Scientia Africana, Vol. 16 (No. 2), December 2017. Pp 29-37
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THE EVALUATION OF TRACE METAL CONCENTRATION IN SELECTED SEAFOOD SPECIES FROM NEW CALARBAR RIVER, IN RIVERS STATE NIGERIA

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Received : 27-03-17
Accepted :30-05-17

ABSTRACT

Three sea foods namely prawn, crab and tilapia fish from 'new calabar river' were assessed to determine their heavy metal concentrations as well as the health effects on the consumers. Samples were treated with concentrated trioxonitrate V and perchloric acid on a hot plate before analyzing the selected metals with an absorption spectrophotometer and flow injection mercury system (FIMS). Results obtained for crabindicated that; nickel (3.890-4.190 mg/kg), cadmium (0.007mg/kg), arsenic (0.010-0.020 mg/kg), lead (3.270-3.310 mg/kg), vanadium (0.004 mg/kg), chromium (2.970- 3.120 mg/kg), cobalt (1.050-1.190 mg/kg) show the highest concentration of all the heavy metals analyzed compared to the other sea foods. Prawn has the least concentration of heavy metals. The concentrations of nickel, lead and chromium in the three sea foods were above World Health Organization standard, while cadmium and vanadium in the three sea foods were within World Health Organization limit. The concentrations of arsenic in prawn and tilapia fish were within acceptable standard, while that of cobalt was within acceptable limit only in prawns. The concentration of heavy metals in sea foods depends on their mode of feeding as well as their body permeability. Heavy metal contaminated fish can cause several health hazards in humans ranging from cancers, liver damage, kidney failure, bronchitis among others.

Key Words: Toxicity, ecosystem, adsorption, permeability, anthropogenic, bio-indicators, concentration.

INTRODUCTION

Contaminations of rivers, seas, lakes and other water bodies as well as aquatic animals by heavy metals have been a cause for concern worldwide especially in developing countries like Nigeria. The rate of industrialization has a great impact on the level of pollution of rivers and aquatic animals; this can be attributed to the release of untreated industrial effluents and waste products into the aquatic system (Malik *et al.,* 2010). Heavy metal pollution of aquatic ecosystem is on the increase due to increase in urbanization, population, industrialization and agricultural practices and has become a global problem (Giguere *et. al.,* 2004). A heavy metal can be defined as a metal with a relatively high density (>7g/cm^3) or atomic weight (>20) and is often assumed to be toxic (Bonetti et. al., 2009). Heavy metals can be classified into "light essential metal", "essential metal" and "toxic heavy metals". Light essential metals are present of higher level than the other as it is extremely vital in biological function (Pourang *et. al.,* 2004). Zinc and copper are examples of essential heavy metals while cadmium and mercury can be characterized as non-essential metals, they could be toxic even when present in low concentration (Saleh *et. al.,* 2010). Though the essential metals are needed by living organisms for certain function, they could become toxic in the aquatic environment when present at high concentrations (Ahmad and Sarah, 2014). Heavy metals as a source of pollution is of great concern not only because of their toxicity but also due to their persistence in the environment (Voutsinou-Taliadouri, 1981). The impossibility of degrading heavy metals results in their being deposited and absorbed in the aquatic ecosystem (Linnik and Zubenko, 2000). Heavy metals gain entrance into the aquatic environment through human activities and natural sources. The ecological balance of the ecosystem is highly affected by the discharge of contaminants into the aquatic body (Malik *et. al.,* 2010). Aquatic organisms such as fish, shrimps and crabs accumulate high concentration of contaminants in their tissues and magnify them up the food chain; as such there are several severe health hazards that threaten fish consumers by the consumption of heavy metal contaminated fish (Giri *et. al.,* 2013). Fish and aquatic organisms are considered excellent bio-indicators for the measurement of heavy metals in the aquatic environments due to a number of reasons ranging from fish occupies a higher tropic level in an aquatic ecosystem to the negative impact of heavy metal toxicity on the physical and physiological behavior of fish as well as the fact that fish is an important constituent of human diet worldwide (Shazili *et. al.* (2006); Pandey *et. al.,* 2014).

