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BIOACCUMULATION OF HEAVY METALS IN THE TISSUES OF PERIWINKLE AND CLAM FROM THE MUD FLATS OF ANDONI RIVER, RIVERS STATE, NIGERIA

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ABSTRACT: *Bioaccumulation of heavy metals in periwinkle (Tympanotonus fuscatus) and clam (Senilla senilis) collected from the mud flats of Andoni River was carried out over a six months period. Surface sediment samples were collected with a hand trowel into polythene bags while periwinkle and clam samples were collected by hand picking during low tide, washed thoroughly and transported in an ice-container to the Research Laboratory of the Department of Biology, Ignatius Ajuru University of Education, Port Harcourt for further analysis. Sample preparation followed standard analytical protocols and heavy metal analysis was by Atomic absorption spectroscopy. The concentration of heavy metals (mg/kg) in T. fuscatus was 10.06 ± 0.22, 5.86 ± 0.25, 3.67 ± 0.1, 3.33 ± 0.42 and 0.65 ± 0.09 for Zn>Cr>Ni>Pb>Cd respectively, while that of clam is 6.54±0.51, 6.41±0.15, 4.10±0.6, 2.67±0.1 and 0.39±0.01 respectively for Zn>Cr>Ni>Pb>Cd in descending order of magnitude. All the heavy metals under investigation showed bioaccumulation in the tissues of periwinkle, except cadmium and except cadmium and zinc for clam. Similarly, the concentrations of all heavy metals were above their Rivers State Ministry of Environment and World Health Organization stated limits save for zinc in periwinkle and zinc and cadmium in clam. Thus, indicating that the continued consumption (particularly in large quantities) of periwinkle and clam from the mud flats of Andoni River could lead to far-reaching health implications.*

KEYWORDS: Bioaccumulation, Andomi River, seafood, periwinkle, clam

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INTRODUCTION

Periwinkle and clam are among the sea foods of choice in the Niger Delta, due largely to their availability, affordability and to a large extent their nutritional value. They are available all year round and are consumed by the low, middle and high class citizens both in the urban and rural communities. Generally, according to Guerin et al., (2011) the consumption of seafood and seafood products has been on the increase as well as the concern for their nutrition and health welfare despite their high protein content and rich source of polyunsaturated fatty acids, vitamins and essential minerals.

Anthropogenic activities either in the sea and or on land have directly and indirectly predisposed sea foods to environmental contaminants/pollutants such as urban runoff, petroleum, heavy metals etc, which can be ingested or absorbed through the food chain. Metal contamination of sea food in particular is fast becoming a global crises given the fact that sea water is vulnerable to increasing discharges from coastal activities (Ahmed et al., 2015).

Here in the Niger Delta region of Nigeria, crude oil spill is common, resulting in the pollution of rivers and creeks. Periwinkle and clam are sedimentary mollusks which are always on or buried in sediments. A reasonable fraction of spilled crude oil sinks to the bottom sediment. These sedimentary organisms in the course of their feeding (on benthic biota) pick up these pollutants which they bio-accumulate in their tissues. Among such toxic substances contained in the crude oil are heavy metals which are non-biodegradable and when eaten by a man may result in serious health issues.

In the last decade studies have been conducted to examine the heavy metal burden of different commercially significant and edible aquatic biota (Wokoma, 2014; Bob-Manuel et al., 2015; Obot et al., 2016; Umesi et al., 2017; Bakia et al., 2018; Ibrahim et al., 2021 and Owoh and Wokoma, 2022). But little is known about *T. fuscatus* and *Senilia senilis* from Andoni River, hence this study.

MATERIALS AND METHODS

The Andoni river is situated in latitude $4^{0}37.18^{/}$N and longitude $7^{0}23.10^{/}$E. Each transverse several villages and towns among which are Ataba, Isiobiama, Ajakajak, Samanga, Ibotirem, Dema and Egbomung. The water is brackish playing host to many fish species and the principal flora is the mangrove vegetation which is home to periwinkles, oysters etc. however, in recent times nypa palm (*Nypa fruticans*) is fast gaining prominence at the expense of the native vegetation. The river plays a significant role in the economy of the people by serving as a fishing ground, major means of transportation/communication and plays host to some oil installations.

