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Photometric Determination Of Macro-Micro Minerals In The West African Mud Creeper, *Tympanotonus fuscatus* var *radula* (Linnaeus, 1758)

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Abstract

The flesh and shell of the West African Mud creeper, ***Tympanotonus fuscatus*** var *radula* from Abule-Eledu Creek were analysed by Flame and Atomic Absorption Spectrophotometry for their contents of the macro-minerals: calcium, phosphorus, magnesium, sodium and potassium, and the micro-minerals: iron, zinc, copper, manganese, chromium, lead and cadmium. The highest macro-mineral was phosphorus; 86±14.15 mg/100g in flesh and 67.05±18.85 mg/100g in shell, while the least was magnesium; 19.58±0.96 mg/100g in flesh and 35.3±0.64 mg/100g in shell. The shell of the investigated periwinkle was significantly higher ($p<0.05$) in content of calcium, magnesium and potassium than in the flesh. The concentrations of micro-minerals; copper (1.25 mg/100g), zinc (0.76 mg/100g), chromium (0.06 mg/100g) and iron (6.00 mg/100g) in the flesh samples were higher than the concentration in the shell and consequently higher than FEPA standard limits of these elements in sea food. It has been observed that ***Tympanotonus fuscatus*** var *radula* from Abule-Eledu Creek could provide a significant proportion of needed inorganic nutrients; these relatively high concentrations of trace metals give certain restrictions on the dietary intake**.**

Keyword: Minerals, Heavy metals, Periwinkle, Abule-Eledu Creek, Lagos Lagoon.

INTRODUCTION

Tympanotonus fuscatus var radula is a gastropod mollusc belonging to the subclass Prosobranchia and commonly called periwinkle in Nigeria (Moruf et al. 2018). It constitutes one of the relatively easily harvested shell fishes occurring widely within the upper intertidal zone of coastal areas (Castrol and Huber, 2005). In Nigeria, it occurs in lagoons, estuaries and mangrove swamps and is usually harvested by hand-picking (Adebayo-tayo et al. 2006). *Tympanotonus fuscatus var radula* is a relatively cheap source of animal nutrients and is mostly consumed in the Southern part of Nigeria and some riverine areas of West Africa.

In the context of nutrition, a mineral is a chemical element required as an essential nutrient by organisms to perform functions necessary for Life (Berdanie et al. 2013). It plays an important role in biochemical reactions as co-enzyme factor. The essential mineral elements are usually classified into two main groups according to their concentration in the animal body; the macro-elements and the microelements (Spears, 1999). Macro minerals needed by the body in relatively large amount, including Ca, P, K, Na, Cl, Mg, and S (Gartenberg, 1990). Micro mineral is a mineral needed in very small amount and is generally found in tissues with very small concentrations, i.e. Fe, Cr, Cu, Zn, Mn, Mo Co, I, and Se (Brown et al. 2004).

Generally, shellfishes vary in their nutrients and mineral contents and can excrete Zn, Cu, Co, Mn, and Hg in their urine (Abolude et al. 2009). Nigerians have started using periwinkle as a commercial meat, though the utilization is yet limited with a little scientific information about the nutritive status of the animal.

In that light, the main objective of this study is to evaluate the macro- and micro-minerals in the edible portion and the shell of the West African Mud Creeper, Tympanotonus fuscatus var radula collected from Abule-Eledu creek in Lagos State, Nigeria.

MATERIALS AND METHODS

Study Setting

The study was carried out in the

($6^0$31.015'N and 3^0 23.948'E) which forms part of the many sluggish tidal creeks that drain into the Lagos Lagoon.

Sample Collection

The periwinkles were collected by scooping from the water bed at low tides. The collected samples were taken to the laboratory and stored in the freezer prior to digestion for analysis of the minerals. All samplings were carried out between the hours of 6.00 and 8.00 am.

Analytical Procedure

The tissues of *Tympanotonus fuscatus var radula* were later scrubbed and extracted from their shells; the extracted tissues were rinsed with distilled water to remove debris and other external adherents. Both the flesh and the shell were then separately dried in an oven at 105^0 C until constant weight was obtained and later separately homogenized using mortar and pestle. 10 g of each homogenate was separately digested as described by APHA (2005). The samples were digested using 1:5:1 mixture of 70 % perchloric acid, concentrated nitric acid and sulphuric acid at 80^0 C in a fume chamber until a colourless liquid was obtained. Some macro minerals (Sodium and potassium) were determined by using a flame photometer (model 405, corning, U.K) while other minerals were determined by Atomic Absorption Spectrophotometer (Perkin & Elmer model 403, USA) as described by Gokoglu and Yerlikaya (2003). All determinations were done in triplicate. Concentration of minerals was expressed as mg/100g for dry weight organism part.