The New Calabar River situated at choba in Rivers State of Nigeria that flows through the University of Port Harcourt Teaching Hospital, (UPTH), University of Port-Harcourt and other Industries, receives untreated waste resulting from the drainage activities of the above institutions and industries. In view of the activities of these institutions and industries which discharge their untreated waste products into the river and due to the fact that the inhabitants carry out fishing activity in the river for protein requirement it is necessary to investigate the level of contamination of sea food in the river. Fish has the ability to accumulate heavy metals in their muscles with the tendency of transferring it to man since they occupy an important place in human nutrition. Proper examination of fish before consumption is therefore essential to ensure that high levels of toxic trace metals are not being transferred to man (Adeniyi and Yusuf, 2003). This study is aimed at assessing the level of heavy metals in sea foods from New Calabar River consumed by the inhabitants living in Choba, Rivers State and also the health risk posed by some sea foods on the human population. The study is also aimed at identifying factors that exposes the sea foods to toxic levels of heavy metals.

MATERIALS AND METHODS

Study Area

Samples of different sea foods were collected from New Calabar River, Choba in Obio-Akpor Local Government Area, Rivers state. Obio-Akpor is bounded by Port Harcourt (Local Government Area) to the south, Oyigbo to the east, Ikwerre to the north, and Emohua to the west. It is located between latitudes 4°45'N and 4°60'N and longitudes 6°50'E and 8°00'E.

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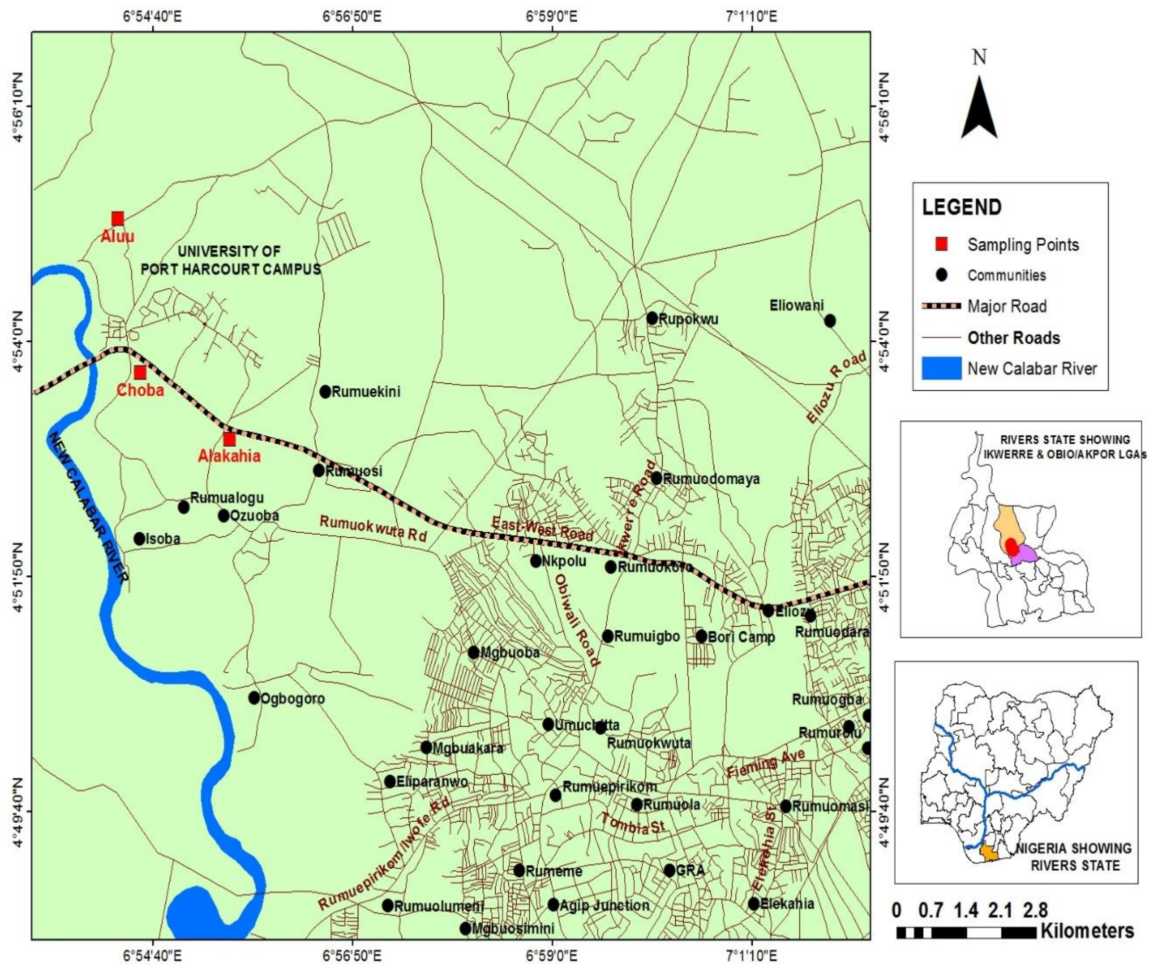