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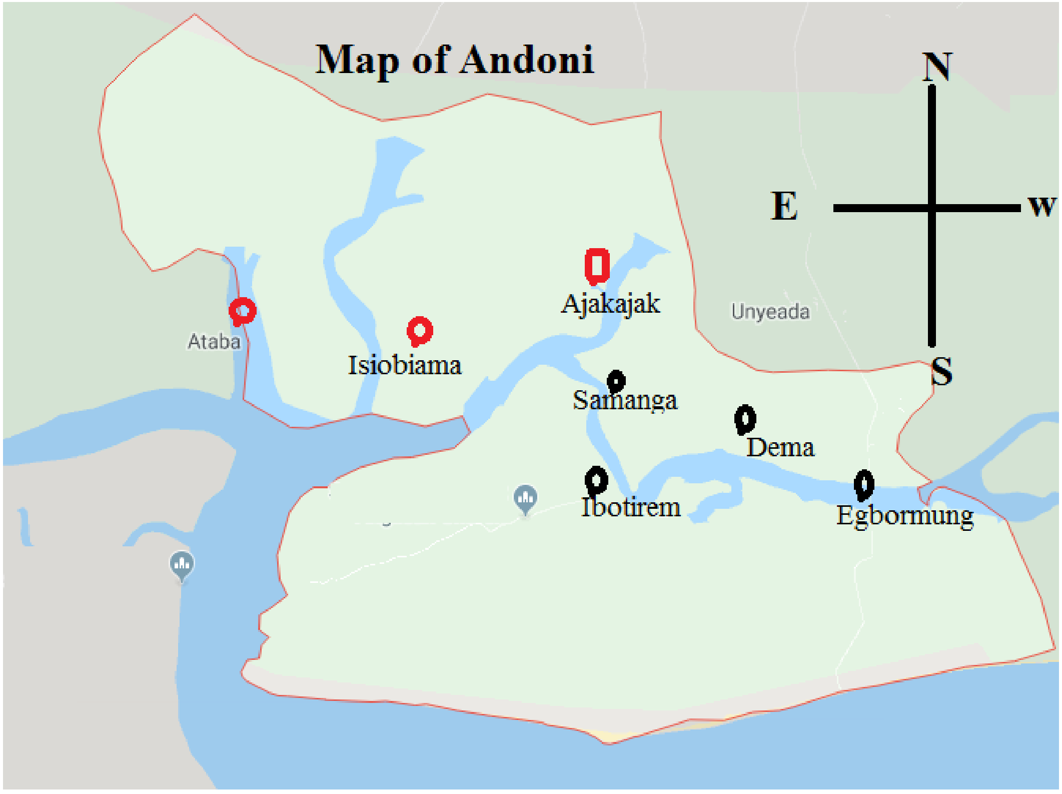

Fig: Map of Andoni showing the study areas

Field methods

Subsurface sediments were collected across the river at low tide by using hand trowel to dig to a depth of about 10cm, before collecting the samples, which were wrapped with aluminum foil, and transported to the laboratory for analysis.

Periwinkle and clam samples were collected randomly on the mud flats by hand-picking during low tide and washed thoroughly with sea water to remove sediment/debris attached to the shell. Samples were then stored in an ice-chest container and transported to the Research Laboratory of Biology Department, Ignatius Ajuru University of Education, Port Harcourt for further analysis.

Laboratory Methods

Analysis of metals was carried out using atomic absorption spectrophotometer. Sample preparation was by acid digestion followed by filtration through a 0.45 micro membrane filter. Ten aliquot of the filtrate was used to analyze for chromium ASTM D1687B, Nickel ASTM D1886, lead ASTM D3559 and zinc ASTM D1691 at appropriate wavelength. The minimum detectable limit is 0.001gm/1. (AAS model NOA11200L/2200).

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Acid digestion of sediment, periwinkle and clam samples was done following the methods prescribed by Allen et al., (1974). 1g of dried, ground and sieved sample was measured into 100ml Kjaldahl flask after which 5ml nitric acid (HNO_3), 1ml 60% perchloric acid ($HClO_4$) and 0.5ml sulphuric acid (H_2SO_4) was added to it. The flask was gently swirled and slowly digested at moderate heat which was increased later. After 10 – 15 minutes of digestion sample was set aside after white fumes appeared to cool. Sample was filtered using number 44 filter into a 50ml volumetric flask and diluted to volume and used for the determination of heavy metals.

