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BIOACCUMULATION OF HYDROCARBON, HEAVY METALS AND MINERALS IN *TYMPANOTONUS FUSCATUS* FROM COASTAL REGION OF BAYELSA STATE, NIGERIA

Emmanuel N. Ogamba[1] --- Sylvester Chibueze Izah[2†] --- Erepadei Omonibo[3]

[1,2,3]Department of Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Bayelsa state, Nigeria

ABSTRACT

Tympanotonus fuscatus is found in mangrove swamps of the coastal region of the Niger Delta Nigeria. It's a source of protein, hence is used in the preparation of delicacies. This study investigated the bioaccumulation of hydrocarbon and heavy metals and minerals in T. fuscatus var radula and T. fuscatus var fuscatus from the brackish coastal region of Bayelsa state, Nigeria. Standard analytical methods were employed. Results showed that the concentration of the metals and hydrocarbon were highest in the shell. The concentration of calcium, magnesium, nickel, cadmium, chromium, mercury and total hydrocarbon content ranged from 10.717-14.533 mg/kg, 6.447 - 8.800mg/kg, 0.048- 0.823mg/kg, 0.010 - 0.036 mg/kg, 0.020- 0.023 mg/kg, 0.001 - 0.002 mg/kg and 0.060 - 0.767 mg/kg respectively. There was a significant difference (P<0.05) in the concentration of metals and hydrocarbon between the two varieties. The concentration of cadmium and mercury were below the limit to cause diseases as reported by the World Health Organization. Similarly the concentrations of nickel, chromium and hydrocarbon in the tissue were also low. High concentration of magnesium and calcium indicated their potential for health benefits. Furthermore, the high concentration of heavy metals and hydrocarbon in the shell of both species also suggested their potentials for bioremediation for such toxicants in the aquatic ecosystem.

Keywords: Bioremediation, Public health, Tympanotonus fuscatus, Water contaminants.

Contribution/ Originality

This study documents bioaccumulation of heavy metals, minerals and hydrocarbon on the tissue and shell of two varieties of *Tympanotonus fuscatus* from brackish coastal region of Bayelsa state, Nigeria.

1. INTRODUCTION

In recent times, the intensity environmental pollution has increased. Badejo, et al. [1] attributed the increase in scope and magnitude to urbanization, insufficient concern of

† Corresponding author

environmental impact analysis of developmental projects and the hurry towards industrialization and urbanization without suitable planning and management approach. Pollution emanates from natural effects which to a large extent depend on the geology and prevailing environmental conditions of the place and anthropogenic activities i.e. main activities on the ecosystem. In Nigeria, the type of pollution that occurs depends solely on the type of activities in the region. For instance, in the northeastern Nigeria, pollution resulting from mining do occur, which often leads to the contamination of potable water sources by non essential heavy metals such as arsenic [2]. Similarly, in the Niger Delta were oil and gas activities are carried out both onshore and offshore, contamination of the ecosystem by hydrocarbon does occur. Ordinioha and Brisibe [3] reported that average of 240,000 barrels of crude oil spills occur in the Niger Delta annually due to unknown causes, third party activity and mechanical failure leading to contamination of surface water, ground water, ambient air, and crops with hydrocarbons such as polycyclic aromatic hydrocarbon and benxo (a) pyrene, radioactive materials and trace metals that can bioaccumulate in some food crops. In animals crude oil could be hemotoxic and hepatotoxic, which could cause infertility and cancer [3]. Pollution of aquatic ecosystem leads to death of the organisms or bioaccumulation of such pollutant in the organisms.

Several variety of invertebrates such as Molluscs including *Tympanotonus fuscatus* inhabit in mangrove brackish water [4, 5]. Genus of other type of periwinkle are Pachymelania and Merceneria, but only the genus Tympanotonus and Pachymelania are found in the Niger Delta region of Nigeria [6]. Others include belong to the genus belong to the genus Majority of them *T. fuscatus* inhabit the shallow coastal regions particularly coral reefs and inter-tidal zones [4]. *T. fuscatus* is found within the intertidal area (i.e estuarine habitats) predominated by mangrove such as *Rhizophora racemosa*, *R. mangle*, *Avicennia Africana*, *Nypa fruticans*, *Laguncularia racemosa* etc. *T. fuscatus* inhabits in the detritus rich mud substratum in quiet waters [4]. *T. fuscatus* crawls under water and remains passive when left exposed by the tide [7].

