RESEARCH ARTICLE **(Open Access)**

Proximate Composition, Mineral Profile and Cholesterol Level in Whole and Fillet of the Guinean Mantis Shrimp, *Squilla aculeata calmani* (Holthuis, 1959) (Crustacea: Stomatopoda)

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Abstract

The Guinean Mantis Shrimp is a crustacean of the Order Stomatopoda, having a carapace that does not cover the posterior thorax and a broad abdomen bearing gills on the appendages. The nutritional profile of *Squilla aculeata calmani* as whole organism and fillet was investigated using standard techniques. The proximate compositions of the fillet and whole organism were significantly different (P>0.05), with fillet having higher protein content (65.91 ± 2.24 %) to the whole organism (31.05 ± 3.55%). The whole organism was significantly higher in calcium, potassium, magnesium and sodium. Cholesterol was not detected in *Squilla aculeata calmani* as whole organism and fillet. The samples were very good sources of oleic acid, a monounsaturated omega-9 fatty acid with hypotensive (blood pressure reducing) effects. The study showed that both the flesh and the shell contribute positively to the nutritional quality of the Guinea Mantis Shrimp, *Squilla aculeata calmani*. As the concentrations of the mineral content were within the allowed daily requirement, the shrimp could be employed as an alternative dietary supplement.

Keywords: Stomatopod; Mantis shrimp; Nutrients; proximate; Lagos Lagoon.

1. Introduction

The Guinean Mantis Shrimp, *Squilla aculeata calmani* (Holthuis, 1959) is a crustacean of the order Stomatopoda, having a carapace that does not cover the posterior thorax and a broad abdomen bearing gills on the appendages. Stomatopod is found in coastal lagoons with muddy bottoms in intertidal and sub tidal areas [23], in high densities in areas with suitable burrowing substrates in the Mediterranean Sea [10, 14]. It is a benthic species, strongly related to bottom sediments as demonstrated by its burrowing behaviour and by the composition of its diet [6, 14]. In Nigeria, Guinean Mantis Shrimp is still considered as a by catch in the trawl fisheries for shrimp and the trap fisheries for lobsters. Edible crustaceans such as shrimp, prawn, crayfish, lobster and crab constitute one of the major sources of nutritious food for human nutrition, providing an important amount of dietary protein and lipid diet in many countries. Crustacean ingests and accumulates omega–3 fatty acids through the food chain algae and phytoplankton, the primary producers of omega-3 fatty acid [11]. The polyunsaturated fatty acids (PUFA) found in aquatic animals oils especially the n-3 family including eicosapentaenoic acid (EPA or C20:5 n-3), the docosapentaenoic acid (DPA or C22:5 n 3) and the docosahexaenoic acid (DHA or C22:6 n-3) has been linked to health benefits, such as the prevention of cardio vascular diseases and some types of cancer, including colon, breast and prostate [9,16,19,11]. Due to their nutritious nature, apart from the supply of good quality proteins and lipids, they also contain several dietary minerals such as calcium, iron etc., which are beneficial and essential and play an important role in maintenance of physiological and biochemical activities in human beings [5].The nutritive values of crustaceans depend upon their biochemical composition, such as carbohydrates, protein, amino acids, lipids, fatty acids, minerals and vitamins. There are much studies encouraging crustacean consumption [8, 22, 24, 11, 1, 5] as against its supposedly high cholesterol content or allergenic reactions. Till date, the study on the biochemical composition of edible crustacean has not been

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attempted for the Guinea Mantis Shrimp in Nigeria. Therefore, the present study is aimed to probe into the aspects for the evaluation of proximate composition of basic biochemical constituents, minerals, free fatty acid as oleic, and cholesterol to assess the nutritional significance of the stomatopod.

2. Materials and Methods

2.1 Sample Collection

Samples of the Guinean Mantis Shrimp were collected from local landings of the Lagos Lagoon with latitudes 6º 26' – 37' N and longitude 3º 23 – 4º 20'E [12]. The shrimps were washed with distilled de-ionised water to remove any adhering contamination, drained and identified according to FAO identification guide [18]. The specimen were kept in crushed ice in insulated containers and brought to the laboratory for refrigeration (- 20̊ C) prior to analysis.

Figure 1: Dorsal view of the Guinean Mantis Shrimp, *Squilla aculeata calmani*

2.2 Samples Analysis

After removing from the freezer, samples were defrost for about one hour, separated into fillet extract and whole shrimps. The various parts were dried at 105ºC and homogenised. The analysis of the moisture, ash, protein, fat and carbohydrate contents was determined using the methods described by [4]. For the Mineral elements determination, the samples were digested in HNO3/HCl. Thereafter some metal parameters namely Ca, P, Mg, Na, Fe, Mn and K were measured by a Varian Spectra Atomic absorption spectrophotometer (AAS), Buck Scientific 210 GVP model following the procedure of [17].