Data Analysis

Data was analyzed using Microsoft Excel 2010 and SPSS version 19. Possibilities less than 0.05 ($p<0.05$) were considered statistically significant.

RESULTS

The result on Table 1 indicates the significant level of macro-mineral contents of the West African Mud Creeper, *Tympanotonus fuscatus var radula* in mg per 100g of sample. The shell of the investigated periwinkle was significantly higher ($p<0.05$) in content of calcium, magnesium and potassium than in the flesh. The flesh contained higher phosphorus (86 ± 14.15 mg/100g) and sodium (55.53 ± 20.97 mg/100g) than the phosphorus (67.05 ± 18.85 mg/100g) and sodium (54.2 ± 22.42 mg/100g) contents of the shell. However, these were not statistically significant. The pattern of macro-mineral compositions of the flesh was Phosphorus > Sodium > Calcium > Potassium > Magnesium while in the shell; it was Phosphorus > Calcium > Sodium > Potassium > Magnesium.

Table 1: Range and Mean ± SEM of macro-mineral concentrations in flesh and shell of *Tympanotonus fuscatus* var *radula* from Abule-Eledu Creek

Element(mg/100g)	Flesh	Shell	*P-Value*
Calcium	(41.98-48.39)	(3630-5507.85)	0.00*
	45.03±1.86	49.91±2.65	
Phosphorus	(57.80-102.20)	(35.83-100.98)	0.47
	86±14.15	67.05±18.85	
Magnesium	(17.86-21.16)	(34.62-36.58)	0.00*
	19.58±0.96	35.3±0.64	
Sodium	(17.6-90)	(16.73-94.25)	0.97
	55.53±20.97	54.2±22.42	
Potassium	(30-36)	(45.86-49.65)	0.00*
	33.33±1.76	47.49±1.12	

Keys: Range (in brackets), Mean±Standard Error,*: Significantly different at ($P<0.05$)

Data on the micro-mineral contents of Tympanotomus fuscatus var radula are shown in Table 2. The periwinkle showed significant difference only in manganese content with 0.31±0.05 mg/100g for flesh and 3.53±0.46 mg/100g for shell. The pattern of micro-mineral compositions of the flesh was iron > copper > zinc > manganese > cadmium > lead > chromium while that of shell was iron > manganese > cadmium > copper > lead > zinc > chromium. The concentrations of copper (1.25 mg/100g), zinc (0.76 mg/100g), chromium (0.06 mg/100g) and iron (6.00 mg/100g) in the periwinkle flesh were higher than the concentration in the shell.

Table 2: Range and Mean±Standard Error of micro-mineral concentration in flesh and shell of *Tympanotonus fuscatus* var *radula* from Abule-Eledu Creek

Element mg/100g	Flesh	Shell	*P-Value*
Copper	(0.21-2.15)	(0.12-1.23)	0.46
	1.25±0.56	0.72±0.32	
Manganese	(0.25-0.4)	(3.18-4.45)	0.00*
	0.31±0.05	3.53±0.46	
Zinc	(0.35-1.24)	(0.019-0.37)	0.11
	0.76±0.26	0.19±0.1	
Chromium	(0.02-0.12)	(0.01-0.08)	0.62
	0.06±0.03	0.04±0.02	
Iron	(3.9-9.69)	(2.83-6.27)	0.4
	6.00±1.85	3.98±1.15	
Lead	(0.04-0.1)	(0.18-0.43)	0.03
	0.07±0.02	0.3±0.07	
Cadmium	(0.08-0.19)	(0.12-2.27)	0.36
	0.12±0.04	0.85±0.71	

Keys: Range (in brackets), Mean±Standard Error,*: Significantly different at (P<0.05)

DISCUSSION

The calcium contents observed in flesh and shell of *Tympanotonus fuscatus var radula* in this study are similar to the report of Ehigiator and Oterai (2012) on the flesh (44.73 ± 1.94 mg/100g) and shell (47.65 ± 2.99 mg/100g) of periwinkle from Benin River in Edo State. This value is higher than *Limicolaria specie* whose calcium content is 36.20 mg per 100g but lower than *Achatina Achatina, Archachatina Marginata* and *Achatina fulica* with calcium contents of 106.30mg/100g, 126.40mg/100g and 66.30mg/100g respectively (Babalola and Akinsoyinu, 2009). Calcium plays important role in blood clotting, muscles contraction and in certain enzymes in metabolic processes (Abolude et al. 2009). The high content of calcium in *Tympanotonus fuscatus var radula* suggests that its consumption can increase the calcium in the body and help in blood clotting process. The value of phosphorus in the investigated periwinkle is higher than the range of 19.7- 36.4 mg/100g reported by Akinjogunla et al. (2017) for *Crassostrea gasar* from Lagos Lagoon. Phosphorus plays a vital part in the oxidation of nutrient in form of phosphate groups in ATP for energy and cell metabolism (Babalola and Akinsoyinu, 2009).

