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Distribution of some Heavy Metals in selected Seafood and Shell from abonnema water in rivers in State Nigeria

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ABSTRACT

Some heavy metals concentrations in shellfish and Seafood sourced from Abonnema water, a major water body in the Nigerian Niger Delta Area, were investigated. Samples were prepared according to American standard test methods. The total mean dry weight, dw concentration of Cadmium ranged from 0.121mg/kg – 0.716mg/kg, Lead, 0.401mg/kg – 5.531mg/kg, Magnesium, 6.101mg/kg – 640.880mg/kg, Calcium, 4630.500mg/kg – 30723.510mg/kg, and non detectable levels were observed for Mercury. While Tympanotonus fusca (periwinkle) shell gave the highest calcium value of 30723.510mg/kg dw, the levels of Cadmium, Lead, Calcium and Magnesium in Penacus indicus (prawn) were significantly lower compared to those found in the flesh of periwinkle and oyster flesh. The mean trace Lead concentrations in the samples studied were statistically (P< 0.05) significant in T. Fusca (flesh and shell) and Crassostrea gasar (oyster) shell, when compared with the WHO acceptable limit of 0.5 – 1.0.mg/kg. This study therefore advocates environmental surveillance of the water and sediment quality to ensure safe shellfish and seafood for human consumption.

***Keywords**:Environmental contaminants; Seafood; Shellfish; Niger Delta; Bioaccumulation; Heavy metals uptake.*

INTRODUCTION

Seafood is used to describe various creatures from the ocean and is categorized into shellfish (e.g. Oysters, squid, missile, lobster, prawns, crab and shrimp) and fish. Seafood is an excellent source of protein and its low – calorific value makes it a healthier alternative to red meats or poultry. It is also rich in Vitamins A, E, C and D as well as calcium and iron [1]. Anthropogenic influences on aquatic habitats, especially arising from increased industrialization has heightened research on the safe level of seafood. Heavy metals among others have continued to pose such environmental hazard [2] and their accumulation in tissues of human and other organisms can be fatal even at low concentrations [3,4]. Unlike persistent organic pollutants, metals accumulate in protein tissues and bone rather than in the fat of animals [5]. Chronic symptoms frequently associated with excessive accumulation of heavy metals, include fatigue, muscle – skeletal pain, neurological disorders, depression, failing memory, and allergic hypersensitivity [6,5]. Emissions of heavy metals in relation with the human activities are of two types: emissions from diffuse sources, such as automobiles and emission from stationary sources (e.g. industry, waste disposal, etc). Diffuse sources are especially important in urban areas [7] as these reflect in some aquatic bodies [8]. Heavy metals are taken up by both flora and fauna. This could provoke increase in concentration in the organisms; if the excretion phase is slow, bio-accumulation gets activated. Mercury is poisonous and is not essential for living organisms [9]. Lead is derived from soil and rocks and fall-outs from dusts and vehicular exhausts, but much is derived from pipes [6]. As cadmium and zinc are found together in natural deposits, so are they similar in structure and function [6]. Magnesium is the fourth most abundant mineral in the body and is essential for good health [9] and is involved in energy metabolism and protein synthesis. Calcium is the most abundant metal in the body and is the main constituent of bones and teeth 10. Abonnema is located in the Southern Niger Delta of Akuku – toru Local Gpvernment Area of Rivers state Nigeria. They are mostly fishermen because they are surrounded by water. Oil spillage is a regular event in the area. The careless disposal of wastes from markets, artisal refineries and abandoned well heads pose environmental threat to Abonnema aquatic ecosystem. It is therefore necessary to evaluate the levels of some heavy metals in some seafoods and their shell, locally sourced from Abonnema river and to compare their tissue distributions.

MATERIALS AND METHODS

Sample preparation

The samples were separated according to type and washed in distilled water to remove all loose silt and dirt and then drained. All samples were labeled and transferred to the laboratory for analysis. The prawns and the detached flesh of the Periwinkle and Oyster were placed on a foil paper, labelled and oven dried at 105^{o}C to constant weight. These were later cut to pieces into a crucible and weighed. The weight of the shell was also taken. Samples were ashed in a heated furnace and later cooleed in a dessicator.

Sample digestion

To a beaker containing 2g samples, 10% HCl was added and was placed on a hot plate according to FAO [11] until the organic matter were broken down evident in volume reduction. On cooling, the content were transferred to a 100ml volumetric flask (fitted with a filter paper) and made up to mark with distiled water. The diluted samples were transfered into sample bottles and labelled. The total metal (Hg, Pb, Cd, Mg and Ca) concentration of the sample was then determined by Atomic Absorption Spectrophotometry (GBC Avanta PM 2.02).

Statistical analyses

Experimental Data (n = 3)were subjected to one - way analysis of variance (ANOVA) using SPSS. V17.0 and mean comparisons were performed using Duncan's new multiple range test ($p \leq 0.05$).