Cholesterol content was estimated using Liebermann-Burchard reagent. Standard cholesterol solution used was 0.4 mg/mL. Liebermann-Burchard reagent was prepared with 0.2 mL concentrated sulfuric acid and 2 mL glacial acetic acid and was covered with aluminium foil. Analsis of free fatty acid (as Oleic) was conducted according to method of [21]. All the analytical procedures were performed in triplicates.

2.3 Data Analysis

Mean and standard Error were derived from data obtained and subjected to analysis of variance (ANOVA), Pearson Correlation Coefficient at significant difference of $P \leq 0.05$.

3. Results and Discussion

3.1 Proximate composition

The proximate composition including moisture, fat, protein, ash etc., are considered as good indicators of physiological condition of an organism. The result of the proximate compositions (Table 1) obtained in the present investigation clearly demonstrate that, the proportion of protein content was dominating over carbohydrates and lipid contents in both fillet and whole body of *Squilla aculeata calmani*. The percentage moisture content in fillet and whole body of the shrimp were 71.82 ± 2.69 % and 69.55 ± 2.93 % respectively. These values were higher to the values reported by [2] for flesh (24.0 %) and whole body (20.0 %) of *Pandalus borealis* from Lagos Atlantic Ocean. This difference could be due to habitat of the species.

The whole crude protein contents (31.05 ± 3.55 %) of *Squilla aculeata calmani* are similar to that (30.74±0.99 %) reported by [5] for *Metapenaeus Monoceros*, however higher than those published by [11] for *Squilla mantis* (11.86 ± 1.14 8%). The protein of the shrimp fillet is higher than that in the whole organism and showed a significance difference when compared. The higher protein and lipid content of the tissues also reveals their involvement in energy production at cellular level [7]. However, the quantities of these constituents may vary considerably within and between the species, size, sex, sexual condition, feeding season, athletic activity, molting stage, reproductive stage of the life cycle etc., [15, 13]. Fat acts as vehicle for the transport of lipid soluble vitamins A, D, E and K. In the present study, the crude fat content appears to be ranging around 0.96 ± 0.12 % and 6.32 ± 0.65 % in fillet and whole body of *Squilla aculeata calmani* respectively. The fat of the fillets is lower than values published by [24] for the mantis shrimp, *Harpiosquilla raphidea* (1.29 ± 0.30 %) from Jambi coast, Indonesia.

Crude fibre was not detected in the fillet of the investigated shrimp, similar to the work of [3] on *Crassostrea gasar* from Lagos Lagoon. The whole body fibre content in *Squilla aculeata calmani* ranging between 0.81 - 0.88 % is higher than the dry matter value (0.133 %) of *Pandalus borealis* reported by [2].

The ash contents in fillet and whole part of *Squilla aculeata calmani* were 3.12 ± 0.61 % and 21.1 ± 1.06 % respectively. The ash content in fillet of the shrimp were higher than values reported for *Penaeus monodon* (1.39±0.23 %); *Litopenaeus vannamei* (1.42±0.28); *Penaeus indicus* (1.63±0.24 %); *Penaeus semisulcatus* (1.49±0.25); *Metapenaeus Monoceros* (1.54±0.24 %) and *Metapenaeus dobsoni* (1.48±0.21 %) [5]

Carbohydrate contents of both fillet (28.11 - 33.01 %) and whole organism (37.55 - 42.8 %) of *Squilla aculeata calmani* are similar to those obtained for the spot-tail mantis shrimp *Squilla mantis* caught in three Tunisian Gulfs [11]. We can therefore infer that the natural diet of *Squilla aculeata calmani* may have a high protein and low carbohydrate content. In this present study, the proximate composition of the investigated shrimp's parts show a significant difference except for the moisture. Generally, the biochemical composition of any organism known to reflect its nutritional quality and is being influenced by several biotic and abiotic factors including season, size of the animal, food, temperature and stage in the life cycle etc [5].

