Comparative Study on the Chemical Composition and Amino Acid Profile of Periwinkle and Rock Snail Meat Powders

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Abstract: For the present study, edible parts (meat) from freshly harvested Tympanotonus fuscatus, Pachymelania aurita and Thais coronata were processed into powders and analyzed for proximate composition, amino acid profile and mineral content. The mean values obtained were compared with each other. Results showed that all the parameters determined varied among the three gastropod species. Powders prepared from the three species had high protein and low fat contents. The protein content ranged from 41.51% for T. fuscatus meat powder to 58.45% for T. coronata meat powder. The fat, ash, crude fibre and carbohydrate contents ranged from 2.94-3.19%, 10.26-13.85%, 0.38-0.46% and 25.13-36.17% respectively. The caloric value ranged from 358.71-371.82kcal/100g. The total amino acid ranged from 77.76g/100g protein for T. fuscatus meat powder to 83.53g/100g protein for T. coronata meat powder while the total essential amino acid ranged from 32.97g/100g protein for T. fuscatus meat powder to 37.77g/100g protein for T. coronata meat powder. Majority of essential amino acid chemical scores were above 100% except for lysine that ranged from 80.00% to 97.24%, tryptophan was 88.18% for T. fuscatus and 90.00% for P. aurita while threonine was 95.26% for T. coronata and 99.41% for T. fuscatus powder. The Ca, K, Na, Mg, Fe and Zn ranged from 41.38-79.02mg/100g, 29.51-42.10mg/100g, 68.24-81.16mg/100g, 140.00-208.05mg/100g, 9.05-11.62mg/100g and 2.64-3.08mg/100g respectively. The high protein and low level of the crude fibre contents in the meat powders will make them suitable for use in complementary foods. Also, the low fat content in the meat powders suggests that they could be incorporated in foods for hypertensive individuals and those that have fat related diseases. Successful application of these powders in food product formulation and product development will lead to increase utilization of these nutritious, cheap and readily available sources of meat protein.

Keywords: Tympanotonus fuscatus, Pachymelania aurita, Thais coronata, Meat Powder, Nutrient Composition

1. Introduction

Shellfish, fish and other aquatic organisms suitable for food are a rich source of biologically valuable protein [1]. Seafood is highly valued not only for its abundance of high quality protein, but also for the n-3 polyunsaturated fatty acids (PUFAs), and other nutrients, such as minerals, trace elements and vitamins [2]. These nutrients are essential for proper functioning of the body and are beneficial for growth, the brain and nervous system [3]. The protein quality of seafood is superior to those of meat and poultry [4]. They therefore play a significant role in human nutrition and health.

Periwinkle (Tympanotonus fuscatus and Pachymelania aurita) and Rock snail (Thais coronata) are gastropods of the phylum mollusca. Molluscs are invertebrates that have their unsegmented soft bodies covered with calcareous shells [1]. Shellfish provide high quality protein with all the dietary essential amino acids for maintenance and growth of the human body [5]. The amount of fatty acid and the proportions of saturated, monounsaturated and polyunsaturated fatty acids in shellfish contribute to a healthful diet [6]. The nutrient composition of molluscs varies widely and depends on several factors including species, sex,
maturity, seasonal conditions and feeding regime [7]. Gastropods are by far the largest group of molluscs and compose of about 80% of the phylum [8]. The size, body and shell morphology as well as habitat of gastropods vary significantly from one species to another.

Periwinkles are shellfish found in the littoral region of the sea, brackish or estuarine water which are seasonal submerge regions like the mangrove swamps [9]. They crawl about under water but usually remain passive when left uncovered by the tide [10]. The two species of periwinkles commonly found in Niger Delta coastal region of Nigeria are *Tymanotonus fuscatus* and *Pachymelania aurita* [11]. *Thais coronata* (Rock snail) on the other hand is a species of sea snail, a marine gastropod mollusc in the family muricidae. They are easily found in the mangrove areas, sandy beaches and muddy sandy substrate areas [12].

Both periwinkle and Rock snail are commercially valuable shellfish in Akwa Ibom State, Nigeria. Their collection and marketing form an important economic activity among the people living along the coastal region. They constitute one of the relatively easily harvested shellfishes. The harvesting is usually by hand-picking. They are excellent sources of protein, good sources of minerals like calcium, potassium, iron and phosphorus and some vitamins [13, 14]. They are used in the preparation of indigenous traditional dishes such as “edikang ikong”, “ekpang nkukwo”, “afia efere” and “afang” soup among others by the Efik and Ibibio ethnic groups in Nigeria. They are consumed by both the rich and poor people. Many low income earners however depend on these shellfish meat as their major source of protein because of their cheapness and availability. The meat is considered good for cardiac disorder as it is free of cholesterol [4]. According to Ebong et al. [12], sub-chronic consumption of rock snail and periwinkle extracts by anaemic albino rats led to increase in red blood cell count, packed cell volume and haemoglobin concentration as well as differential white blood cell count and with no deleterious effect on the liver enzymes.

