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Biochemical Profile of the Mangrove Oyster, *Crassostrea gasar* (Adanson, 1757) from the Mangrove Swamps, South-West, Nigeria

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ABSTRACT

The biochemical compositions (Fatty acids, Amino acids and Vitamin contents) of the Mangrove oyster, *Crassostrea gasar* (*C. gasar)* from the mangrove swamps were determined using various standard procedures. The study indicated that the species had all the essential amino acids among which, lysine with value of 11.61 g/100 g content was the highest while the least value of 1.29 g/100 g was found for Tryptophan. Aspartic acid with value of 11.13 g/100 g was present in high concentration among the non-essential amino acids while the least concentration value of 0.86 g/100 g was found in Glutamic acid. Fatty acid composition ranged between 46.18 to 46.99% saturated, 41.02 to 41.8% monounsaturated and 12.03 to 12.21% polyunsaturated acids in the flesh of *C. gasar*. The most abundant fatty acid in mangrove oyster was Oleic C18.1 (29.4%), the other major fatty acids detected were Palmitic acid {C16.0} and Docosahexanoic acid {C22.4}. The concentration of vitamins in the flesh of *C. gasar* collected was fairly constant within the two sampling sites. This study, demonstrated that this species was characterized by low fat content (<3.0%), is a good resource of eicosapentaenoic (20:5n-3, EPA) and docosahexaenoic (22:6n-3, DHA). Therefore, *Crassostrea gasar*, as a shellfish with a good source of quality biochemical properties which could be recommended in specific nutritional needs as seafood because of its low cholesterol levels and high nutrient values for human consumption.

***Keywords*:** Aspartic acid, Amino acid, Fatty acid, *Crassostrea gasar*.

Introduction

Sea foods and their products are a good source of amino acids and their proteins are considered of high biological quality. Shellfish such as oysters are valuable food for human health and contain about 80% of water, 17.2% of protein, and many vitamins such as A, D, E, B_1, B_2, B_6, B_{12}, C etc., and minerals that satisfy human nutritional needs.[1,2] Consumers demand for shellfish and other seafood has resulted in a significant rise in their aquaculture (fresh, brackish or marine waters) with a total production of 73.8 metric tonnes in 2014.[3] Species of shellfishes that the Europeans are passionate about are the oysters, mussels, lobsters, cockles, whelks, clams, crabs and others.[4] In artisanal and commercial fisheries, *Crassostrea* spp. is massively harvested by mainly female fisher folks for food, sales and/or their shells used as additives for animal foods are sold to industries.[5] In traditional and modern aquaculture, the Molluscan phylum is known to spread out effectively into diversified habitats; the bulk of which are aquatic, some are found mostly in shallow waters and sometimes in intertidal zones where they dig into the mud in the river beds which now exist as their habitat.[6] This genus of the mollusc belongs to one of the most cultivated species to supply food in order to provide sustainable resources for coastal communities. Aquatic animals contain high levels of proteins (17-20%) with an amino profile similar to that of meat from land animals, thus making it beneficial in countries where there is high consumption of shellfishes.[7]

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The contents of free amino acids and free fatty acids are two important factors to consider as they determine the quality and acceptability of the sea foods. Moreover, amino acids play important roles in cell signalling and act as regulators of gene expression and protein phosphorylation cascade [8] and also nutrient transport and metabolism in animal cells.[9] King*et al*.[1] reported on the nutritional components of shellfishes as good source of Vitamin B_2, niacin, iron, purines, sodium, vitamin C, zinc, magnesium and Omega -3 fatty acids. Apart from their nutritional importance, amino acids also influence meat palatability [10] and flavour.[11] The Food and Agriculture Organization as reportedthat people who eat crustaceans and molluscs have reduced levels of triglycerides and blood fats that cause clogging of arteries and this has been attributed to the omega-3 fatty acids content of these shellfishes.[3] Fatty acid composition of aquatic animals is influenced by intrinsic variables (sex, age, size and way of life) as well as extrinsic factors (diet, salinity and temperature).[2] Temperature is a major factor that influences fatty acid composition. As temperature decreases, the level of unsaturation tend to increase to assists in maintaining the freezing point below that of surrounding water to ensure membrane fluidity and general body flexibility.[12] However, at higher temperatures, an increase of phospholipid is necessary to counteract excessive fluidity. This situation may partially explain the raised concentration of Saturated Fatty Acids (SFA) found in the oysters' musculature.[13]

The excellent standard quality of seafood in human nutrition lies not on their high quality protein for which there are many other alternatives, but in the high content of n-3 highly unsaturated fatty acids (n-3 HUFA), mainly the eicosapentaenoic acid (20:5n-3, EPA) and the docosahexaenoic acid (22:6n-3, DHA), which are associated for the prevention of many humans diseases.[14] Given that most oysters harvested ultimately ends up in our tables as delicacies, it is very important to monitor periodically their food values which are need in the body. Nutritional information on mangrove oysters is generally scattered in literatures and most times only discussed on the general seafood items and with emphasis on fin fishes. The nutritional

composition of many commercially harvested species of shellfish from other regions within Nigeria waters has been described,[7,15-19] and this confirmed that shellfish vary in their nutrients and mineral contents [1] but there is a dearth of documented information on someof the biochemical properties on the oysters found in the Lagos Lagoon..