Table 1: Mean ± SEM Variations in the Proximate Composition of *Squilla aculeata calmani*

Proximate (%)	Fillets	Whole organism	*P-Value*
Moisture	(67.81 - 76.93) 71.82 ± 2.69	(63.93 - 73.77) 69.55 ± 2.93	0.60
Crude Protein (DMB)	(62.7 - 70.23) 65.91 ± 2.24	(24.33 - 36.37) 31.05 ± 3.55	0.00
Crude Fat (DMB)	(0.84 - 1.19) 0.96 ± 0.12	(5.11 - 7.33) 6.32 ± 0.65	0.00
Crude Fiber (DMB)	0.00	(0.81 - 0.88) 0.85 ± 0.02	0.00
Total Ash (DMB)	(2.12 - 4.22) 3.12 ± 0.61	(18.99 - 22.2) 21.1 ± 1.06	0.00
Carbohydrate (DMB)	(28.11 - 33.01) 30.01 ± 1.52	(37.55 - 42.8) 40.68 ± 1.6	0.01

3.2 Mineral content

The variations in the mineral composition of fillet and whole part of *Squilla aculeata calmani* are shown in Table 2. The mineral composition in mg $100g^{-1}$ of fillet of the shrimp was Ca (9674.45 ± 301.62) , P (2794.45 ± 353.25) , Mg (311.73 ± 23.24), Na (85.9 ± 3.15), K (80.94 ± 8.2), Fe (47.96 ± 3.24) and Mn (485.68 ± 23.52) while the mineral composition in Mg $100g^{-1}$ of whole organism was Ca (16203.21 ± 102.96), P (2634.26 ± 55.05), Mg (623.67 ± 53.86), Na (198.56 ± 13.66), K (253.46 ± 2.93), Fe (39.68 ± 2.87) and Mn (522.75 ± 29.99). The pattern of mineral contents in fillet of *Squilla aculeata calmani* was Ca > P > Mn > Mg > Na > K > Fe while for the whole organism; it was Ca > P > Mg > Mn > K > Na > Fe. The values of Ca, Mg, Na and K of the whole organism were significantly higher than the values obtained in the fillet of the shrimp. The result conforms to the report of [24] which indicates that the mantis shrimps can be a good source of macro minerals (Na, K, Ca and Mg) and of micro mineral (especially Zinc) for human health.

3.3 Correlation Analyses

Tables 3 and 4 showed the correlation matrixes for fillet and whole body of *Squilla aculeata calmani* respectively. In each case there were approximately perfect positive relationships between proximate and mineral components. In the whole organism, perfect relationship was exhibited by total ash with sodium (r = 1) with significance at 0.05 level. Unlike the report of [3] on Mangrove Oyster, *Crassostrea gasar* from Lagos Lagoon, negative relationship was not observed in the correlation matrixes for both fillet and whole organism.

Table 2: Mean±SEM Variations in the Mineral Contents of *Squilla aculeata calmani*

Mineral (mg/100g)	Fillets	whole	*P-Value*

Calcium	(9324.02 - 10274.89) 9674.45 ± 301.62	(15997.29 -16307.43) 16203.21 ± 102.96	0.00*
Phosphorus	(2394.24 - 3498.77) 2794.45 ± 353.25	(2534.27 - 2724.15) 2634.26 ± 55.05	0.68
Manganese	(454.68 - 531.83) 485.68 ± 23.52	(463.11-558.17) 522.75 ± 29.99	0.39
Magnesium	(287.31-358.19) 311.73 ± 23.24	(517.9 - 694.22) 623.67 ± 53.86	0.01*
Potassium	(72.54-97.34) 80.94 ± 8.2	(247.84 - 257.68) 253.46 ± 2.93	0.00*
Sodium	(81.5-92) 85.9 ± 3.15	(172.94 - 219.58) 198.56 ± 13.66	0.00*
Iron	(43.46-54.26) 47.96 ± 3.24	(34.18 - 43.88) 39.68 ± 2.87	0.13

Key: *: Significant difference at P< 0.05

Table 3: Correlation between Proximate and Mineral Contents of *Squilla aculeata calmani* (Fillet)

	M	C.Pro	C.Fat	Ash	NFE	Ca	P	Mn	Mg	K	Na	Fe
M	1											
C.Pro	0.9990	1										
C.Fat	0.9575	0.9693	1									
Ash	0.9924	0.9860	0.9146	1								
NFE	0.9864	0.9927	0.9919	0.9587	1							
Ca	0.9756	0.9843	0.9975	0.9411	0.9984	1						
P	0.9225	0.9386	0.9946	0.8679	0.9734	0.9848	1					
Mn	0.8711	0.8919	0.9757	0.8039	0.9399	0.9577	0.9932	1				
Mg	0.9588	0.9704	0.9999	0.9164	0.9924	0.9978	0.9942	0.9747	1			
K	0.9455	0.9589	0.9992	0.8981	0.9861	0.9939	0.9979	0.9835	0.9990	1		
Na	0.9977	0.9997	0.9747	0.9818	0.9953	0.9882	0.9464	0.9022	0.9758	0.9653	1	
Fe	0.9972	0.9995	0.9765	0.9803	0.9960	0.9893	0.9489	0.9055	0.9774	0.9673	0.9999	1

