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Heavy Metal Content of Some Selected Shellfish from Oil Producing Communities in Bayelsa State, Nigeria

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Abstract

The level of heavy metals in marine ecosystem has been intensively studied during recent years as these hazardous substances could be accumulated in the biota. Generally, the presence of contaminants in shellfish is as a result of human activities such as industrial, agricultural wastes, crude oil exploration and spillage and this has pose a significant threat to humans' health and other animals feeding on them over the years. In this study, some heavy metals levels in shellfishes sourced from the rivers of Otuoke community in Ogbia local Government Area, Oporoma community in Ekeremor Local Government Area and Sangana community in Brass Local Government Area, all in Bayelsa state, were investigated and the samples were prepared according to Food and Agricultural Organization of United Nation FAO (1994) standard test methods. The total mean of cadmium, Lead, and mercury ranges between 0.00mg/g to 0.002mg/g in periwinkle, prawn and oyster gotten from the three communities and was compared with the WHO acceptable limit of 0.5mg/kg – 1.0mg/kg. This could have been due to increased rainfall during the period of this study which in turn increase water levels and hence reduced or dilute the heavy metal concentration and thus less risk of bioaccumulation or possibly that the oil producing communities from where the shellfish where obtained might have possibly be link to lack of cases of oil spillage over a recent past before the commencement of the study. This study therefore advocates that periwinkle, prawn and oyster which are shellfishes used for this study from the rivers in these communities are safe for human consumption with respect to heavy metals load especially within the raining season when this study was conducted.

Keywords: Heavy-Metal, Shellfish, Oil-Producing, Community, Bayelsa State.

INTRODUCTION

Oil spill is global environmental problem which occur on daily bases across the globe as a result of leakage during processing, corrosion of oil pipes, poor maintenance of infrastructure and deliberate acts of vandalism or theft of crude oil from pipes. Oil spill is a common phenomenon in the Niger Delta region of Nigeria and multinational oil companies (MNOCs) in this region records several oil spills but most times investigations of spills in the region are also heavily disputed and politically sensitive. As it were, there are no consistent figures on the number of oil spills in the Niger Delta (Ordinioha and Brisibe, 2013), but it is estimated that oil spill accounts for as many as 546 million gallons of oil into the Niger Delta environment over the last five decades, equivalent of about 11 million gallons annually (Amnesty International 2010).

Oil spill has high pollution impact on the environmental negatively due to large scale of habitats greatly affected. Different types of environments are affected by oil spill as a result of the release of heavy metal into ecosystems (Amin *et al.*, 2008). Basically, heavy metals such as Cadmium (Cd), Lead (Pb) and mercury(hg) are present in crude oil and drilling fluid which is widely used in oil field industries (Agusa *et al*., 2005) and it is a significant contributor to the higher levels of heavy metals in different environment such as soil and water. The existence of heavy metal in aquatic environment poses a significant threat to life since the source of this pollutants come from oil export facilities

and petrochemical plant (Massas *et al*., 2013). The bioaccumulation of toxic metals rising to hazardous levels in aquatic lives has become a problem of increasing concern (Dean *et al*., 1972; Manahann, 1994., Idodo, 2002). Plants can also bio-accumulate heavy metals in their tissues in concentrations above the WHO permissible levels which are considered to be hazardous or life threatening to humans, and to other animals. Thus, feeding on aquatic lives, crops from such environment may lead to contamination of the food chain (Adnan *et al*, 2010, Patil *et al*., 2012).

Shellfishes (oyster, prawn and periwinkle etc) are widely consumed in many parts of the world because it has low saturated fat, high protein and micro nutrient (they also contains trace elements like; iodine, cobalt, iron, phosphorus, calcium, copper and fair proportion of the B-vitamin known to support good health) (Tucker, 2007). Shellfish accumulate toxic chemicals such as heavy metals directly from water and diet, and contaminant residues may ultimately over time reach extremely high concentrations above those measured in the water, sediment and food (Nkpaa *et al*., 2013.; Osman *et. al*., 2007.; Goodwin *et al*., 2003; Labonne *et al*., 2001), thus, they are considered good indicators for heavy metal contamination in aquatic systems (Burger *et al*., 2002). Though we assume that sea foods are safe to our health, sometimes these foods contains not only the nutrients that are required for optimal health but also other natural or introduced substances, often prejudicial to health commonly referred to as contaminant or toxicant. By definition, a contaminant is any substance not intentionally added to food, but which is present as a result of its production, manufacture, processing, preparation, treatment, packaging, storage, transport or handling or due to an environmental contamination (Al-Sayed, 2006).

