CHEMICAL COMPOSITION AND AMINO ACID PROFILE OF A CARIDEAN PRAWN (*MACROBRACHIUM VOLLENHOVENII*) FROM OVIA RIVER AND TROPICAL PERIWINKLE (*TYMPANOTONUS FUSCATUS*) FROM BENIN RIVER, EDO STATE, NIGERIA

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ABSTRACT

The proximate, mineral composition and amino acid profile of the body parts of *Macrobrachium vollenhovenii* (African river prawn) and *Tympanotonus fuscatus* (tropical periwinkle) were determined. The length and weight of the prawns varied from 15cm to 17.6cm and 72.76g to 130.65g respectively while the length and weight of the periwinkles varied from 22.72mm to 54.72mm and 1.53g to 7.59g respectively. Chemical analysis was done in triplicates while the data obtained were analysed using descriptive statistics, analysis of variance and Duncan's multiple range test. The protein content of the two species was high. Protein values ranged from 67.68-69.71%, fat values ranged from 6.87-7.68%, ash values ranged from 10.16-10.55%, fibre values ranged from 0.40-0.54%, moisture values ranged from 10.25-10.71%, carbohydrate values ranged from 0.58-3.65%. Protein, fat, ash, fibre, moisture and carbohydrate were significantly different ($P<0.05$) between the body parts of the two species. The mineral values of the two species were high especially that of phosphorus (P) and calcium (Ca). Phosphorus ranged from 100.81-106.71mg/100g. Calcium ranged from 44.73-52.00mg/100g. Magnesium (Mg) ranged from 20.48-21.70mg/100g. Zinc (Zn) values ranged from 1.16-2.14mg/100g. The Ca, P and Zn content between the body parts of the two species were significantly different ($P<0.05$) from each other except for magnesium which was not significantly different ($P>0.05$). Thirteen amino acids were reported, 8 essential amino acids and 5 non-essential amino acids. Glutamine, asparagine, lysine, leucine, arginine, glycine and valine were the most abundant amino acids. The ratios of essential amino acids (EAA) to non-essential amino acids (NEAA) in prawns and periwinkles were 1.05 and 1.09 respectively. The alanine, arginine, asparagine, glutamine, glycine, histidine, serine, threonine, leucine, lysine, methionine, phenylalanine & valine contents in the body parts of the two species were significantly different ($P<0.05$) from each other. In conclusion, *Macrobrachium vollenhovenii* (African river prawn) and *Tympanotonus fuscatus* (tropical periwinkle) are good sources of protein and amino acids which can be used for feed formulation and consumed by humans. They also contain considerable amounts of minerals and are low in fat.

Keywords: Proximate composition, mineral composition, amino acid profile, *Macrobrachium vollenhovenii*, *Tympanotonus fuscatus*.

1. INTRODUCTION

Shellfish is a fisheries and culinary term for exoskeleton-bearing aquatic invertebrates used as food. They can be divided into two groups namely; molluscs and crustaceans. Familiar marine molluscs enjoyed as a food source by humans include many species of clams, mussels, oysters, winkles and scallops. Some crustaceans commonly eaten are shrimps, prawns, lobsters, crayfish and crabs. Finfish, shellfish and other aquatic organisms suitable for food and feed are of worldwide importance. They are excellent sources of high quality proteins which are superior to those in meat and poultry. Biochemical assays and nutrients play a vital role in physical growth, development, maintenance of normal body function of physical activity and health. The knowledge of the biochemical composition of any edible organism is extremely important since the nutritive value is reflected in biochemical contents as stated by Nagabhushanam and Mane [1]. Generally, fish and shellfish meat is considered to be highly nutritious, owing to its content of essential amino acids and proteins, for example, shrimp meat is an excellent source of protein [Yanar and Celik [2] and shrimp is one of the most popular species as it is a part of almost every nation's traditional meal rich in protein and minerals.