Even though periwinkle and rock snail are consumed on daily basis, our knowledge on the nutritive value is still fragmentary. Their short shelf-life coupled with the bulkiness caused by inedible shell limits their consumption to the coastal region where they are found. Also, lack of processing of these nutritious meats into form that could be used in food product formulation and development has hindered efficient utilization of the meat. The present study was aimed at processing periwinkle and rock snail meats into powders and comparing the nutrient composition of the powders.

2. Materials and Methods

2.1. Material Procurement

Freshly harvested periwinkles (*Tymanotonus fuscatus* and *Pachymelania aurita*) were obtained from Oron market while Rock snail (*Thais coronata*) was obtained from Itu creek, both in Akwa Ibom State, Nigeria.

2.2. Preparation of Periwinkle and Rock Snail Meat into Powder

For each of the samples, the whole body was thoroughly washed with potable water to remove mud and other adhered materials. Each sample was put in a stainless pot and boiled in water for 5 min at 100°C, drained and allowed to cool to ambient temperature (27±2°C). The edible portion (meat) was manually removed from the shell with the aid of a stainless pin. The shells were discarded while the meats were washed in potable water, drained, dried at 60°C for 24 h in a conventional air oven (model PP 22 US, Genlab, England) milled into fine powder using a manual grinder, packaged in air-tight plastic containers, labeled and stored at 4°C for analysis.

2.3. Methods of Analysis

The crude protein, fat, ash and crude fibre were determined following the methods described in AOAC [15]. Carbohydrate was calculated by difference [16]. Amino acid profile of the samples was determined by the method described by Spackman et al. [17]. The samples for amino acid determination were dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator (Labortorums Technic AG, Model CH – 9230) and loaded into a Technicon Multi-Sample Amino Acid Analyzer (TSM) (Technicon TSM-1, model DNA 0209, Dublin, Republic of Ireland). Essential amino acid scores were computed with respect to the FAO/WHO reference amino acid pattern [18]. The minerals (Ca, K, Na, Mg, Fe and Zn) were determined using atomic absorption spectrophotometer (UNICAM, Model 939, UK) as described in AOAC [15].

2.4. Statistical Analysis

Data were presented as means ± SD (Standard deviation) of triplicate determinations. Statistical analysis was performed by using SPSS version 18 statistical package (SPSS, Inc. USA). Analysis of variance (ANOVA) was done to determine significant difference at p<0.05. Means were separated using Duncan’s Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Proximate Composition

The proximate composition of powders prepared from edible parts of *Tymanotonus fuscatus*, *Pachymelania aurita* and *Thais coronata* is presented on Table 1. The result showed that the proximate composition varied among the three gastropod species studied. This variation could be attributed to a number of factors including differences in species, feeding regime and many other physical and environmental conditions [7, 19]. Nurmidia et al. [20] stated that proximate composition of mollusc varied not only within species but also between species. Similar variations in the proximate composition of edible parts of different species of gastropods have been reported [9, 13, 14, 21].
Protein was the major organic component of the powders made from the three investigated gastropod species. *Thais coronata* power had the highest protein content of 58.45% and showed a significant difference (p<0.05) from the other two samples. *Tympanotonus fuscatus* powder had the least protein content (46.51%). This value was within the range of 40.27-47.80% reported by Adebayo-Tayo et al. [9] and Job and Ekanem [13] for *Thais coronata* meat.

The value for individual amino acids, total amino acids and total of eighteen (18) amino acids were identified from the meat powder having the least value while *P. aurita* meat powder had the highest protein content of 58.45% reported by Ehigiator and Oterai [22] for *T. fuscatus* meat. The protein content of 51.30% recorded for *P. aurita* powder in the present study was higher than the values of 49.54% and 48.62% reported by Adebayo-Tayo et al. [9] for fresh water snails from Niger Delta creek in Nigeria. The ash content of a food material gives an idea about the inorganic content of the sample from where the mineral elements could be derived. The high ash content in the meat powders is therefore an indication that they contain high mineral elements.

