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Nutritional Composition of Selected Shellfish Consumed in Rivers State, Nigeria

Kiin-Kabari D.B.*, Hart A.D., Nyeche P.T

Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria
*Corresponding author: kabaridavid@yahoo.com

Abstract The objective of this work was to determine the proximate composition, micro nutrient, and total volatile nitrogen content of selected shellfish (oyster, clam, periwinkle, and whelk) consumed in Rivers State, Nigeria. The moisture content of the samples ranged from 73.37% for oyster to 84.80% for periwinkle (rough). Ash content was 6.85% for periwinkle (smooth) to 14.02% for whelk. Fat content was 0.55% for periwinkle (rough) to 1.75% for whelk. Crude protein content ranged from 9.97% to 13.96%, while consumption of 100g of any of these would provide 17-24% of the RDA. Carbohydrate values ranged between 0.26% and 0.93%. The results for minerals were as follows: calcium 52.53mg/100g, 46.27mg/100g, 103.70mg/100g, 5.37mg/100g, and 493.31mg/100g for oysters, clam, periwinkle (rough and smooth) and whelk, respectively. Magnesium content ranged from 55.73mg/100g for oysters to 1113.5mg/100g for whelk, potassium content ranged from 54.86mg/100g to 288.54mg/100g. Values for sodium were between 96.64mg/100g and 403.75mg/100g, phosphorus was from 90.70mg/100g to 286.22mg/100g. The values for iron ranged between 6.68mg/100g for whelk and 25.71mg/100g for clam, zinc was 10.42mg/100g to 96.55mg/100g, and iodine 2.9mg/100g to 11.35mg/100g. This study showed that molluscs are good sources of protein and minerals and increased consumption of these foods will help in alleviating the evasive problem of protein and micronutrients deficiencies.

Keywords: *Nutritional composition, Shellfish, Oysters, Clams, Periwinkles, Whelks*

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1. Introduction

Shellfish are forms of sealife regarded as food by humans. They are classified into molluscs, crustaceans and echinoderms [1]. Seafoods such as oyster (*Crassosterea graser*), clam (*Anadora semillis*), periwinkle (*Tympanostomus fuscatus and Tympanostomus fuscatus var. radula*), and whelk (*Buccimum undatum*) belong to the mollusc's family. Molluscs have more varied forms than any other animal phylum [2]. They include gastropods (snails, slugs, periwinkles, whelks and others), bivalves (clams, oysters, and others), cephalopods (squids), and other lesser-known but similarly distinctive subgroups [2,3]. The majority of species still live in the oceans, from the seashores to the abyssal zone, but some form a significant part of the fresh water fauna and the terrestrial ecosystems [1]. Molluscs are extremely diverse in tropical and temperate regions, but can be found at all latitudes [4]. About 80% of all known molluscs are gastropods [1].

Molluscs are natural part of the diet that contain high level of several important nutrients and are excellent sources of protein to both riverine communities and the entire population at large, as they occur abundantly in the brackish and fresh water [5]. Seafood is known to contain 12.00% - 18.58% of protein [6]. Periwinkle had also been reported to contain as much as 60.93% protein (dry matter), when compared to whole hen's egg [7]. Shellfish are rich in long-chain polyunsaturated fatty acids (omega-3) eicosapentaenoic and docosahexaonoic acids [8,9]. Their ash content is about 5.84% [10], they are rich in essential micronutrients such as calcium (129.18mg/100g), magnesium (31.19mg/100g), potassium (71.13mg/100g), phosphorus (60.52mg/100g), iron (10.90mg/100g), and zinc (1.31mg/100g) as reported earlier by Obande *et al*., [10]. This makes molluscs a ready source of food for eradicating "hidden hunger". Hidden-hunger is a micronutrient deficiency that exists in populations where food supply is adequate in terms of meeting energy requirements and yet people are not considered "hungry" [11]. Millions of people suffer ill health due to dietary deficiencies, while Nigeria is blessed with a lot of these seafoods which, if studied and properly harness, will go a long way in raising the nutritional status of the diets of populations around Rivers State and other coastal states within the Niger Delta region of Nigeria, and the World at large. But, there is paucity of information on the nutrient composition of these seafoods, their potentials as possible sources of nourishment for human and animals have been assumed rather than ascertained or established. Thus, the objective of this work was to determine the proximate composition, micro nutrient, and total volatile nitrogen content of selected shellfish (oyster, clam, periwinkles, and whelk) consumed in Rivers State, Nigeria.