RESULTS

Table 1**: Mean concentration (±SD) of heavy metals in Periwinkle and Clam from the Andoni River and their Bioaccumulation Factor (BAF).**

Heavy Metal	Mean conc. of Sediment ($mgkg^{-1}$)	Mean conc. of Periwinkle ($mgkg^{-1}$)	Mean conc. of Clam ($mgkg^{-1}$)	BAF of Periwinkle	BAF of Clam
Zn	8.52±0.84	10.06±0.22	6.54±0.51	1.18	0.77
Pb	2.20±0.85	3.33±0.42	2.67±0.1	1.51	1.21
Cd	1.43±0.6	0.65±0.09	0.39±0.01	0.45	0.27
Cr	4.73±0.79	5.86±o.25	6.41±0.15	1.24	1.36
Ni	2.94±0.41	3.67±0.1	4.10±0.6	1.25	1.39

Heavy metal concentration in periwinkle varied from 0.65mg/kg-10.06mg/kg, representing the metals cadmium and zinc respectively and that of clam fluctuated from a low of 0.39mg/kg (cadmium) to a high of 6.54 mg/kg (zinc). Generally, the concentrations of zinc and cadmium were respectively the highest and lowest in the tissues of both periwinkle and clam.

The metal most accumulated by periwinkle from the sediment in Andoni River is lead (1.51) followed by Nickel (1.25) and the least is cadmium (0.45). The descending order of magnitude of bioaccumulation in periwinkle is Pb>Ni>Cr>Zn>Cd.(See Table). While the metal most accumulated by clam from the sediment in Andoni River is nickel (1.39) followed closely by chromium (1.36) and the least is cadmium (0.27). The descending order of magnitude of bioaccumulation in periwinkle is Ni>Cr>Pb>Zn>Cd.

DISCUSSION

The mean concentration of lead obtained in this study varied from 3.33±0.42mg/kg in periwinkle to 2.67 mg/kg in clam, is above the value reported by Umesi *et al.*, (2017) in the tissues of claim *Senilia senilis* in Andoni River, it is also higher than that observed in Woke *et al.*, (2015) who reported a range of 0.20±0.02 – 0.5 ±0.02mg/kg from the same study

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area, as well as that of Wokoma (2014) who recorded a concentration range of 0.17±006 – 0.2.23±0.03 mg/kg in the tissue of fishes from Sombreiro River. The findings of Bakia et al., 2018 also reveal lower values of lead for *L. fasciatus* (0.11±0.07) *R. kanaurta* (1.74±1.41) and *P. sculptilis* (0.69±1.56) while that of *S rubrum* (4.02±0.94) falls within the range of the present study. However, the findings of Obot *et al.*, (2016) in the tissues of *H. bicolar* (8.18±2.96) and *E. frimbriata* (8.305 ± 2.74) as well as the 8.92±0.51mg/kg in *H. nigresceus* reported by Bakia et al., (2018) are higher than the result of the present study.

The mean concentration of cadmium recorded in the tissues of *Tympanotonus fuscustus* and *Senilia senilis* are higher than that reported by Dimari & Hati (2009) in the intestines of *Tilapia gallier* $(0.09 \pm 0.06mg/kg)$, *Clarias lazera* $(0.10 \pm 0.05mg/kg)$, from lake Alau, Maiduguri, Nigeria as well as the range of values (0.04±0.0 – 0.11±0.001 mg/kg) reported by Umesi *et al.,* (2017) in the tissues of three clam (*Senilia senilis)* sizes at the same study area.

The mean value of Cadmium found in this study 0.65±0.09 and 0.39±0.01 mg/kg in the tissues of periwinkle and clam respectively from the Andoni River are congruent to the report of Bakia et al (2018) in *P. scruptilis* (shrimp) 0.713±0.06 mg/kg) and *P versicolor* (Lobster) 0.202±0.02 mg/kg from Saint Martin Island, Bangladesh, 0.82±0.44 mg/kg in Tilapia from the Andoni River as recorded by Owoh and Wokoma, (2022) and 0.74 mg/kg in the muscle of *O. niloticus* from the Okujagu Ama Creek by Ekweozor et al., (2017). However cadmium was not detected in the investigation carried out by Wokoma (2014) and Friday et al., (2013). Higher values of cadmium relative to the present study were reported by Bakia et al., (2018) in shrimp (*P. scuptilis*) and crab (*T. crenata*) with the concentrations of 30.438±0.05 and 12.1±0.29 mg/kg respectively.