T. fuscatus has the potential to accumulate and biomagnify contaminants such as heavy metals, polycyclic aromatic hydrocarbons etc in the environment [7-9]. Hence this gastropod a promising bio-indicator for bio-monitoring [10, 11]. Bioaccumulation route is through passive diffusion with some active transport; the digestive System, respiratory system [12]. The ingestion of these pollutants has health implications in the aquatic organisms (decline in productivity and reproduction potentials) and humans that depend on them for protein [9]. Two varieties of *T. fuscatus* exist i.e *T. fuscatus var radula* and *T. fuscatus var fuscatus*, and both have high economic value in the Niger Delta [13]. The two gastropods that co-habit the mud-flat with *T. fuscatus* are *Neritina adansoniana* and *Pachymelania fusca var quadriseriata* [4] *T. fuscatus* is euryhaline, surviving in waters with wide range of salinities 0.1mg/l to 25mg/l [4]. *T. fuscatus* var *fuscatus* is bisexual and characterized by turrented, granular and spiny shells with tapering ends [4, 14] while *T. fuscatus* var *radula* is characterized by absence of tubercle on the shell [14].

The flesh is used in the preparation of delicacies while the shell has been widely employed in construction work during building of houses and walk-ways in rural communities. Typically, two varieties of *T. fuscatus* is found in mangrove forest of the Niger Delta. Therefore, This study

aimed at evaluating the level hydrocarbon, heavy metals and minerals in the shell and flesh of *T. fuscatus var radula* and *T. fuscatus var fuscatus* from the coastal mangrove region of Bayelsa state, Nigeria.

2. MATERIALS AND METHODS

2.1. Sample Collection and Preparation

Triplicate samples of *T. fuscatus var radula* and *T. fuscatus var fuscatus* were obtained from vendors from Nembe in Nembe Local Government Area and Lobia in Southern Ijaw Local Government Area respectively of Bayelsa state between May and June 2013. Both varieties of *T. fuscatus* was transported to the laboratory in an ice box.

2.2. Sample Preparation and Laboratory Analysis

Both varieties were washed with running tap water and boiled to ease the removal of the flesh from its shell. The flesh was dried in an oven at 105^{o}C. The dried flesh and shell was separately ground using mortar and pestle. The samples were stored in Ziploc bags at room temperature prior to analysis. The ground samples were digested with nitric acid. The metals calcium, magnesium, cadmium, chromium, nickel and mercury and total hydrocarbon were analyzed.

2.3. Statistical Analysis

SPSS software version 16 was used for the statistical analysis. A one-way analysis of variance was carried out at P = 0.05, and Tukey HSD was used to compare the means.

3. RESULTS AND DISCUSSION

Table 1 presents the total hydrocarbon content, heavy metals (nickel, cadmium, chromium and mercury) and minerals (calcium and magnesium, concentration) in the shells from two varieties of *T. fuscatus* found in the brackish water region of Bayelsa state, Nigeria. The highest and least concentrations of calcium were observed in *T. fuscatus var radula* from Lobia (37.933±3.180 mg/kg) and Nembe (60.573±0.273mg/kg). Basically, there were significant variations (P<0.05) between the locations, while there was no significant variation (P>0.05) in calcium between the two varieties from each location. Magnesium was highest and least in *T. fuscatus var radula* (24.433±0.219mg/kg) from Nembe and *T. fuscatus var fuscatus* (30.907±0.521mg/kg) from Lobia. There were significant variations (P<0.05) in magnesium levels between the locations and varieties. Nickel concentration was least in the samples from Lobia and highest in those from Nembe. However, the concentration ranged from 0.61 mg/kg (*T. fuscatus var radula*) to 2.527mg/kg (*T. fuscatus var fuscatus*), being significantly different (P<0.05) across locations. Cadmium and chromium concentrations ranged from 0.030mg/kg to 0.520mg/kg and 0.040 to 3.400 mg/kg respectively in *T. fuscatus var fuscatus*. However, apart from *T. fuscatus var fuscatus* from Nembe, there was no significant variation (P>0.05) among the

varieties across the locations. There was significant variation (P<0.05) in the concentration of mercury from both locations and varieties ranging from 0.020 to 0.050mg/kg. Total hydrocarbon content ranged from 0.520 (*T. fuscatus var fuscatus*) to 5.667 mg/kg in from in samples Nembe, being significantly different (P<0.05) across both locations. The bioaccumulation in this study was in the order; mercury<cadmium<nickel<chromium<total hydrocarbon<magnesium<calcium and typically highest in *T. fuscatus var fuscatus* than *T. fuscatus var radula.*