2. Materials and Methods

Fresh raw oyster, clam, rough periwinkle, smooth periwinkle, and whelk were obtained from "Nembe" seafood market in Port Harcourt, Rivers State, Nigeria.

2.1. Sample Preparation

The samples were prepared by using the traditional method of seafood processing in Rivers State, Nigeria. The molluscs samples were washed properly, put into a stainless pot and boiled for 5m at 100°C. After boiling, the samples were poured into a perforated basket to drain and allowed to cool at room temperature (28±2°C). The edible portion (meat) was extracted from the shell with the aid of a sterile pin in the case of the periwinkle and whelk, and a sharp knife in the case of oyster and clam. The samples were frozen at -20°C until required for use.

2.2. Chemical Analysis

Chemical analysis was performed to determine the proximate composition of the samples: moisture, ash, crude protein, total carbohydrate, and fat content, as well as the total volatile nitrogen using the AOAC [12] standard method.

2.3. Mineral Content

Mineral analysis was done by dry ashing according to procedure 14.013 of AOAC [12]. Muffle furnace (Model SKL, China) at temperature of 550 °C was used for ashing. After sample preparation, total mineral determination was done using Atomic Absorption spectrophotometer (AAS) (Hitachi Z-5300, polarized Zeaman, Hitachi Ltd; Japan). The light source was Hollow cathode lamp of each element, using acetylene and air combinations, with air pressure of 0.3Mpa, and air flow rate of 6.5L/min, acetylene pressure of 0.09Mpa and a flow rate of 1.7 L/min was used. Other operating conditions such as wavelength and lamp current are given for each element as follows: Ca = 422.7 nm and 2 mA, Fe = 248.3 nm and 2 mA, K = 766.5 nm and 1 mA, mg = 285.2 nm and 1mA, Na = 589.0 nm and 1mA. Phosphorous was determined by molybdenum blue method and the absorbance read at 700nm using a spectrophotometer uv-visible (CELiL model CE2021 U.K).

2.4. Iodine Content

Iodine content was determined by the method described by Maeyer *et al*., [13]. Five gram (5.00g) of the sample was weighed into a 250ml flask and 50ml of water was added, shook and swirl, 1ml of 2N H_2SO_4 was added, 5ml of 10% KI (potassium iodide) was used as an indicator. The flask was stoppered and kept in the dark. The sample was titrated gradually with 0.005M sodium thiosulphate (NaS_2O_3) to a colourless endpoint. Percentage iodine content was calculated using the following formula:

$$\% \text{ iodine} = \frac{Ns\ X\ Vs\ X\ MI\ X\ VE\ X1000}{Va\ X5.00X\ W}$$

Ns=normality of sodium thiosulphate (NaS_2O_3); Vs=volume of NaS_2O_3 consumed for the titration; MI=molecular weight of iodine; VE=total volume of solution; Va=volume of aliquot of solution used for titration, W= weight of sample used.

2.5. Statistical Analysis

All the analyses were carried out in duplicate. Data obtained were subjected to Analysis of Variance (ANOVA); differences between means were evaluated using Turkey's multiple comparison tests and significance accepted at $P \leq 0.05$ level. The statistical package in Minitab 16 computer program was used

3. Results and Discussion

3.1. Proximate Composition

Proximate Composition of Oyster, Clam, Periwinkle rough, Periwinkle smooth, and whelk are shown in Table 1.

The moisture content of the molluscs ranged from 60.97% for whelk to 84.80% for periwinkle (rough), showing significant ($P<0.05$) variation in their moisture content. These variations in moisture content of molluscs could be due to the effect of environment as reported by Osibona *et al*., [14]. Moisture content of 79.60% – 81.20% had earlier been reported for periwinkle [15]. Moisture range of 60.00 – 61.05% was also reported by earlier researchers for whelk found in Europe, Asia, and Africa [16,17].