Mercury is poisonous and is not essential for living organisms because mercury in all forms poisons cellular function by altering the tertiary and quaternary structure of proteins and by binding with sulfhydryl and selenohydryl groups (Berlin, 2007). Consequently, mercury can potentially impair function of any organ, or any subcellular structure. The chief target organ of mercury is the brain, but peripheral nerve function, renal function, immune function, endocrine and muscle function, and several types of dermatitis have been described. With massive acute exposure to mercury, erosive bronchitis and bronchiolitis potentially leading to respiratory failure may be accompanied by CNS symptoms such as tremor or erethism. Chronic exposure to clinically significant doses of mercury vapor usually produces neurological dysfunction.

Cadmium is a severe pulmonary and gastrointestinal irritant, which can be fatal if inhaled or ingested (Shinwari, 2006). Acute cadmium ingestion can also cause gastrointestinal tract erosion, pulmonary, hepatic or renal injuries and coma, depending on the route of poisoning (Dairi, 2006). Chronic exposure to cadmium has a depressive effect on levels of norepinephrine, serotonin, and acetylcholine (Dairi, 2006). Rodent studies have shown that chronic inhalation of cadmium causes pulmonary adenocarcinomas (Ashraf, 2005).

Lead (Pb) a soft and malleable heavy metal which is not also essential for human consumption constitute a public health problem due to its adverse effects, mainly affecting the central nervous system and haematopoietic process in the most vulnerable populations, such as pregnant and lactating women and children (Koyashiki *et al*., 2010). Lead (Pb) can pose a threat to infants via breast milk from mothers with current exposure to lead or mothers exposed by the redistribution of bone lead has been identified as a source of exposure to the infant (Koyashiki *et al*., 2010). Neuropsychological research over the years has revealed that Pb exposure can result in declines in intelligence, memory, processing speed, comprehension and reading, visuospatial, motor and executive skills. Among the cognitive deficits induced by Pb toxicity, visuospatial deficits appear to be major. Anxiety, depression and phobia can also occur, while outcome, intervention, and rehabilitation results are largely dependent on the level of Pb exposure (Mason *et al*., 2014).

Ogbia, Ekeremo and Brass Local Government Areas are all located in Bayelsa state Nigeria. Oil spillage is a regular event in these areas occasion by the oil producing activity in the area. The careless disposal of wastes from, artisal refineries and abandoned well heads pose environmental threat to Ogbia, Ekeremo and Brass L.G.A aquatic habitats. It is therefore necessary to evaluate the levels of some heavy metals in some shell foods, locally sourced from Ogbia, Ekeremo and Brass rivers and to compare their distributions.

Heavy metals are generally known to be toxic to humans as it interrupt cellular functions by altering the tertiary and the quaternary structure of proteins, decrease reproductive functions, causes aneamia, severe pulmonary, gestational irritants, spontaneous abortions in women and many other disorders. Thus, the people of these communities where oil spillage occur on regular basis consumes these heavy metals from shellfishes which may lead to bio-accumulates in the body or across the biota. Thus, this study measured the heavy metals accumulation in some selected shellfishes (oyster, prawn and periwinkle) within some oil producing communities in Bayelsa State.

MATERIALS AND METHODS

Location

The Study Area

Brass, Ekeremor and Ogbia Local Government Areas which are home to several oil producing communities are the area of study; and they are the

leading source of on-shore crude oil production in Bayelsa State. Bayelsa State is located between Latitudes 4°15'N and latitude 5º23' south and longitude 05º22' West and 06º45'East. It shares boundaries with Delta state, River state on the East and Atlantic Ocean on the West and South. The state has a land area of 21110sqkm/10,773km square (Duncan, 2016).