RESULTS AND DISCUSSION

The levels of Hg, Cd, Pb Mg and Ca in soft tissue and shell of the Crassos*trea gasar* (Oyster) and *Tympanotonus fusca* (Periwinkle) as well as seafood, *Penacus indicus* (Prawn) collected at random from Abonnema water were measured. 0.001 – 30723.51mg/kg dw. Mercury was not detected for all samples except for *C. Gasar* which concentration in flesh outweighs those of the shell (Table 1). A similar observation was made by Shirneshan et al. (2012). High Hg levels of 3.01 mg/kg dw far exceeded the levels in fishes studied by Conti et al. (2012) that gave elevated levels of 0.027 ppm from contaminated Mediterranean Sea surrounding Lampedusa island and compared favourably with the concentrations in bottlenose Dolphins [14]. The nutrient elements, Ca and Mg are essential in diet but produce undesirable effects at higher levels, or in situation where the balance between intake and excretion has been upset. Mercury, Lead and Cadmium are toxic even at very low concentrations and have no known function in biochemical processes [6].

Table 1 Mean concentration (mg/kg dw) in studied samples

Samples	Hg	Cd	Pb	Mg	Ca
T. fusca flesh	<0.001	0.716^{x}±0.001	5.531^{a}±0.001	640.88^{w}±21.11	18707.99^{b}±40.21
T. fusca shell	<0.001	0.391^{f}±0.001	2.401^{i}±0.001	6.451^{m}±0.96	30723.51^{g}±16.47
C. gasar flesh	3.01^{g}±0.000	0.212^{y}±0.001	0.611^{b}±0.02	304.11^{x}±11.07	8097.33^{c}±40.01
C. gasar shell	0.67^{h}±0.000	0.281^{f}±0.12	2.071^{j}±0.78	6.101^{n}±1.66	30258.64^{g}±33.64
P. indicus	<0.001	0.121^{z}±0.001	0.401^{b}±0.001	257.78^{t}±10.45	4638.50^{d}±21.06
WHO limit	0.5	0.5 – 1.0	2.0	Not applicable	Not applicable

Values are means ± SE (n = 3); means in the same column with the same superscripts are not significantly different at $p \leq 0.05$.

Cadmium levels in Oyster flesh were comparable to those of Chaharlang et al. [12] Highest levels were found in the flesh of Periwinkle and differed significantly with those found in the shell. Cadmium levels, except for the periwinkle were within acceptable limits for human consumption of 0.5 – 1.0 mg/kg as reported by Kakulu et al. [13]. The abundance of all studied metals in the shell *C. gasar* over the flesh is indicative of clear mobilization route expressed. The reverse was the case for *T. fusca* with a mean Cd concentration of 0.391 mg/kg dw. High Lead levels in Periwinkle samples clearly indicates considrable anthropogenic inputs. It is interesting to note that *C. Gasar* and *T. Fusca* are known to accumulate contaminants and form biological indicators of pollution [12,13]. High levels (5.531 mg/kg dw) of lead in the flesh of Periwinkle could be responsible for decreased calcium content in same tissues. Investigations by Conti et al. [15] revealed 0.035 ppm Pb and 0.001 ppm Cd from contaminated Mediterranean Sea fish. Lead most likely interferes with functions performed by essential mineral such as calcium, iron, copper, and zinc [6], especially several red blood cell enzyme systems. Ingested, injected, or inhaled Lead is toxic to virtually every system in the animal body. Dietary concentration of 5 ppm is almost associated with adverse health effects; levels as low as 1 ppm have had undesirable effects. The high Lead content may be attributed to a higher state of contamination from the use of leaded gasoline (GESAMP, 1991) in operation in and around the water.

Lead can displace calcium in bone, fish or from animal – derived food (UNEP, 1999). It binds with the sulfhydryl bonds and inactivates the cysteine – containing enzymes, thus allowing more internal toxicity from free radicals, chemicals, and other heavy metals. Overall, more of the calcium content were located in the shell (up to 30723.51 mg/kg dw). High calcium levels can cause contipation and might increase the risk of kidney stones (WHO, 1992). Levels of Magnesium for all samples was remarkably high and were statistically significant ($P \leq 0.05$). They are important in maintenance of normal muscle and nerve function. Up to 640.88mg/kg dw of Mg was found in the flesh of Periwinkle. However, enhanced levels of these heavy metals may bring about bioaccumulation in other organisms, including man that depend on them for survival. Although not all sources and biotic receptors are spatially linked, and also physical and ecological processes are important in transferring MeHg from source regions to bioaccumulation in marine food webs and from lower to higher trophic levels (Chen et al., 2008), closer surveillance is pertinent.

High levels of Cd and Pb observed for the seafood sourced from Abonnema water, a major fishing feed in the Nigerian Niger Delta is quite alarming among others. The contaminants migration and deposition between the shell and edible flesh for the shell fishes could be interesting in the study of the fate of these contaminants. Also, depletion of available nutrients with contamination was observed for the species studied.

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