All the powder samples had very low crude fibre contents which ranged from 0.38% for *T. coronata* meat powder to 0.46% for *P. aurita* meat powder. Similar variations in the crude fibre content of edible parts of different species of shellfish have been reported by other authors [20, 25, 26]. The crude fibre content values obtained in the present study were lower than 0.49% and 0.51% reported by Job and Ekanem [13] and Ehigiator and Oterai [22] for crude fibre contents of edible parts of *P. aurita* and *T. fuscatus* respectively. The low level of crude fibre in the powders will make them suitable for use in complementary foods. The carbohydrate content in *T. coronata* meat powder (25.15%) was significantly (p<0.05) lower than the values in the powders of the other two species. The percentage carbohydrate contents in *T. fuscatus* and *P. aurita* meat powders were 36.17% and 35.04% respectively but the values were not significantly (p>0.05) different from each other. The carbohydrate contents recorded in the present study were lower than 47.64% and 51.49% reported by Adebayo-Tayo et al. [9] and Job and Ekanem [13] for *T. fuscatus* and *P. aurita* meat respectively. The caloric value of the samples ranged from 358.71kcal/100g to 371.82kcal/100g with *T. fuscatus* meat powder having the least value while *P. aurita* meat powder had the highest value.

### 3.2. Amino Acid Composition

Amino acids are component subunits of protein. According to Sarma et al. [27], the amino acid is one of the most important nutritional qualities of proteins. They play a vital role both as building blocks of proteins and as intermediates in metabolism [5]. The amino acid composition of powders prepared from edible parts of *T. fuscatus*, *P. aurita* and *T. coronata* is presented on Table 2. The result showed that a total of eighteen (18) amino acids were identified from the powders of the three gastropod species. It was observed that the individual amino acids, total amino acids and total essential amino acids varied between the three species. Similar variations in the amino acid composition of some mollusc species have been reported by other authors [5, 28]. Leiwakabessy and Lewerissa [28] reported that variation in the amount of amino acid in marine organisms is not only occurred in different species but also in within species. According to Wesselinova [29], the amino acid content of marine organisms varies depending on a variety of factors such as the species, size, seasonal conditions and geographical location.

The total amino acid contents of *T. fuscatus*, *P. aurita* and
The meat powders of *T. coronata* were 77.76g/100g protein, 79.02g/100g protein and 83.53g/100g protein respectively. For all the species, glutamic acid was the highest contributor to the total amino acid.

### Table 2. Amino acid composition of *T. fuscatus*, *P. aurita* and *T. coronata* meat powder (g/100g protein).

| Amino Acid | Tympanotonus fuscatus | Pachymelania aurita | Thais coronata |
|------------|-----------------------|---------------------|---------------|
| Leucine    | 7.24±0.04             | 8.70±0.02           | 9.22±0.05     |
| Lysine     | 4.64±0.01             | 5.19±0.06           | 5.64±0.03     |
| Isoleucine | 3.80±0.05             | 3.41±0.05           | 3.60±0.10     |
| Phenylalanine | 3.46±0.11          | 4.08±0.01           | 4.43±0.06     |
| Tryptophan | 0.97±0.02             | 0.99±0.02           | 1.36±0.11     |
| Valine     | 3.80±0.05             | 3.65±0.04           | 4.09±0.02     |
| Methionine | 1.44±0.03             | 1.60±0.04           | 1.84±0.10     |
| Cystine    | 1.15±0.10             | 1.02±0.03           | 0.91±0.06     |
| Threonine  | 3.38±0.02             | 4.05±0.10           | 3.24±0.04     |
| Tyrosine   | 3.09±0.04             | 3.09±0.08           | 3.44±0.05     |
| Proline    | 3.96±0.02             | 3.45±0.00           | 3.96±0.12     |
| Arginine   | 6.19±0.03             | 5.95±0.03           | 6.02±0.03     |
| Histidine  | 2.55±0.01             | 2.46±0.05           | 2.33±0.02     |
| Alanine    | 3.87±0.06             | 4.09±0.04           | 4.28±0.06     |
| Glutamic acid | 12.11±0.03          | 11.96±0.06          | 13.32±0.10    |
| Glycine    | 4.01±0.02             | 3.94±0.02           | 4.01±0.04     |
| Serine     | 3.54±0.04             | 3.24±0.01           | 3.59±0.00     |
| Aspartic acid | 8.56±0.03           | 8.15±0.11           | 8.25±0.02     |
| TAA        | 77.76±0.02            | 79.02±0.08          | 83.53±0.4     |
| TEAA/TAA (%) | 32.97±0.04        | 35.78±0.02          | 37.77±0.03    |
| TSSA       | 2.59                  | 2.62                | 2.75          |

Values are means ± SD (standard deviation) of triplicate determinations. Means on the same row with different superscripts are significantly different at *p*<0.05. TAA = total amino acid; TEAA = total essential amino acid; TSSA = total sulphur amino acid.