The state has a vegetation characterized by mangrove forest and in the north it has a thick forest with arable lands for cultivation. Bayelsa state is a picturesque tropical rain forest, with an area about 21,110 square kilometers. More than three quarters of this area is covered by water, with a moderately low land stretching from Ekeremor to Nembe.

The state lies within the heaviest rainfall area in Nigeria, with heavy rain forest and a short dry season (usually from November to March). The mean monthly temperature is in the range of 25ºC to 31ºC and mean maximum monthly temperature range from 26ºC to 31ºC. The mean annual temperature is uniform for the entire Bayelsa state. The hottest months are December to April. The difference between the wet season and the dry season on temperatures is about 2ºC at most. Relatively humidity is high in the state throughout the year and decreases slightly in the dry season. The three communities (Brass, Ekeremor and Ogbia) were purposely selected because of its previous oil spills history and three commonly consume shellfishes were randomly selected from each of the communities.

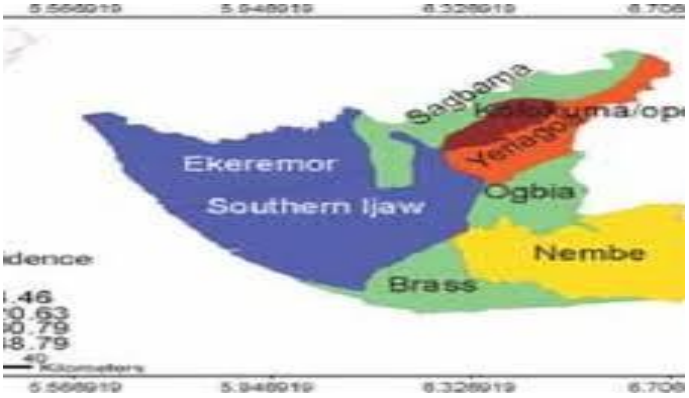

Fig 1.0: Showing map of Bayelsa state

Materials

Sample Collection and Preparation

Periwinkle, oyster and prawn were collected in large quantity from a river in Otuoke community in Ogbia Local Government Area, Oporoma Community River in Ekeremor Local Government Area and Sangana Community River in Brass Local Government Area all in Bayelsa state, Nigeria. The samples were collected by July which is one of the month with high rainfall.

The prawns and the detached flesh of the Periwinkle and Oyster were placed on a foil paper, labeled and oven dried at 45ºC continuously. They were later cut to pieces into a crucible and blended into powder. All samples were labeled, stored in an airtight container and kept in the laboratory for analysis.

Heavy Metal Estimation

To a beaker containing 2g samples, 10% HCl was added and was placed on a hot plate according to Food and Agricultural Organization of United Nation FAO (1994) until the organic matter were broken down evident in volume reduction. Upon cooling, the content were transferred to a100ml volumetric flask (fitted with a filter paper) and made up to mark with distilled water. The diluted samples were transferred into sample bottles and labeled. The total metal (Hg, Pb, and Cd,) concentration of the sample was then determined by Atomic Absorption Spectrophotometer (AAS).

Statistical Analysis

Data obtained was expressed as Mean ± Standard Deviation and analyzed using the statistical package for social sciences (SPSS). Values at $P< 0.05$ were regarded as significant in comparison with appropriate controls.

RESULTS

The heavy metal content of the commonly consume seafoods; prawn, periwinkle and oyster from three different oil producing communities in Bayelsa state were assayed and the heavy metal assayed for includes; Cd, Pb and Hg.

The heavy metals results obtained for all three sample from three different oil producing communities indicates an infinitesimal concentrations of Cd, Pb and Hg in all samples.

