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Seasonal Variations in Heavy Metal Content of Periwinkle Samples obtained from Oil Producing Communities within Bayelsa State, Nigeria

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Abstract
The effects of seasonal variations on the heavy metal content of periwinkle (Littorina littorea) were investigated. Samples were obtained from five stations within the oil producing communities of Bayelsa State, Nigeria. The standard digestion method was used to determine the levels of zinc, lead, nickel, copper, cadmium and chromium with the aid of the atomic absorption spectrophotometer (AAS). (Cadmium (0.216 – 0.727 ppm) and chromium (0.003 – 0.110 ppm) were significantly higher. Zinc, lead, nickel and copper were below the minimum permissible limits. Results obtained for chromium was significant at p(0.05) for the Pearson correlation coefficient. Oil production increases the concentration of heavy metals in water causing harmful to living and non-living resources. Further studies within the study area will assist in effective monitoring of the environment for sustainable development.

Keywords : Oil production, seasonal variation, heavy metals.

Introduction

Seafood is a vital source of proteins constituting about 40% of animal protein of an average Nigerian (Adebayo-Tayo *et al.,* 2008). Periwinkle *(Littorina littorea) is common marine seafood consumed in Bayelsa State, Nigeria*. They are rich in Omega-3 fatty acids which could prevent cardiovascular disease (Idongesit *et al.,* 2008). The periwinkles also have a high protein and low fat content and are consumed in Europe, Africa and Asia (Babalola *et al.*, 2019). Bayelsa State is located in the Niger Delta region of Nigeria that covers an area of about 70,000km^2, making it the largest river delta in Africa and the third largest in the world (UNEP, 2011).

Oil exploration in the Niger Delta region of Nigeria has resulted in environmental, socio-economic and physical damages over the years and due to limited scrutiny and no proper assessment, these have accumulated (Achi, 2003). The destruction of vegetation due to exploration and exploitation has resulted in environmental degradation, loss of source of livelihood and environmental pollution (Bayode *et al.,* 2011). Environmental pollution affects weather, soil fertility, aquatic habitats and wildlife. The effects of oil spill on the environment are dependent on oil dosage, oil type, meteorological conditions, physical geography and biota (Nwankwo & Ifeadi, 1988).

Heavy metals are non-biodegradable inorganic chemicals that cannot be metabolized by the body. They are toxic with the ability to accumulate in aquatic ecosystems and organisms (Olgunolu *et al.,* 2015). Heavy metals are the most common environmental pollutants. They occur naturally in water but rarely at toxic levels (Kurnaz *et al.,* 2016). The natural concentrations of heavy metals in the sea are very low.

Global heavy metal pollution is an environmental problem associated with the agricultural and industrial revolution (Zodape *et al.,* 2012). Toxic and hazardous discharges containing heavy metals contribute to the pollution of aquatic ecosystem resulting in cytotoxic, mutagenic and carcinogenic effects (Kim *et al.,* 2015). These metals are taken up and accumulated by aquatic organisms from the environment and food sources via the food chain. The level of accumulation of heavy metals in aquatic organisms is affected by internal and external factors (Gokoglu *et al.*, 2008).

Oil exploration, exploitation and development in the Niger Delta region of Nigeria over the past six decades have left a lot of devastation on the aquatic ecosystems (Bayode *et al.,* 2011). Oil contamination of the aquatic environment occurs frequently through leakages of hydrocarbons and lubricants; sabotage; oil theft and illegal refining. Oil spill and oil production has negatively affected the production of fish and seafood in the Niger Delta (Osuagwu & Olaifa, 2018). Heavy metal contamination results from these activities. Heavy metals exert negative effects on biological processes and influence nutritional and biological status of seafood (Udosen *et al.,* 2001). Accumulated heavy metals are carried through the food chain to the consumers. Cases of food intoxication, infection, heavy metal poisoning etc. have been reported in Rivers State, Nigeria where oil exploration and exploitation also takes place (Chinedu & Chukwuemeka, 2018).