Periwinkles are invertebrates and belong to the phylum *Mollusca* and class *Gastropoda* as classified by Buchaan [3]. They are widely distributed shore snails, chiefly herbivorous and they have a dark and sometimes spiral banded shell that readily withstands the buffeting waves characterized by turreted, granular and spiny shells with tapering ends as observed by Jamabo and Chinda [4]. Freshwater prawns of the genus *Macrobrachium* are decapod crustaceans belonging to the family *Palaeomonidae. Macrobrachium spp* are found in most inland freshwater areas and occur throughout the West Africa region. Freshwater prawns, like all, crustaceans, have a hard outer skeleton or shell that must be shed regularly in order for growth to occur D'Abramo and Brunson [5]. The objective of this study was to determine the proximate, mineral composition and amino acid profile of the Caridean prawn (*Macrobrachium vollenhovenii*) and tropical periwinkle (*Tympanotonus fuscatus*).

2. MATERIALS AND METHODS

Animals used: Animals used for this study were marketable size of the African river prawn (*Macrobrachium vollenhovenii*) with weight ranging from 72.76g to 130.65g. The prawns were gotten Ovia River, Edo State, Nigeria. The tropical periwinkle (*Tympanotonus fuscatus*) with weight ranging from 1.53g to 7.59g was gotten from Benin River, Edo State, Nigeria. The prawns were separated into three (3) parts: whole prawn, edible portion (flesh) and exoskeleton & appendages while the periwinkles were separated into two (2) parts: edible portion (flesh) and the shell. The samples were oven dried at 75^0C and ground to fine powder for analysis. All analysis was done in triplicate.

Biochemical, minerals and amino acid analysis: For each species used, the biochemical compositions such as protein, lipid, carbohydrate, moisture, crude fibre and ash content were measured using the method of Association of Official Analytical Chemists (AOAC) [6]. Nitrogen was determined by the micro-Kjeldahl method and the percentage nitrogen was converted to crude protein by multiplying by 6.25. Carbohydrate was determined by difference. All determinations were performed in triplicates. Minerals (Ca, Mg, P and Zn) were determined using the atomic absorption spectroscopy technique International Institute of Tropical Agriculture (IITA) [7]. Amino acids were examined using the HPLC system with a UV detector at 420nm.

The results obtained from chemical analysis were subjected to descriptive statistics and tested using analysis of variance and Duncan's multiple range tests using SPSS version 16 (Inc. Illinois, USA) Statistical Package for Windows.

3. RESULTS

Table 1 shows the proximate and mineral composition of the whole portion, edible portion, exoskeleton & appendages of *Macrobrachium vollenhovenii* and the edible portion and shell of *Tympanotonus fuscatus*. The protein content of the body parts of the two species shows that it was high when compared with other nutrient composition but higher in the edible portion of the prawn (71.37%) than in the other body parts. The edible portion of *T. fuscatus* had higher fat (7.68%) while the exoskeleton & appendages of *M. vollenhovenii* had the lowest fat content (6.87%). The ash content ranged between 10.16 and 10.55% with exoskeleton and the shell of the periwinkle with higher values of ash that the other body parts. Fibre was less than 1.0mg/100g in all the body parts. The carbohydrate content of the body parts of both species was low and it varied from 0.58-3.65% with the edible portion of the periwinkle with the highest value.

The results of the mineral analysis are shown in Table 2. The exoskeleton and the appendages of *M. vollenhovenii* had the highest calcium (52.00mg/100g) and the edible portion of *T. fuscatus* had the lowest calcium value (44.73mg/100g). The magnesium content of the body parts of both species was not significantly different ($P>0.05$) from each other. The magnesium concentration varied between 2.48 – 21.70mg/100g. The phosphorus content was generally high in all the body parts for both species ranging from 100.81-106.71 mg/100g. The whole portion of *M. vollenhovenii* had highest content of phosphorus (102.67mg/100g) while the exoskeleton & appendages of *M. vollenhovenii* had the lowest (100.81mg/100g). The zinc content was very low compared to other metals with values ranging between 1.16 and 1.24 mg/100g.