Table 1: Heavy metal concentration in periwinkle obtain Ogbia, Sangana and ekeremor L.G.A in Bayelsa state

	Cadmium (mg/g)	Lead (mg/g)	Mercury (mg/g)
Ogbia	0.002±0.00	0.001±0.00	0.002±0.00
Sangana	0.001±0.00	0.002±0.00	0.001±0.00
Ekeremor	0.001±0.00	0.002±0.00	0.001±0.00

Table 2: Heavy metal concentration in prawn obtained from Ogbia, Sangana and Ekeremor L. G. A of Bayelsa

	Cadmium (mg/g)	Lead (mg/g)	Mercury (mg/g)
Ogbia	0.001±0.00	0.002±0.00	0.001±0.00
Sangana	0.001±0.00	0.001±0.00	0.00±0.00
Ekeremor	0.001±0.00	0.001±0.00	0.001±0.00

Table 3: Heavy metal concentration of oyster, Sangana and Ekeremor L. G. A of Bayelsa state

	Cadmium (mg/g)	Lead (mg/g)	Mercury (mg/g)
Ogbia	0.002±0.00	0.001±0.00	0.002±0.00
Sangana	0.001±0.00	0.001±0.00	0.001±0.00
Ekeremor	0.001±0.00	0.001±0.00	0.001±0.00

DISCUSSION

The bioaccumulation of heavy metals (Cd, Hg and Pb) in some selected shellfishes (periwinkle, oyster and prawn) from oil producing communities in Bayelsa state were evaluated. The extent of occurrence or accumulation of heavy metals by organisms is dependent on the heavy metal load on the surrounding medium (environment) (Johnson *et al.*, 2022) and heavy metals present in rivers may be accumulated by shellfish either via their food or aquatic environment which they found themselves (Maddock, 1977). This possibly would have been due to the fact that the concentration of the heavy metals at the location where the fishes where harvested where low and hence could not bio-accumulate which is line with the finding of Ghosh 1973 who stated that there's a strong correlation between the environmental level of a particular heavy metal and the bioaccumulation index in plant or animal found in such locality. The possible anticipated low levels of Cd, Pb and Hg in the environments where the samples were collected could have been due to increased rainfall which in turn increase water levels and hence reduced or dilute the heavy metal concentration and thus less risk of bioaccumulation as explained by Adnan *et al.*, 2012.

More so, though the level of heavy metals in the waters and sea bed sediment from which the shellfishes where harvested was not analyzed but evidence by the result of bioaccumulation obtained from this study and it is supported by the report of maddock 1977; Ghosh 1973.

Besides, since there is no recent record of crude oil spill in the region. Going by the fact that the last crude oil spill in region was in 2016 due to activities of pipeline vandals, oil production operations, inadequate or non-functional production equipment, hence, after two years it is believed that the region have been flushed naturally or diluted by several seasons of heavy rainfall. Above all, the lifespan of the fishes should also be consider as fishes and shellfishes that were present at a time of pollution two years ago may not be alive today for this study.

It was obvious that heavy metals concentration in the oil producing communities from where the shellfish where obtained may have been low and might have possibly be link to lack of cases oil spillage over a period of time before the commencement of the study.

For this studies, infinitesimal levels of heavy metals was detected in the tissues of all three shellfishes investigated and this was within World Health Organization (WHO) recommended permissible/ safe limit of 0.350mg per 70kg body weight per week for mercury (Hg), 0.049mg per 70kg body weight per week for cadmium (Cd) and 1.750mg per 70kg body weight per week for Lead (Pb) and shows that periwinkle, prawn and oyster from these communities are safe for consumption with respect to heavy metals load especially within the raining season when this study was conducted, our observations could also be related to stressing environmental factors and the life cycle of the organisms under study and recurrent crude oil spill in the region.

CONCLUSION

Since there is no recent record of crude oil spill in the region after the spill of 2016 due to activities of pipeline vandals, oil production operations, inadequate or non-functional production equipment, So, after two years it is believed that the region should have been flushed out or diluted by heavy rainfall, fishes, shellfishes and plants that were present as at the time may no longer be in a existence.

In conclusion, this study shows that shellfishes obtained from the rivers of the three different oil producing communities (Otuoke, Sangana and Oporoma) had low levels of Cd, Pb and Hg and are therefore safe for human consumption with respect to heavy metals load especially within the raining season when this study was conducted.

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