Methodology

Sample collection and treatment

Samples were collected at five stations where oil production activities take place. The stations are Yenagoa (4°55'N, 6°16'E), Azuzuama (4°43'N, 5°57'E), Nembe (4°32'N, 6°18'E), Ogbia (4°40'N, 6°16'E) and Brass (4°18'N, 6°14'E). Sampling was carried out twice within the year during the dry season (January to March) and the wet season (July to October) at intervals of three weeks (Okunade & Okunade, 2017; Popovic *et al.,* 2010).

Periwinkle samples were obtained from the selected stations in the company of local fishermen using the methods described by Hewitt & Martin (1996) and Hoedt *et al.* (2001). The samples were preserved in ice blocks during transportation to the laboratory and used within 24 hours.

Mineral and heavy metal analysis

The analysis of samples for mineral and heavy metal concentrations was carried out using standard digestion method (FAO, 1996). Samples were digested in 6 mL hydrochloric acid (HCl) and made up to 30 mL with distilled water. Filtration was carried out using acid wash filter paper and the filtrates were stored in sample bottles. The filtrate was then analyzed in duplicates using a Unicam atomic absorption spectrophotometer (AAS) for the determination of zinc (Zn), lead (Pb), nickel (Ni), copper (Cu), cadmium (Cd) and chromium (Cr) (Otitoju and Otitoju, 2013). Heavy metal content obtained was compared with the World Health Organization (WHO) recommended Minimum Permissible Limits (MPL).

Results

From the periwinkle samples, high heavy metal content was reported for cadmium and chromium. Zinc was detected at two stations (Azuzuama and Ogbia) during the dry season only (Table 1). The content recorded for both stations was 0.001 ppm which is below the MPL. At stations where lead was detected, the content was less than the MPL. During the dry season, Yenagoa reported the highest lead content of 0.030 ppm while Nembe recorded the lowest of 0.007 ppm. During the wet season, the highest lead content was recorded at Yenagoa (0.030 ppm) and the lowest content was reported at Brass (0.002 ppm).

S.No.	Station	Zn (ppm)	Pb (ppm)	Ni (ppm)	Cu (ppm)	Cd (ppm)	Cr (ppm)
1	Yenagoa	0.000	0.030	0.001	0.023	0.563	0.003
2	Azuzuama	0.001	0.010	0.000	0.010	0.533	0.043
3	Nembe	0.000	0.007	0.000	0.023	0.640	0.057
4	Ogbia	0.001	0.013	0.000	0.013	0.727	0.020
5	Brass	0.000	0.000	0.000	0.013	0.010	0.000

Table 1: Heavy metal content of periwinkle samples during dry season

Nickel was detected only at Yenagoa during the dry season. The content of 0.001 ppm was below the MPL. Nickel was not detected at any of the stations during the wet season. Copper was detected at the various stations during the dry season below the MPL. The highest copper content during the dry season was at Yenagoa and Nembe (0.023 ppm) and the lowest was reported at Azuzuama with 0.010 ppm.

All the stations recorded cadmium content above the MPL during both seasons. During the dry season, the highest cadmium content was at Ogbia (0.727 ppm) and the lowest was at Brass (0.010 ppm). During the wet season, the highest cadmium content was reported at Nembe (0.713 ppm) while the lowest content was reported at Brass (0.216 ppm). Chromium content for periwinkle samples during the dry season at Nembe (0.057 ppm) was above the MPL. Chromium content below the MPL was reported at other stations with Yenagoa having the lowest of 0.003 ppm. Chromium was not detected at Brass during the dry season.