Table-1. Concentration of total hydrocarbon and metals in the shell and two varieties of *Tympanotonus fuscatus* found in the brackish water region of Bayelsa state, Nigeria

Parameters	Lobia		Nembe	
	T. fuscatus var radula	T. fuscatus var fuscatus	T. fuscatus var radula	T. fuscatus var fuscatus
Calcium , mg/kg	37.933±3.180a	41.933±0.291a	60.573±0.273b	54.860±1.155b
Magnesium, mg/kg	28.800±0.493b	30.907±0.521b	24.433±0.219a	30.483±0.726b
Nickel, mg/kg	0.610±0.049a	0.760±0.058a	1.333±0.145ab	2.527±0.549b
Cadmium, mg/kg	0.473±0.047b	0.520±0.058b	0.480±0.058b	0.030±0.000a
Chromium, mg/kg	2.773±0.376b	3.400±0.577b	3.367±0.273b	0.040±0.012a
Mercury, mg/kg	0.020±0.000a	0.025±0.001a	0.043±0.009a	0.050±0.001a
Total hydrocarbon content, mg/kg	4.720±0.379c	3.280±0.006b	5.667±0.353c	0.520±0.012a

Note: The same letters in each row indicate no significant difference (*P*>0.05) according to the Tukey HSD statistics; Each value is expressed as mean ± standard error (n = 3).

The total hydrocarbon content, heavy metals (nickel, cadmium, chromium and mercury) and minerals (calcium and magnesium) concentration in the tissue from two varieties of *T. fuscatus* found in the brackish water region of Bayelsa state, Nigeria is presented in Table 2. Calcium concentration is significantly different (P<0.05) from both variety and location ranging from 10.717mg/kg (*T. fuscatus var radula* from Nembe) to 14.533mg/kg (*T. fuscatus var fuscatus* from Lobia). The magnesium concentration showed no significant variation (P>0.05) between the varieties from the different locations, ranging from 6.447 mg/kg (*T. fuscatus var fuscatus* from Lobia) to 8.800mg/kg (*T. fuscatus var radula* from Nembe). In nickel, significant variation (P<0.05) exist between the locations, but no significant variation (P>0.05) between the two varieties from the same location, ranging from 0.048 mg/kg (*T. fuscatus var fuscatus* from Lobia) to 0.823mg/kg (*T. fuscatus var radula* from Nembe). The concentration of cadmium, chromium and mercury ranged from 0.010 to 0.036 mg/kg, 0.020 to 0.023 mg/kg and 0.001 to 0.002 mg/kg respectively showing no significant difference (P>0.05) between the two variety across both locations. The total hydrocarbon content ranged from 0.060 to 0.767 mg/kg (all in *T. fuscatus var radula* from Lobia). There were significant variations (P<0.05) between the two varieties across both locations. The variations between the two species could be attributed to biochemical composition, resulting in differences between their capacities to absorb and concentrate the studied parameters. Again, the concentrations of the heavy metals, minerals elements and

hydrocarbon were in the order; calcium>magnesium>nickel>hydrocarbon>cadmium>chromium>mercury.

Table-2. Concentration of total hydrocarbon, mineral elements and heavy metals in the tissue of two varieties of *Tympanotonus fuscatus* found in the brackish water region of Bayelsa state, Nigeria

Parameters	Lobia		Nembe	
	T. fuscatus var radula	T. fuscatus var fuscatus	T. fuscatus var radula	T. fuscatus var fuscatus
Calcium, mg/kg	12.800±0.577b	14.533±0.273c	10.717±0.268a	12.640±0.115b
Magnesium, mg/kg	8.600±0.557b	6.447±0.203a	8.800±0.058b	6.520±0.115a
Nickel, mg/kg	0.069±0.015a	0.048±0.006a	0.823±0.073b	0.660±0.017b
Cadmium, mg/kg	0.031±0.009a	0.036±0.012a	0.016±0.002a	0.010±0.000a
Chromium, mg/kg	0.024±0.012a	0.020±0.000a	0.023±0.002a	0.020±0.000a
Mercury, mg/kg	0.002±0.000a	0.001±0.000a	0.001±0.000a	0.001±0.000a
Total hydrocarbon content, mg/kg	0.060±0.012a	0.767±0.044c	0.357±0.015b	0.300±0.058b

Note: The same letters in each row indicate no significant difference ($P>0.05$) according to the Tukey HSD statistics; Each value is expressed as mean ± standard error (n = 3).