Table 1: Proximate (%) & mineral composition (mg/100g) of the whole & edible portion, exoskeleton of M. vollenhovenii and the edible portion & shell of T. fuscatus

		M. vollenhovenii		*atus*	
Parameters/Parts	**Whole prawn**	**Edible portion**	**Exo & App**	**Edible portion**	**Shell**
Protein	69.71±0.40^{b}	71.37±0.07^{a}	68.77±0.05^{c}	68.46±0.26^{d}	67.68±0.18^{e}
Fat	7.13±0.07^{c}	7.33±0.11^{b}	6.87±0.06^{d}	7.68±0.24^{a}	7.64±0.15^{a}
Ash	10.28±0.30^{bc}	10.31±0.05^{bc}	10.55±0.10^{a}	10.16±0.09^{c}	10.42±0.12^{ab}
Fibre	0.54±0.02^{a}	0.45±0.01^{c}	0.40±0.02^{d}	0.51±0.05^{b}	0.47±0.01^{c}
Moisture	10.64±0.11^{a}	10.71±0.13^{a}	10.25±0.08^{c}	10.37±0.08^{bc}	10.44±0.16^{b}
Carbohydrate	1.70±0.31^{c}	2.42±0.12^{b}	0.58±0.17^{d}	3.65±0.20^{a}	2.54±0.56^{b}
Calcium	51.21±2.11^{a}	47.64±0.63^{b}	52.00±1.24^{a}	44.73±1.94^{c}	47.65±2.99^{b}
Magnesium	21.70±1.27^{a}	20.80±1.16^{ab}	20.48±0.78^{b}	21.16±0.49^{ab}	20.91±0.66^{ab}
Phosphorus	102.67±2.30^{b}	106.71±4.36^{a}	100.81±0.70^{b}	102.21±0.53^{b}	100.98±0.53^{b}
Zinc	1.22±0.04^{ab}	1.16±0.06^{b}	1.24±0.07^{a}	1.24±0.03^{a}	1.17±0.06^{b}

Means±S.D of triplicate determinations
Rows with different superscripts are significantly different

Table 2: Amino acid composition (mg/100g) of the whole & edible portion, exoskeleton of M. vollenhovenii and the edible portion & shell of T. fuscatus

		M.vollenhovenii		**T. fuscatus**	
Parameters/Parts	**Whole prawn**	**Edible portion**	**Exo & App**	**Edible portion**	**Shell**
Alanine	35.30±1.39^{cd}	37.18±0.26^{b}	39.92±0.17^{a}	35.02±0.42^{d}	36.18±0.97^{c}
Arginine	40.62±0.39^{a}	39.55±0.25^{b}	37.08±0.57^{d}	38.24±0.64^{c}	36.69±0.13^{d}
Asparagine	65.12±0.59^{d}	68.35±0.37^{b}	70.07±0.13^{a}	67.26±0.72^{c}	63.15±0.55^{e}
Glutamine	105.56±0.37^{c}	108.03±0.30^{b}	111.52±0.76^{a}	106.48±2.47^{bc}	107.43±1.10^{b}
Glycine	39.51±0.28^{a}	36.98±0.39^{b}	39.31±0.15^{a}	36.36±0.49^{c}	36.27±0.39^{c}
Histidine	12.14±0.09^{c}	13.46±0.11^{b}	15.38±0.16^{a}	15.39±0.82^{a}	15.02±0.22^{a}
Serine	13.28±0.21^{d}	14.56±0.24^{b}	15.63±0.22^{a}	14.16±0.23^{c}	13.52±0.24^{d}
Threonine	26.36±0.08^{a}	21.75±0.45^{c}	21.79±0.21^{c}	22.46±0.59^{b}	22.23±0.37^{bc}
Leucine	61.45±0.26^{b}	62.15±0.36^{a}	61.65±0.43^{b}	62.39±0.17^{a}	62.27±0.17^{a}
Lysine	63.07±0.54^{d}	65.39±0.13^{a}	64.10±0.53^{bc}	63.60±0.16^{c}	64.45±0.61^{b}
Methionine	9.35±0.10^{d}	12.26±0.10^{c}	11.49±0.24^{d}	13.13±0.04^{a}	12.65±0.11^{b}
Phenylalanine	26.07±0.55^{d}	26.61±0.20^{c}	28.22±0.18^{a}	27.40±0.14^{b}	26.59±0.20^{c}
Valine	41.96±0.40^{d}	41.36±0.12^{c}	42.32±0.17^{b}	43.16±0.24^{a}	42.89±0.34^{a}

Means±S.D of triplicate determinations
Rows with different superscripts are significantly different

Table 2 shows the amino acid composition of the whole portion, edible portion, exoskeleton & appendages of *M. vollenhovenii* and the edible portion and shell of *T. fuscatus*. There was significant differences (P<0.05) in the concentration of most amino acids. Glutamine was the most significant amino acid which was represented by 111.52mg/100g for the exoskeleton & appendages of *M. vollenhovenii* and 107.43mg/100g for the shell of *T. fuscatus.* Histidine and Leusine was found in high concentration in three of the body parts of both species particularly in the edible portion of both species and the shell of the perinwinkle.