Similar observation had been reported by other authors.

### Table 3. Essential amino acid score of periwinkle and Rock snail meat powder protein (%).

| Amino Acid | Tympanotonus fuscatus | Pachymelania aurita | Thais coronata |
|------------|-----------------------|---------------------|---------------|
| Leucine    | 109.53                | 131.62              | 139.49        | 6.61 |
| Lysine     | 80.00                 | 89.48               | 97.24         | 5.80 |
| Isoleucine | 135.71                | 121.79              | 128.57        | 2.80 |
| Phen. + Tyro. | 103.97               | 113.81              | 124.92        | 6.30 |
| Tryptophan | 88.18                 | 90.00               | 123.64        | 1.10 |
| Valine     | 108.57                | 104.29              | 116.86        | 3.50 |
| Met. + Cyst. | 103.60               | 104.80              | 110.00        | 2.50 |
| Threonine  | 99.41                 | 119.12              | 95.29         | 3.40 |

* Reference amino acid pattern of pre-school children (2 – 5 years) (FAO/WHO/UNU, 1985). Phen. = Phenylalanine; tyro = tyrosine; Met = Methionine; Cyst. = cystine.

### 3.3. Minerals

Minerals are essential nutrients that are needed to facilitate proper functioning of certain organs in the body. The mean concentrations of mineral elements (Ca, K, Na, Mg, Fe and Zn) in *Tympanotonus fuscatus*, *Pachymelania aurita* and *Thais coronata* meat powders are summarized in Table 4. The result showed variation in all the mineral elements determined between the species. It has been reported that variation in mineral composition of marine foods could be due to the differences of species, area of catch, and many physical and environmental conditions [20, 32].

Overall, magnesium was the most abundant mineral present in the powders from the three gastropod species analyzed. This observation was in agreement with the report by Nurnadia *et al.* [20] for marine fish and shellfish from the west coast of Peninsular, Malaysia. Magnesium value was highest (208.05mg/100g) in the powder prepared from *T. coronata* meat and was significantly different from the values in the powders from the other two species.
been reported to reduce blood pressure in humans [35].

Sodium and potassium are important for developing and maintaining bones and teeth as well as supporting the healthy functioning of muscles, nerves and the heart [34]. Potassium is required in relatively large amounts in the body because it functions as an important electrolyte in the nervous system, plays a role in osmoregulation and can help control blood pressure [33]. Magnesium is a mineral that affects the metabolism of calcium, sodium and potassium [33]. It is important for bone health; is needed as a cofactor for numerous reactions in the body and is also essential for nerve and muscle conductivity [33].

T. corona powder had the highest concentration of calcium (79.02mg/100g) and potassium (42.10mg/100g) while T. fuscatus powder had the least concentration of calcium (41.38mg/100g) and potassium (29.51mg/100g). The calcium and potassium values in the three powders were significantly (p<0.05) different from each other. Calcium is an essential mineral in the heme molecule of hemoglobin, the component of the blood cell that carries oxygen in the blood stream. Adequate iron in the diet is essential to minimize the incidence of iron deficiency anaemia, which is considered a major public health problem, especially in young children. T. fuscatus meat powder had the highest zinc content (3.08mg/100g) while the least value (2.64mg/100g) was recorded for P. aurita meat powder. The values were however not significantly (p >0.05) different from each other. The zinc values recorded in the present study were lower than 12.42mg/100g and 10.42mg/100g reported by Kiin-kabari et al. [14] for smooth and rough periwinkle meats respectively. Zinc is essential for the synthesis of DNA and RNA, proteins and insulin. It is also essential for proper functioning of immunity system and for activation of some enzymes [34].

4. Conclusion

The results of the study showed that the proximate composition, amino acid profile and mineral content of T. fuscatus, P. aurita and T. corona meat powders varied among the species. Powders prepared from the three gastropod species had high protein content, low fat and fibre contents. Comparison between the essential amino acid composition and the reference values of FAO/WHO showed that most of the essential amino acids would meet the recommended ranged for children aged 2 – 5 years and adults. The high protein and low crude fibre contents in the powders will make them suitable for use in complementary foods. Also, the low fat content in the powders suggests that they could be incorporated in foods for hypertensive individuals and those that have fat related diseases. Successful application of these powders in food product formulation and product development will lead to increase utilization of these nutritious, cheap and readily available sources of meat protein.

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