Protein is the major structural component of cells and is responsible for the building and repair of body tissues. The protein content of the molluscs ranged from 9.97% to 13.96%. The periwinkles (rough and smooth) do not show any significant different ($P>0.05$) in protein content. The result had shown that molluscs constitute a rich source of protein which according to Egonmwan [18], are of high biological value. Thus, with increased consumption, the serious problem of protein deficiency can be mitigated in Rivers State, Nigeria, and the world at large.

Fat content ranged from 0.53% to 1.75%. Although the fat content was low compared to other species of animal, Judith and Jenny [8] indicated that consumption of molluscs in large proportion reduced the risk of hypercholesterolemia which is capable of causing cardiovascular disease, due to its high omega-3 fatty acid content.

Carbohydrate content ranged from 0.26% to 0.93%, this is at variance with 7.66% carbohydrate reported earlier by Obande *et al.,* [10]. Low carbohydrate content indicates that high consumption of molluscs must be supplemented with energy-rich foods to balance the energy-protein intake requirement.

The ash content ranged 6.85% for rough periwinkle to 14.02% for whelk. There was no significant difference ($P>0.05$) in the ash content of oyster and that of smooth periwinkle. High ash content of molluscs is an indication that they are rich in micronutrients (minerals).

Table 1. Proximate Composition of Oyster, Clam, Periwinkle (rough), Periwinkle (smooth), and Whelk

Samples	Moisture (%)	Protein (%)	Fat (%)	CHO (%)	Ash (%)
Oyster	73.37^{c}±0.071	13.31^{b}±0.113	0.53^{c}±0.057	0.92^{a}±0.170	11.87^{b}±0.255
Clam	73.72^{c}±0.141	13.96^{a}±0.085	0.89^{b}±0.085	0.72^{ab}±0.127	10.71^{c}±0.212
Periwinkle (Rough)	84.80^{a}±0.350	9.97^{c}±0.212	0.83^{b}±0.071	0.55^{ab}±0.071	6.85^{d}±0.156
Periwinkle (Smooth)	80.22^{b}±0.350	10.05^{c}±0.141	0.89^{b}±0.085	0.26^{b}±0.113	11.58^{bc}±0.283
Whelk	60.97^{d}±0.141	13.96^{a}±0.198	1.75^{a}±0.071	0.93^{a}±0.141	14.02^{a}±0.226

Mean values bearing the same superscript in the same Column do not differ significantly (p>0.05).
Values are means ± standard deviation of duplicate samples
KEY: CHO – Carbohydrate

3.1.1. Percentage Recommended Daily Allowance (RDA) for Protein.

As shown in Table 2. Consumption of 100g of any of the seafoods by an adult male, as the only source of protein in the diet, would provide 23.77% RDA for protein from oyster, 24.93% from clam and whelk, 17.80 - 17.95% from rough periwinkle and smooth periwinkle; this showed that molluscs are good source of protein.

Table 2. Percentage *RDA of Protein Consumed in 100g of Molluscs

Sample	Protein (g)	RDA (%)
Oyster	13.31	23.77
Clam	13.96	24.93
Periwinkle (Rough)	9.97	17.80
Periwinkle (Smooth)	10.05	17.95
Whelk	13.96	24.93

*Based on 56g protein per day for an adult male [19]
Key: RDA – Recommended Daily Allowance

3.2. Mineral Composition

The results in the present work had revealed that seafoods are rich sources of micronutrients: calcium, magnesium, potassium, sodium, phosphorus, iron, zinc, and iodine, as shown in Table 3. Whelk has the highest value for calcium and magnesium. Although, a Calcium value of 52.53mg/100g and 50.37mg/100g as obtained in this study compares favourably with the report of Davies and Jamabo [20] for periwinkle and oysters, respectively. Calcium in addition with other micro minerals and protein can help in bone formation with calcium acting as principal contributor. Calcium is important in blood clotting, muscles contraction and in certain enzymes in metabolic processes [21].