4. DISCUSSION

The protein content of *M. vollenhovenii* and *T. fuscatus* were high in respect to the other nutrient composition and this agreed with Dinakaran *et al*., [8] which stated that protein is the most prominent biochemical component of crustaceans. The high protein content in *M. vollenhovenii* can be attributed to its omnivorous feeding habit [Bello-Olusoji [9] and also may be due to stress conditions caused by toxicity of heavy metals on protein metabolism or due to enhanced proteolytic activity as a consequence of increased metabolic demands following exposure to toxic pollutants in the freshwater environment [Kharat *et al*., [10]. The protein content of *M. vollenhovenii* (68.77-71.37%) compares favourably with that recorded by Ngoan *et al*., [11] which ranged from 65.4-83.3% and Dinakaran *et al*., [8] for *M. idae* (57.32-61.44%). The protein content of *T. fuscatus* (67.68-68.46%) was similar to that recorded by Devanathan *et al*., [12] for *Babylonia spirata* (a gastropod). The fat content of the two species in this study which ranged from 6.87-7.68% compared favourably with that recorded by Bassey *et al*., [13] for *Pomecia palludosa*, a gastropod and *Ergeria radiata*, a clam which ranged from 6.03-7.60% and that recorded by Balasubramania and Suseelan [14] which ranged from 6.2-7.6%. The fat content of *M.vollenhovenii* and *T. fuscatus* in this study is low and can be considered to belong to a low fat class (Abulude *et al*.,[15]), an indication that the species would not become rancid (Deekae and Idoniboye, [16]). According to Okuzumi and Fujii [17], lipids are highly efficient as sources of energy and they contain twice the energy of carbohydrates and proteins. As a general rule, they act as major food reserve along with protein and are subject to periodic fluctuations influenced by environmental variables like temperature. (Nagabhushanam and Farooqui,[8]).

The ash content obtained in the exoskeleton & appendages of *M vollenhovenii* and the shell of *T. fuscatus* was high. This is due to the high level of chitin strengthened by a high level of calcium metal in the exoskeleton & appendages of *M. vollenhovenii* and the shell of *T. fuscatus* (Adeyeye, [19]) and the high ash content is of significance in measuring the mineral content of the species as the amount of ash shows the richness of the food in terms of element composition (Hanan *et al*.,[20]); high levels of ash has been observed in shrimps found in Lagos lagoon. (Adeyeye,[21]). Jike-Wai and Deekae, [22] states that the high ash values of the species are not suprising as crustaceans have shells and these shells contain more ash than any other type of fish. The ash content of *T. fuscatus* compared favourably with that recorded by Adebayo-Tayo and Ogunjobi [23] which had a value of 10.50% but disagreed with that recorded by Fasakin *el al*., [24] which was lower. The fibre content of the two species were low (0.40-0.54%) and agreed with that recorded by Bukola *et al.*, [25] (0.28-0.32%), (Mba, [26]) which ranged from 0.21-0.34% and that recorded by Babu *et al*., [27]. The low fibre is not a surprise as animal products contain lower fibre than plants hence needs supplementation in diets (Jike-Wai and Deekae, [22]). The two species studied had a carbohydrate content that ranged from 0.58-3.65% and this was similar to that recorded by Sudhakar *et al*., [28] (1.57%) for *Podopthalmus vigil* and Ravichandran *et al*., [29] (1.5-2.4%). The low carbohydrate content recorded in this study agrees with Okuzumi and Fujii [17] which stated that carbohydrates constitute only a minor percentage of total biochemical composition. The moisture content of the two species was similar to that recorded by Omotoso [30]. According to Bassey *et al*., [13], knowledge of the moisture content of foodstuff serves as a useful index of their keeping qualities and susceptibility to fungi infection and a low moisture content in both species is advantageous in terms of their shelf-life.