Magnesium, being the macro-mineral with the lowest value in this study is lower than the value reported for *Oryctes rhinoceros by* Okaraonye and Ikewuchi (2009). According to Hambidge (2000), magnesium is an activator of the enzyme system which functions in the metabolism of carbohydrates to produce energy. As with calcium and phosphorus, a proportion of the magnesium contained in plant foodstuffs may be present in the form of phytin (Ca or Mg salt of phytic acid). Magnesium is involved in the formation of the bone structure in the body, therefore a meal containing *Tympanotonus fuscatus var radula* would assist in bone formation.

The sodium content (55.53 mg/100g) is above the 20.29mg/100g reported for *Oryctes rhinoceros* (Okaraonye and Ikewuchi, 2009) while the potassium value is similar to 45.0 mg/100g reported for grasshopper by Olaofe et al. (1998). Sodium and chlorine being found mainly in the body fluids while potassium occurring mainly in the cells. They are essential in the regulation of pH, osmotic pressure, acid-base equilibrium, water balance, nerve impulse transmission and active transport of glucose/amino acids (Asuquo et al. 2004).

Aquatic organisms were reported to be selective in metal accumulation due to toxicity effects (Ayodele and Abubakar, 2002). The mode of action of heavy metals on biological systems is thought to be through enzymes systems, although extra ordinary concentrations may result in direct tissue damage (Abubakar and Garba, 2006). Regulatory ability, behaviour and feeding habits are factors that influence the accumulation of metals in the different species (Marzouk, 1994). Regulation of metal body burden by aquatic organisms can be through three principal mechanisms, via gut, urine and diffusion through the body surface (Abolude et al. 2009).

The flesh copper content in this study is 1.25 ± 0.56mg/100g while the requirement per day is 1-3 mg/100g (Ogungbenle and Omowole, 2012), therefore consumption of 100g of the periwinkle per day is able to supply the daily requirement of copper. Copper is an essential element that serves as a cofactor in a number of enzymes systems (cytochrome oxidase and d tyrosinase) and necessary for the synthesis of hemoglobin (Sivaperumal et al. 2007). Copper is associated with iron and catalyses oxidation-reduction mechanism concerned with tissue respiration while tyrosinase is concerned with tyrosine (Babalola and Akinsoyinu, 2009).

The present value of manganese in the periwinkle flesh is lower than FEPA (2006) standards limits of Manganese (0.5mg/kg) in sea food. As a cofactor or component of several key enzyme systems, manganese is essential for bone formation (mucopolysaccharide synthesis), the regeneration of red blood cells, carbohydrate metabolism, and the reproductive cycle. Severe skeletal and reproductive abnormalities have being associated with the deficiency of manganese in mammals (Abiona et al. 2018).

The zinc content (0.76 mg/100g) was lower to that recorded by Ehigiator and Oterai (2012) for the edible portion of *Macrobrachium vollenhovenii* (1.16 mg/100) and *Tympanotonus fuscatus* (1.24 mg/100g) from Benin River. However, the concentration of zinc recorded in the samples exceeded the FEPA (2006) recommended standards limits of 0.10 mg/kg in sea food. Zinc is believed to play a positive role in wound healing.

Chromium levels were above the FEPA (2006) standards limits of 0.05mg/kg for sea food. Apart from its vital role in carbohydrate metabolism (i.e glucose tolerance and glycogen synthesis), trivalent chromium is also believed to play an important role in cholesterol and amino acid metabolism and acts as a cofactor for the hormone insulin. However, high intake beyond the permissible limit is carcinogenic to man and other mammals.

The iron content of 3.98-6.00 mg/100g in *Tympanotonus fuscatus* var *radula* compared favourably well with that of grasshopper (3.7mg/100g) reported by Olaofe *et al*., (1998). Iron in organisms is essential because of its contribution in the formation of haemoglobin, myglobin and hemenzymes (Mercer, 1992).

The mean concentration level of lead in the investigated snail exceeded the FEPA (2006) standards limit of 0.01 mg/kg for fish food. Lead is a toxic element which has no biological functions and shows carcinogenic effect on

known to cause musculo-skeletal, renal, ocular, neurological, immunological, reproductive and developmental effects (Schuster, 2004).

Cadmium levels were recorded in flesh and shell of the periwinkles were above the FEPA (2006) maximum permissible limits of 0.003mg/kg for sea food. Cadmium is a highly toxic non–essential heavy metal which could be harmful to living organisms even in low concentration (Tsui and Wang, 2004).

CONCLUSION

The observations in dietary minerals suggest that *Tympanotonus fuscatus* var *radula* could provide a significant proportion of needed inorganic nutrients, therefore regarded as an essential sea food for healthy functioning of the body. The shells could as well be affirmed as good feedstuff in animal feed formulation.

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