The higher bioaccumulation in the shell than the tissue could be due to the fact that the shell is always in contact with the toxicants in the environment. The occurrence of hydrocarbon and metals such as cadmium, chromium and mercury could be attributed to their exposure to these contaminants found in the environment. However, oil and gas activities could release hydrocarbon into the water, which could settle in the sediment and the swamp where they gradually bioaccumulate in both varieties of *T. fuscatus*. However, the concentration of cadmium and mercury were below the World Health permissible Limit of 0.5 – 1.0 mg/kg and 0.5 mg/kg respectively. The high occurrence of divalent cations such as calcium and magnesium may be due to their role in the formation of skeletal structures in chordates, exoskeleton in gastropods and other animals. Magnesium plays essential role in the metabolism of food and synthesis of fatty acids and proteins and also acts in neuromuscular transmission. Magnesium also has therapeutic value, further justifying the consumption of *T. fuscatus* by humans.

The concentration of the studied parameters in the tissue of the *T. fuscatus* varieties studied showed some similarities with previous findings. Ikejimba and Sakpa [7] reported the concentration of cadmium in *T. fuscatus var radula* samples from Egbokodo River, Warri, Nigeria between September and February, to be in the range of 0.00 – 0.005mg/g. Davies, et al. [9] reported the concentration of chromium and cadmium (small and large) in *T. fuscatus* in the range of 0.010 – 0.34 mg/kg and <0.001 – 0.006 mg/kg respectively (normal soft tissue), 0.009 – 0.038 mg/kg and <0.001 – 0.006 mg/kg respectively (normal shell) and 0.016 – 0.023 mg/kg and <0.001 – 0.004 mg/kg (depurated soft tissue) from Elechi creek, Niger Delta Nigeria. Chindah, et al. [10] reported concentration of total hydrocarbon content, chromium and cadmium in the tissue of *T. fuscatus* in three ecological zones of Bonny River System, Niger Delta, Nigeria in the

range of 0.015 – 0.015 mg/kg, 0.0 – 1.0 mg/kg, 0.0 – 1.0 mg/kg respectively (dry season) and 8.405 – 23.207 mg/kg, 0.027 – 0.349 mg/kg and 0.333 – 0.454 mg/kg respectively (wet season). Nwabueze, et al. [15] reported the concentration of total hydrocarbon content, mercury and cadmium in the tissue of *T. fuscatus* from Warri River as 0.0045 – 0.098mg/g, <0.001ppm and <0.001 ppm respectively. Also, the concentration in this study was not in consonance with some other authors report. Andem, et al. [8] reported the concentration of total hydrocarbon, cadmium, mercury and nickel in the tissues of periwinkle (*Tympanotomus fuscatus*) from Qua Iboe River, Ibeno area of Akwa Ibom State in the range of 0.004-0.050 mg/g, 0.043- 0.53mg/g, 0.020-0.033mg/g and 0.03- 0.04mg/g respectively. Nwaichi, et al. [16] reported the concentration of mercury, cadmium, magnesium and calcium in *T. fuscatus* from Abonnema water In Rivers State, Nigeria as <0.001mg/kg, 0.716mg/kg, 640.88 mg/kg and 18707.99 mg/kg respectively (flesh) and <0.001 mg/kg, 0.391mg/kg, 6.451mg/kg, 30723.51 mg/kg respectively (shell). Clinton, et al. [13] reported total hydrocarbon in *T. fuscatus* from an oil polluted mangrove wetland located in the Niger Delta Nigeria, between November 2001 and October 2002 as 449.30 µg/g.

4. CONCLUSION

The study evaluated the bioaccumulation of metals and total hydrocarbon and mineral element contents in shell and flesh of two varieties of *Tympanotonus fuscatus* from coastal brackish water region of Bayelsa state, Nigeria. Total hydrocarbon and heavy metals including nickel, cadmium and chromium were high in the shell, suggesting their potentials in remediation studies. Furthermore, the concentration of mercury and cadmium were lower than World Health permissible limit for edible food. This also suggests that there is no health hazard posed by these metals due to their consumption. However, caution should be exercised with the consumption of *T. fuscatus* from the studied area with regard to the total hydrocarbon content of >0.5mg/kg recorded in the organisms.

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