The high ash content of *M. vollenhovenii* and *T. fuscatus* suggests high mineral composition of the species (Jike-Wai and Deekae, [22]). The calcium and phosphorus content in the two species were the most abundant and this agreed with Oksuz *et al*., [31] which stated that both minerals are the most abundant in fish. The phosphorus content in this study was higher than the calcium content and this is in agreement with Babu *et al*., [27] for *Bursa spinosa*, a gastropod which had higher content of phosphorus than calcium. The values of phosphorus (100.81-106.71mg/100g) and calcium (44.73-52.00mg/100g) in the two species were similar to that reported by Adeyeye *et al*., [21]. Phosphorus is an essential component in nucleic acids and the nucleoproteins responsible for cell division, reproduction and the transmission of hereditary traits (Hegsted, [32]). It also acts as a key substance for energy release.

The magnesium content in this study (20.48-21.70mg/100g) was similar to that recorded by Adeyeye *et al*., [33] for *Penaeus notabilis*. Hambidge, [34] records that magnesium is an activator of the enzyme system which functions in the metabolism of carbohydrates to produce energy. The zinc content (1.16-1.24mg/100g) was similar to that recorded by Sudhakar *et al*., [29] for *Podopthalmus vigil* and that recorded by Fasakin *et al*., [25]. The levels of zinc in the two species studied were lower than the permissible limits (Hanan *et al*., [21]). Zinc is present in all tissues of the body and is a component of more than 50 enzymes (Bender, [35]). Meat is the richest source of zinc in the diet and supplies one-third to one-half of the total zinc intake of meat-eaters. The observations in dietary minerals suggest that *M. vollenhovenii* and *T. fuscatus* could provide a significant proportion of calcium if consumed regularly. Calcium in conjunction with phosphorus, magnesium, manganese, vitamin A, C & D, chlorine and protein are involved in bone formation but calcium is the principal contributor. It also plays important role in blood clotting, muscles contraction and in certain enzymes in metabolic processes (Abulude *et al*., [16]).

The most significant amino acid in the two species was glutamine which was represented by 111.52mg/100g for *M. vollenhovenii* and 106.48mg/100g for *T. fuscatus.* The most abundant amino acids in both species were glutamine, asparagine, lysine, leucine, arginine, glycine, and valine. These constitute about 50% of the total amino acids and this agreed with that recorded by Babu *et al*., [27]. The essential amino acids detected in this study were threonine, valine, arginine, methionine, leucine, lysine phenylalanine and histidine while the non-essential amino acids were serine, asparagine, alanine, glycine and glutamine. According to Sikorski *et al*., [36], glycine, alanine, serine and threonine give tasty sweet, while arginine, leucine, valine, methionine, phenylalanine and histidine give bitter taste. The ratios of essential amino acids (EAA) to non- essential amino acids (NEAA) in *M. vollenhovenii* and *T. fuscatus* were 1.05 to 1.09 respectively. These obtained ratios are not in agreement with reported by Yanar and Celik, [2] with green tiger shrimp, *P. semisulcatus* and speckled shrimp, *Metapeneaus monoceros.* Iwasaki and Harada [37] explained that EAA/NEAA ratio of many species is 0.70 on the average whereas this ratio was reported to be 0.56 in crab and squid. Thus, the different amino acids might be associated with the varying tastes as well as textural properties of meat of the two species. The amino acid content in the two species were higher than that recorded by Bassey *et al*., [13], Devanathan *et al*., [12], Sudhakar *et al*., [28] and Babu *et al.*,[27].

5. CONCLUSION

In conclusion, the present work revealed that *Macrobrachium vollenhovenii* and *Tympanotonus fuscatus* are good sources of protein and amino acids; hence, they can be used as substitute for meat and finfish and for feed formulation for animals. Also, both species can provide significant proportion of calcium, phosphorus, zinc and magnesium for important metabolic processes. The exoskeleton & appendages of *M. vollenhovenii* and the shell of *T. fuscatus* can be ground and used for formulating animal feed as they contain considerable amounts of minerals. Both species are low in fat and are considered to belong to a low fat class group. They are also low in carbohydrates and fibre.

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