Key: *M; Mosture, C. Pro; Crude Protein, NFE; C. Fat; Crude Fat, Nitrogen Free Extract*

Table 4: Correlation between Proximate and Mineral Contents of *Squilla aculeata calmani* (Whole)

	M	C.Pro	C.Fat	Ash	NFE	Ca	P	Mn	Mg	K	Na	Fe
M	1											
C.Pro	0.9991	1										
C.Fat	0.9962	0.999	1									
Ash	1	0.999	0.9962	1								
NFE	0.9534	0.9396	0.9236	0.9536	1							
Ca	0.9968	0.9925	0.9861	0.9969	0.9744	1						
P	0.9625	0.9499	0.9353	0.9627	0.9995	0.9812	1					
Mn	0.9888	0.9943	0.998	0.9887	0.8977	0.9737	0.9112	1				
Mg	0.9249	0.9078	0.8885	0.9253	0.9965	0.9523	0.9934	0.8579	1			
K	0.8904	0.8701	0.8476	0.8909	0.9863	0.924	0.9806	0.8126	0.9966	1		
Na	1	0.9991	0.9962	1	0.9533	0.9968	0.9625	0.9888	0.9249	0.8904	1	
Fe	0.9974	0.9996	0.9999	0.9973	0.929	0.9884	0.9401	0.997	0.8949	0.8552	0.9974	1

Key: *M; Mosture, C. Pro; Crude Protein, NFE; C. Fat; Crude Fat, Nitrogen Free Extract*

3.5 Cholesterol and Oleic contents

Cholesterol was not detected in both fillet and whole body part of *Squilla aculeata calmani* in the present study, indicating that *Squilla aculeata calmani* is cholesterol-free or that the cholesterol is below detectable limit. The fillet oleic content (2.94±1.12 %) was lower than the oleic level in the whole organism (3.41±0.68 %) but the comparison was not statistically significant (P = 0.742) (Fig. 2). Oleic acid, a monounsaturated omega-9 fatty acid with hypotensive (blood pressure reducing) effects [20] in *Squilla aculeata calmani*, was observed to be similar to the report of [11] on *Squilla mantis* from the Gulf of Hammamet (3.85 ± 0.04) and the Gulf of Tunis (4.95 ± 0.01).

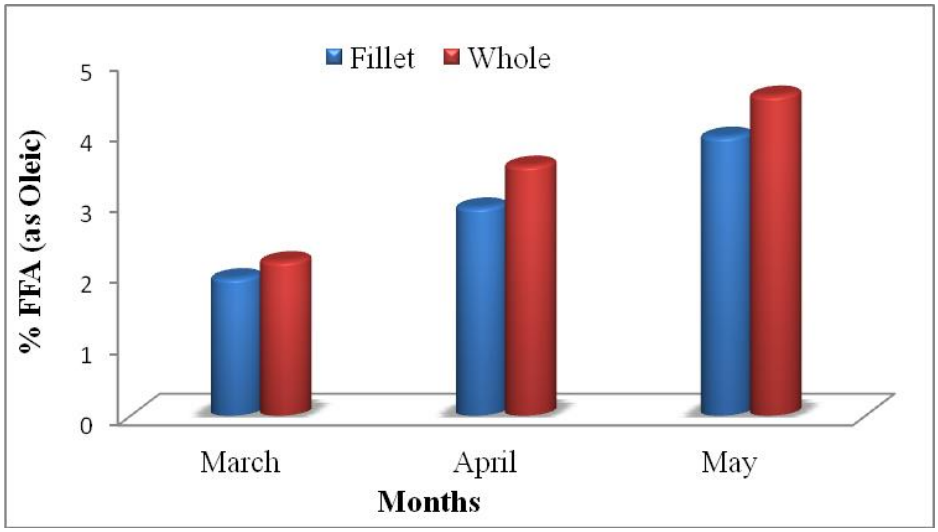

Figure 2: % Free Fatty Acid (as Oleic) in the *Squilla aculeata calmani* (March- May, 2018)

4. Conclusions

The study has revealed a significant higher percentage of fillet crude protein to the whole part of *Squilla aculeata calmani*. However, the whole (Flesh+Shell) is richer in organic (Crude fat, fibre, carbohydrate and ash) and inorganic nutrients (Ca, Na, Mg, P, Mn). The samples were very good sources of oleic acid, a monounsaturated omega-9 fatty acid with hypotensive (blood pressure reducing) effects. The study showed that both the flesh and the shell contribute positively to the protein quality of Guinea Mantis Shrimp, *Squilla aculeata calmani*.

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