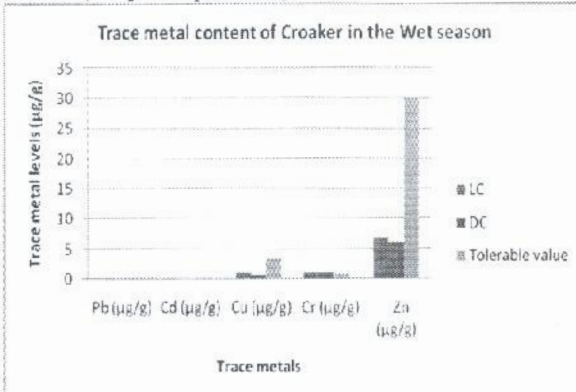

Fig.4 Trace metal content in Croaker in the Wet Season(April - October)

Table 1: Effect of season on metal contents of Sole and Croaker

Season	Metal contents (μg/g)				
	Pb	Cd	Cu	Cr	Zn
Wet	0.34 ±0.11	0.34 ±0.04 [a]	0.48±0.04 [b]	0.73±0.10 [b]	6.70±0.64
Dry	0.17 +0.05	0.8 +0.02 [b]	0.75±0.12 [a]	1.01±0.09 [a]	7.11±0.30

Table 2: Differences in metal content between fish species

Fish Species	Metal contents (μg/g)				
	Pb	Cd	Cu	Cr	Zn
Sole	0.41 ±0.12 [a]	0.26 ±0.06	0.56 ±0.08	0.95 ±0.10	7.92 ±0.51 [a]
Croaker	0.13 ±0.04 [b]	0.19 ±0.04	0.62 ±0.10	0.76 ±0.10	5.83 ±0.44 [b]

Table 3: Effect of location on metal content of Sole and Croaker

Location (States)	Metal contents (μg/g)				
	Pb	Cd	Cu	Cr	Zn
Delta	0.28±0.10	0.23±0.04	0.65+0.11	0.86÷0.11	6.38±0.46
Lagos	0.27+0.11	0.23+0.06	0.54÷0.05	0.85+0.09	7.37±0.61

RECOMMENDATIONS

It is important to publish these findings and educate consumers, particularly those in coastal areas on the health and safety hazards associated with fish consumption.

The project is on-going, and should be expanded to include all economically important fish species from coastal artisanal fisheries.

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