Figure 1. Map of Rivers state and sample site (Eludoyan et al., 2011)

Sample Collection

Different sea foods were obtained by the water side of 'new calabar river' from local fishermen. Sea foods obtained among others: Tilapia fish, prawns and crabs.

Methodology

Determination of Heavy Metals in Sea foods from New Calabar River: Samples were properly cleaned by rinsing with distilled water to remove debris, sediments and other external adherent. Exactly 2.00g of the sample was weighed, dried at 65 °C in the laboratory oven and crushed to smaller particles. A solution containing 9ml of concentrated trioxonitrate V acid (HNO_3) with 3ml of perchloric acid ($HClO_3$) was then prepared. Thereafter 25ml of distilled water was added to the sample and allowed to react together for about 40minutes before being transferred to the heating mantle at the temperature of 115 °C. Sample was left on the heating mantle until its volume reduced to one third of initial or original volume and all its component has been decomposed or when its color had turned to pale yellow. Once the digestion was completed all tissue samples were completely dissolved in the acid, then the mixture cooled to room temperature. The solution was then filtered using a funnel with whatman filter paper of 0.55mm into the measuring cylinder. The digesting vessel was rinsed with distilled water and made up to a known volume and kept in the 100ml plastic container for analysis. The filtrates were prepared ready for aspiration with the Thermo Elemental Flame Atomic Absorption Spectrophotometer (AAS) using the analytical hollow cathode lamp of interest with the appropriate wavelength and frequency. Analyses were carried out twice with the average heavy metal concentration recorded.

RESULTS AND DISCUSSION

Table 1: Concentration of Heavy metals in sea foods from New Calabar River (mg/Kg)

Heavy	Prawn			Crab			Tilapia fish			WHO
Metals	1st run	2nd run	Mean	1st run	2nd run	Mean	1st run	2nd run	Mean	Standards
Ni^{2+}	1.050	1.150	1.100	3.890	4.190	4.040	2.660	2.710	2.685	0.430
Cd^{2+}	0.001	0.001	0.001	0.010	0.010	0.010	0.007	0.007	0.007	0.030
As^{2+}	0.003	0.003	0.003	0.020	0.010	0.015	0.010	0.010	0.010	0.010
Pb^{2+}	2.690	2.720	2.705	3.270	3.310	3.290	2.980	3.010	2.995	0.400
V^{2+}	0.001	0.001	0.001	0.004	0.004	0.004	0.001	0.001	0.001	0.020
Cr^{2+}	1.690	1.720	1.705	2.970	3.120	3.045	3.580	3.630	3.605	0.100
Co^{2+}	0.070	0.070	0.070	1.190	1.050	1.120	0.400	0.390	0.395	0.240

The concentrations of some heavy metals in prawn, crab and tilapia fish were represented in Table-1. The concentrations of nickel in the aquatic organisms under study were above World Health Organization (WHO) standard with crab having the highest concentration. An intake of high concentration of nickel could lead to cancer of the lungs, nose, larynx and prostrate. Ingestion of nickel above acceptable limit can result to respiratory failure, Lung embolism, birth defects, asthma and chronic bronchitis . Nickel and its compounds may also result in the development of a dermatitis known as nickel itch (ASTDR, 2005).