Bakia et al., (2018) reported mean values of Zn in the range of 43.26±0.38 for shrimp and 47.36±0.37 for crab from the Saint Martin Island, Bangladesh which were found to be higher than the one (10.06±0.22 and 6.54±0.51) for periwinkle and clam respectively reported in this work. Similar high values (77.47 mg/kg) were also recorded by Wangboje and Ikhuabe, (2015) and the range of 84.76 – 136.9mg/kg recorded in *Oreochromis niloticus* from Koycegiz Lake by Yilmaz (2009). However, the mean value of Zn recorded in this research for both periwinkle and clam are higher than the 1.648, 0.286 and 0.304 mg/kg recorded respectively in *Tilapia zilli*, Catfish and *Bagrus bajad* by Ibrahim et al., (2021). The difference could be as a result of the different anthropogenic activities going on in the various study area.

The mean value of zinc recorded in this study for periwinkle is in close affinity with the $11.67 - 21.37mg/kg$ reported by Wokoma (2014), 9.21±0.14 and 12.10±0.16 mg/kg in marine fishes (*R. kanagurta* and *H. nigresceus* respectively) recorded by Bakia et al., (2018). While for clam, the closely related values are those of Bakia et al., (2018), 6.93±0.15 and 7.55±0.45 mg/kg observed in *S. rubrum* and *L. atkinson* respectively.

The concentration of Nickel (3.67±0.10 mg/kg) in the tissue of periwinkle and 4.10 ±0.6 mg/kg in clam from the Andoni River is congruous to the concentration of $3.69 \pm 0.33mg/kg$ in the tissue of *Chrisichthyes nigrodigitatus* as observed by Wokoma (2014) as well as the 3.68 ± 0.156 in the kidney of cat fish from Okilo River as reported by Bob-Manuel et al., (2015). It is however lower than the values of 90.23±17.0 mg/kg in *Illisha africana* and 48.62±31.69 mg/k in *H. bicolor* as reported by Obot et al., (2016). Earlier, Wokoma (2014) and Bob-Manuel et al., (2015) had reported lower concentrations of nickel

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in *Psuedotolithus elongatus* with a range of 0.28- 2.89 and *Clarias gariepinus* also with a range of 0.201 – 2.327 mg/kg respectively.

The result of chromium obtained in this study is lower than the range of 8.15±0.75 – 31.67±26.15 mg/kg reported by Obot et al., (2016) and the mean of 9.91±0.98 mg/kg by Wokoma (2014) in the tissues of *Mugil cephalus* from Sombreiro River, Niger Delta. The concentrations of chromium (5.86±0.25mg/kg in periwinkle and 6. 41±0.15 mg/kg clam) in this study is in close affinity with the values of 6.30±0.62 in *Psuedotolithus elongatus* and 7.41±0.78 in *Chrisichthyes nigrodigitatus*) as recorded by Wokoma (2014), but higher than the values recorded in fin and shell fishes from Bodo and Kaa river by Adata et al., (2015), 0.660±0.077 in muscle, 1.035±0.014 in liver, 0.090±0.05 in gills and 2.859±0.105 mg/kg in kidney observed by Bob-Manuel et al., (2015) in catfish from the Okilo creek in the Niger Delta area of Nigeria.

CONCLUSION

The observed variation in the concentration of heavy metals in the present investigation relative to others is a function of differences in the geographical location, ecology, dominant anthropogenic activities, urban runoff, presence or absence of industrial concerns, human population etc in the various study areas.

The heavy metal with the highest concentration in sediment, periwinkle and clam is zinc followed by chromium and the least is cadmium. In terms of bioaccumulation all the metals of interest in this study had bioaccumulation factor (BAF) values of 1 and above in periwinkle except cadmium which had a value of 0.45. Similarly, in clam except zinc and cadmium with BAF of 0.77 and 0.27 respectively other heavy metals had values above 1. This shows that there is active accumulation of heavy metals by biota (principally periwinkle and clam) in the study area. Similarly, the concentrations of all heavy metals were above their Rivers State Ministry of Environment and World Health Organization stated permissive limits save for zinc in periwinkle and zinc and cadmium in clam. Thus, indicating that the continued consumption (particularly in large quantities) of periwinkle and clam from the mud flats of Andoni River could predispose such consumers to health hazards. .

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