Magnesium content of the molluscs ranged from 55.76mg/100g – 1113.55mg/100g, these values were higher than 0.25 – 0.59mg/100g reported earlier for periwinkle and oysters [20]. This disparity in the magnesium concentration could be attributed to the difference in their feeding habits and other environmental factors [20]. Molluscs are thus shown to be good sources of magnesium, an essential micronutrient needed for nervous system health [22]. The values for potassium were between 54.80mg/100g and 288mg/100g, sodium was 96.64 – 403.75mg/100g, while phosphorus content ranged from 90.70 – 286.22mg/100g. The phosphorus content of molluscs compares to that recorded for beef (156), liver (313), eggs (218) and milk (95) mg/100g [23]. Potassium is needed in fluid balance and regulation of nerve impulse conduction, regular heart beat and cell metabolism [24]. Sodium plays a vital role in regulating the pH, osmotic pressure, water balance, nerve impulse transmission and active transport of glucose/amino acid [20].

The value for iron ranged between 6.68 and 25.71mg/100g, similar to 27.61mg/100g iron content of molluscs reported by USDA [19] and 9.69-29.50mg/100g reported for periwinkle and oysters [20]. Iron content of 6.79 – 11.0mg/100g for molluscs had also been reported earlier [10,16]. Iron is important for red blood formation, therefore molluscs can be recommended for pregnant women and children [10]. The zinc content ranged from 10.42 – 96.56mg/100g, these values were higher than 1.21mg/100g reported earlier for aquatic snail [10]. Zinc is an important micronutrient needed for healthy skin, reproductive and immune function [20]. The result for iodine in the present work showed values ranging from 2.96mg/100g to 11.35mg/100g. There was however, no significant (P>0.05) difference in the iodine content of Whelk (11.04mg/100g) and that of rough Periwinkle (11.35mg/100g). Iodine is an essential micronutrient needed to prevent goitre [25]. From the study, the shellfish show good composition of minerals which are of great necessity to health and growth of the body. Helping tissues, muscles and nerves as well as absolute metabolism of the body therefore its consumption should be encouraged.

Table 3. Mineral Composition of Oyster, Clam, Periwinkle (Rough), Periwinkle (Smooth), and Whelk

Mineral Elements (mg/100g)	Molluscs Samples				
	Oyster	Clam	Periwinkle-R	Periwinkle-S	Whelk
Calcium	52.53^{c}±0.071	40.27^{e}±0.085	103.70^{b}±0.071	50.37^{d}±0.057	493.31^{a}±0.141
Magnesium	55.76^{e}±0.030	71.85^{d}±0.110	214.08^{b}±0.030	177.78^{c}±0.040	1113.55^{a}±0.210
Potassium	56.73^{d}±0.057	161.19^{b}±0.099	81.31^{c}±0.163	54.86^{e}±0.071	288.54^{a}±0.071
Sodium	263.24^{c}±0.113	344.56^{b}±0.028	112.60^{d}±0.156	96.64^{e}±0.099	403.75^{a}±0.354
Phosphorus	286.22^{a}±0.085	90.70^{e}±0.212	186.84^{c}±0.283	160.14^{d}±0.198	229.94^{b}±0.495
Iron	16.52^{b}±0.014	25.71^{a}±0.090	15.05^{c}±0.071	10.45^{d}±0.057	6.68^{e}±0.113
Zinc	96.56^{a}±0.071	11.83^{d}±0.042	10.42^{e}±0.057	12.42^{c}±0.071	24.90^{b}±0.127
Iodine	2.96^{c}±0.099	10.64^{b}±0.085	11.35^{a} ±0.071	10.50^{b}±0.071	11.04^{a}±0.057

Mean values bearing the same superscript in the same row do not differ significantly (P>0.05).
Values are means ± standard deviation of duplicate samples

Table 4. Percentage Recommended Daily Allowance (RDA) for Minerals as provided by 100g/portion