The concentration of cadmium in prawn, crab and tilapia fish from the 'new calabar river' were within WHO standard as shown in Table 1. Cadmium and cadmium compounds results in various forms of cancer. Ingesting high concentration of cadmium results in irritation of the stomach which leads to vomiting and diarrhea. Long-term exposure to lower concentrations leads to a buildup in the kidneys and possible kidney disease, lung damage, and fragile bones (Ekpo *et. al.*, 2008).

Results obtained from Table 1 shows that arsenic concentration in prawn and tilapia fish were within WHO specification. However the concentration of the heavy metal is slightly above concentration for crab. Exposure to low concentration of arsenic can result to nausea and vomiting, anemia, leukemia, arrhytmia, damage to blood vessels, and a sensation of "pins and needles" in hands and feet. Ingestion of very

Scientia Africana, Vol. 16 (No. 2), December 2017. Pp 29-37
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high concentrations can possibly result in death. Exposure to low concentrations over a long time can cause a skin discoloration and the appearance of corns or warts on the palms, soles, and torso (ASTDR 2005).

Lead concentrations in the three aquatic organisms under study (prawn, crab and tilapia fish) were above the maximum limit stipulated by WHO hence unsuitable for consumption. Lead is a highly toxic metal and can affect every organ and system in the human body. Exposure of adults to high concentration of lead over a long period of time can lead to decreased performance in the functions of the nervous system such as weakness in fingers, wrists, or ankles; high blood pressure, renal failure, damage of the liver and red blood cells (Shazili *et. al.,* 2006). Exposure to high concentrations of lead can result in brain and kidney damage and ultimately cause death. In pregnant women, exposure to high levels of lead may lead to abortion. Exposure to high concentrations in men can damage the organs responsible for sperm production (Kamaruzzaman *et. al.,* 2010)

Vanadium is a trace metal considered as an essential nutrient, needed in small quantities in human and found in certain foods (Shazili *et. al.,* 2006). It is a natural remedy for health conditions such as anemia and diabetes. The sea foods under study contain low concentration of vanadium below WHO maximum limit as shown in the result. However, when taken above the recommended limit it can result in nausea, mild diarrhea, decrease in number of red blood cells, increased blood pressure and lung cancer (Shazili *et. al.,* 2006).

Chromium is an essential heavy metal that is biologically used in glucose metabolism. The chromium concentrations in the three sea foods under study were above WHO maximum limit. Skin contact with chromium can cause skin ulcer, it can also lead to various allergies such as severe redness and swelling of the skin (ASTDR, 2005). Long term exposure can also lead to liver and kidney damage as well as irritation of the skin (Shazili *et. al.,* 2006).

Cobalt is an essential nutrient for human and also a major part of Vitamin B_{12} (Sivapermal *et. al.,* 2007). The concentration of cobalt in prawn, crab and tilapia fish from the 'new calabar river' were below WHO maximum limit as shown in Table 1. Cobalt enhances the proper functioning of the thyroid and help in formation of hemoglobin. Excessive intake of cobalt can lead to congestive heart failure, shortness of breath, low thyroid function, enlargement of the thyroid gland (goiter) and increase in red blood cells (polycythemia) (Alexander, 2000).