S.No.	Station	Zn (ppm)	Pb (ppm)	Ni (ppm)	Cu (ppm)	Cd (ppm)	Cr (ppm)
1	Yenagoa	0.000	0.030	0.000	0.000	0.471	0.110
2	Azuzuama	0.000	0.007	0.000	0.000	0.661	0.056
3	Nembe	0.000	0.010	0.000	0.000	0.713	0.041
4	Ogbia	0.000	0.020	0.000	0.000	0.682	0.066
5	Brass	0.000	0.002	0.000	0.000	0.216	0.038

Table 2: Heavy metal content of periwinkle samples during wet season

During the wet season, the chromium content for Yenagoa, Azuzuama and Ogbia were above the MPL (Table 2). The highest chromium content was 0.110 ppm (Yenagoa) and the lowest was 0.038 ppm (Ogbia). Chromium content during the dry and wet seasons were significant at p(0.05) for the Pearson product moment correlation coefficient. The results obtained for zinc, lead, copper and cadmium were not significant. The results obtained for the dry and wet seasons are compared with the MPL in Fig. 1 showing the various error bars.

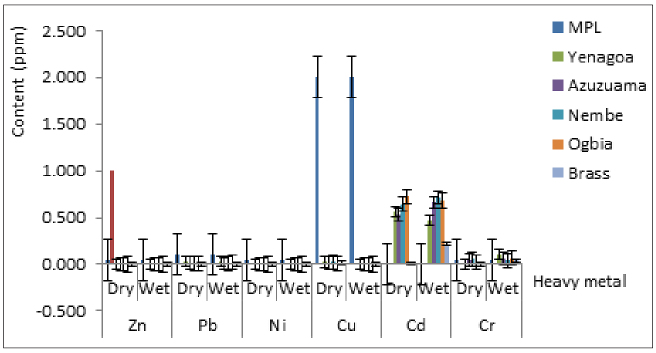

Figure 1: Heavy metal composition of periwinkle for dry and wet season.

Discussion

In periwinkle samples, zinc was detected only at Azuzuama and Nembe during the dry season. Zinc was detected in all the oyster samples from the stations. The zinc content was higher during the dry season. The prawn samples had zinc content only during the dry season at Azuzuama. For crab samples, only Azuzuama had zinc content for both seasons. Yenagoa had zinc content during the wet season only.

The lead content of the periwinkle samples at Yenagoa remained constant. At Azuzuama, the zinc content was higher during the dry season and at Nembe, Ogbia and Brass the zinc content was higher during the wet season. In the oyster samples, lead content was higher during the dry season ay Yenagoa, Ogbia and Brass. At Azuzuama and Nembe the lead content was higher during the wet season. In the crab samples, Yenagoa, Azuzuama, Nembe and Ogbia had higher lead content during the dry season.

Nickel was detected in periwinkle samples only at Yenagoa during the dry season. In the oyster samples, nickel was detected on at Yenagoa and Ogbia.

Copper was detected in all the periwinkle samples during the dry season only. In prawn, copper was detected at Yenagoa, Azuzuama, Nembe and Ogbia during the dry season. Copper was detected in prawn at Azuzuama, Nembe abd Ogbia during the wet season. At Azuzuama, Nembe and Ogbia the copper content was higher during the wet season. Capeme *et al.,* (1999); Jayasankar & Polywal (2000); and Oranusi *et al.,* (2018) reported similar mineral and heavy metal composition of seafood samples.

Conclusion

Heavy metals were detected in some of the samples analyzed. In a few cases, the values obtained were far above the acceptable limits. In the study area, the wet season is characterized by inflow of water into the water bodies from upstream. This causes reduction in the concentration of heavy metals.

Samples from Yenagoa recorded Nickel content of 0.082 ppm. The waterway is characterized with high commercial transportation activities and the surrounding waters serve as route for oil servicing activities. Ogbia recorded 0.062 ppm Ni. This station is close to Oloibiri in Bayelsa State, where crude oil was first discovered in commercial quantity in Nigeria. The levels copper in periwinkle was within the permissible limits with the exception of Nembe during the wet season. The cadmium levels were remarkably high for the two seasons. Cadmium is found closely associated with zinc and is a trace constituent in most foods.

Oil exploration activities increase the concentration of heavy metals in water to dangerous levels. This can cause harmful effects on both living and non-living resources hence the need for caution. Further studies within the study area will assist in effective monitoring of the environment for sustainable development.

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