Mineral Elements	RDA	%*RDA		Per 100g Molluscs		
(mg)		Oyster	Clam	Periwinkle-R	Periwinkle-S	Whelk
Calcium	1000	5.25	4.03	10.37	5.04	49.33
Magnesium	400	13.94	17.96	53.52	44.45	278.39
Potassium	2000	2.84	8.06	4.07	2.74	14.43
Sodium	500	52.65	68.91	22.52	19.33	80.75
Phosphorus	700	40.89	12.96	26.69	22.88	32.85
Iron	8	206.50	321.35	188.13	130.63	83.50
Zinc	11	887.82	107.55	94.72	112.91	226.36
Iodine (µg/d)	150	197.33	709.33	756.67	700.00	736.00

*Dietary Reference Intake, National Academy of Sciences [26]

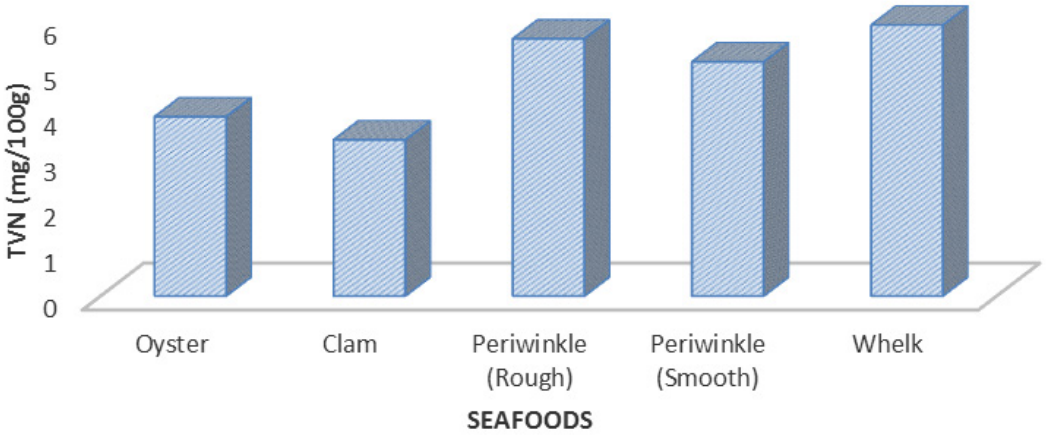

Figure 1. Total Volatile Nitrogen (TVN)

3.2.1. Percentage Recommended Daily Allowance (RDA) for Minerals

The percentage RDA is presented in Table 4. Assuming 100g of molluscs was consumed by an adult male, it would provide 5.25 – 49.33% RDA for calcium, 13.94 – 278.39% for magnesium, 2.34 – 14.43% for phosphorus, 83.50 - 321.35% for iron, 94.72 – 887.82% for zinc, and 197.33 – 756.67% RDA for iodine. It was however, noted that most adults consume more iodine than the RDA of 190 – 300µg daily, not including that from use of iodized salt at the table [27].

3.3. Total Volatile Nitrogen (TVN)

As shown in Figure 1, seafoods used for this work possessed good quality status as their TVN values were between 3.4 and 5.9mg/100g, these values are well below the maximum limit of 30mg/100g specified by the National Agency for Food Drug Administration and Control (NAFDAC). The values obtained thus showed that the molluscs were fit for consumption.

4. Conclusion

The findings from this work showed that seafoods contain considerable amount of protein and minerals. High protein values of 13.96%, 13.96%, and 13.31% were noted in whelk, clams, and oysters, respectively. A high ash content of 14.02% was recorded in whelk, which also gave higher values for magnesium (1113.56mg/100g), calcium (493.31mg/100g), potassium (288.54mg/100g), and sodium (403.75mg/100g). Oyster, with a value of 286.22mg/100g was shown to be the richest in phosphorus. Consumption of seafoods (molluscs) will provide 17.95 – 24.93% of the RDA for protein, 12.96 – 40.89%, 83.50 – 321.35%, 94.72 – 887.82%, 5.04 – 49.33%, 13.94 – 278.39%, and 197.33 – 756.67% of the RDA for phosphorus, iron, zinc, calcium, magnesium, and iodine, respectively. With increased consumption of oysters, clams, periwinkles, and whelks, the serious problem of micronutrient deficiency can be addressed. However, the bio-accessibility of these minerals and the digestibility of the mollusc's protein shall be investigated in the next study.

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