Aquatic organisms like prawns, fish, oysters, periwinkles, crab and mussels accumulate large quantities of heavy metals due to their habitat and feeding nature (Edem *et. al.,* 2009). The mechanism of uptake from water makes it possible for the gills and surface membranes to be responsible for the diffusion and facilitated transport in fishes (Shazili *et. al.,* 2006). The concentration of heavy metals in fishes depends on the rate at which they take in food through their gut as well as their rate of excretion (Bull *et. al.,* 1981). Within an aquatic environment, reports have shown that sediments and aquatic animals are exposed to higher level of heavy metal pollution than in water surface (Luinnik and Zubenko, 2000). The concentration of each of the heavy metals considered in this study is highest in crab compared to prawn and tilapia fish. This can be attributed to their mode of feeding. Crabs are bottom feeders that obtain most of their nutrients from sediments as such contain high heavy metal concentration owing to the fact that sediments are exposed to higher concentrations of heavy metals than water surface (Adeniyi and Yusuf, 2003). The concentration of heavy metals in tilapia fish is higher than that in prawn. This is because the rate of diffusion through the gills of the fish is faster than in prawn. The gills constitutes a metabolically active part of the fish that can accumulate higher levels of heavy metals as observed in various fishes such as the common Carp (*Cyprinus carpio)* and *Tinca tinca* from Lake Beysehir, Turkey (Khail and Faragallah, 2008). Studies have shown that the high metal concentrations in the gills could be due to the formation of complex ion in the mucus, which could not be completely removed from the gill lamellae before analysis (Ali and Fishar, 2005). Another factor that affects the concentration of heavy metals in aquatic organisms aside their feeding habit is the rate of adsorption through the outer layer of their skin which is known as dermal adsorption. Prawns are usually victims of heavy metal exposure through dermal adsorption (Shazili *et. al.*, 2006). The environment contaminated with metals may first contact with the glycoprotein layer of the animal which is the mucus and then migrated to plasma membrane (Bull *et. al.*, 1981). The metal toxicants may meet two major binding site; "physiologically inert sites" and "physiologically active site". In case of "physiologically inert site", the organism cell metabolism is not affected by the metal; however it is affected at the "physiologically active site" where the disruption of cell function may occur (Khail and Faragallah, 2008).

Figure 2: Prawn

Figure 3: Dorsal view of crab

Scientia Africana, Vol. 16 (No. 2), December 2017. Pp 29-37
 ISSN 1118 – 1931

Figure 4: Ventral view of crab

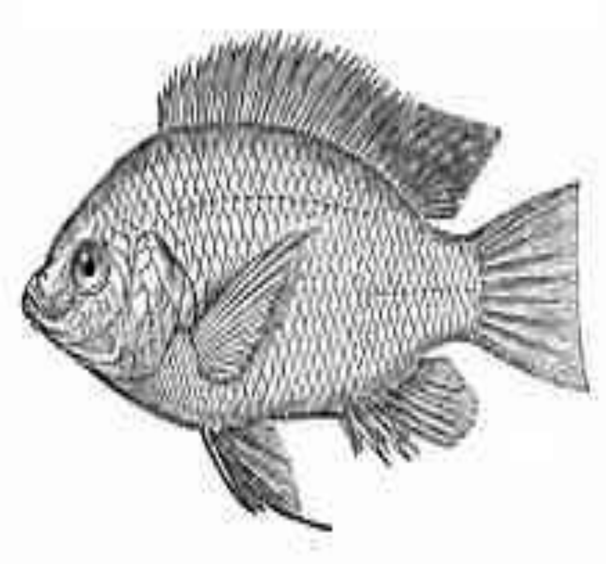

Figure 5: Tilapia fish

Heavy metals could find their way into aquatic organisms either directly through the guts by their feeding habits due to consumption of contaminated water and food, non-dietary routes across permeable membranes such as gills or through dermal adsorption owing to the nature of their skin. Humans which happen to be the highest consumer in the trophic level of the food chain or food web are at risk to accumulate high concentration of metal toxicants even more than the consumed contaminated aquatic organisms (Adeniyi and Yusuf, 2003). All the aquatic organisms considered in this study are unfit for human consumption owing to the fact that they contain one or more toxic heavy metals capable of exposing the consumers to different health hazards ranging from different forms of cancers, kidney infections, thyroid gland enlargement, birth abnormalities, bronchitis, central nervous system damage and other adments. Due to the fact that the'new calabar river' is surrounded by industries, hospital and an institution, a regulatory body should be constituted to prevent the indiscriminate disposal of untreated waste materials into the water bodies. Regular monitoring of the concentration of heavy metals in sea foods should be carried out to ensure they are safe for consumption.

The authors wish to appreciate the management and staff of DIABLOSS Laboratory Limited, No. 25 Liberty Drive, Off Alcon Road Woji Port Harcourt for their support, assistance and response that enabled this work to be completed on schedule.

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