The present work therefore was undertaken to generate information on the biochemical (amino acids, fatty acids and vitamins) composition of the mangrove oysters which are in abundance in the Lagos Lagoon with the objective to encourage an increase in the inclusion of this species in the diets and also the popularization of this species so that the economy of this fishing areas would increase as inhabitants will go fishing for mangrove oysters, not only for themselves but also for commercial purposes.

Materials and Methods

Sampling Sites

The oyster samples were collected from the mangrove swamps between July – December, 2019 from two (2) sampling stations. These stations were chosen because of the frequent domestic and industrial activities noticed in these swampy areas; Ebute-Oko and Tomaro off Lagos Lagoon, Lagos State, South West, Nigeria (Table 1). The Lagoon is characterized with seasonal fluctuation in salinity, high brackish water during the dry season (December – May) and freshwater conditions exists in the rainy season (June – November).[20] It lies between Latitude 6^o 26' - 6^o 37' N and Longitude 3^o 23' - 4^o 20' E in the western part of Nigeria, covering a surface area of 208 km. [2,21]

Preparation of the samples

The oyster, *C. gasar* samples obtained from the two different sites off Lagos Lagoon were stored in an ice chest at 4°C and conveyed to the laboratory for analysis. The collected oysters were washed thoroughly with distilled water to remove extraneous matters from the shells. The oysters were opened using a stainless steel knife and the flesh were removed using stainless steel scalpel blades.

Determination of Amino Acid Profile

The amino acid composition of *C. gasar*soft tissues (flesh) obtained from the Lagos Lagoon were separately determined following the methods of Ishida *et al*., 1981[23] and has been described earlier by Mohanty*et al*., 2012.[24] The *C. gasar* flesh was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Acid Analyzer (TSM). All data were presented as Mean ± Standard Deviation.

Determination of Fatty Acid Profile of C. gasar tissue

The fatty acid compositions of *C. gasar*flesh and shell were separately determined using the AOAC method.[25] A 250 mL capacity extracting flask was dried in the oven at 105°C, transferred to the desiccators to cool to the laboratory temperature and the weight of the flask was measured. About 2.5 g of the samples was weighed into the labelled porous thimble. Petroleum ether (200 mL) was added to the dried 250 mL capacity flask. The covered porous thimble with the sample was placed in the condenser of the Soxhlet extractor arrangement that had been assembled. The sample was extracted for 5 hours. The porous thimble was carefully removed and the petroleum ether in the top container (tube) was collected for recycling (reuse).The extraction flask was removed from the heating mantle arrangement when it was almost free of petroleum ether. The extraction flask with the oil was dried at 105°C for 1 hour.

Table 1: GPS Coordinate descriptions of sample areas locations in the Lagos Lagoon

Locations	Latitude	Longitude	State
Ebute –Oko	N05° 41'. 9° 28'	E07° 08'. 3° 68'	Lagos
Tomaro	N05° 40'. 7° 57'	E07° 09'. 5° 81'	Lagos

Source: [22]

The flask containing the dried oil was cooled in the desiccators and the weight of the cooled flask with the dried oil was measured. For the analysis of the methyl esters of fatty acids, a Hewlett Packard HP 6890 Series gas chromatograph coupled with a Hewlett Packard 5973 mass spectroscopy detector (GC"MS) system was used. A HP"5 MS capillary column (30 m length, 0.25 mm i.d., 0.25 µm film thickness) was used for the GC system. The temperature program was set up from 50 to 250°C with 4°C/min, both the injector and detector temperatures were 280°C and Helium was used as carrier gas. The injection volume was 2 µL. Ionization energy EI of 70 eV was used for mass spectroscopy detector, with a source temperature of 150°C.

Determination of Vitamin Contents of C. gasar (Flesh)

The vitamin content profile of the *C. gasar* soft tissue was analysed using the modified method of Mohanty*et al*., 2012.[24] The flesh was made to attain the laboratory atmospheric condition on the bench after removing the sample from the storage chamber at less than 4^oC. The flesh was pressed and completely homogenised in the mortar carefully with pestle to avoid forming balls. 0.10 grams of the sample was weighted into the 10ml beaker capacity. The samples were extracted in the container using the AOAC method with slight modification.[25] After the extraction, the extract was concentrated to 0.10 mL for the chromatographic analysis.

Statistical analysis

All experiments were performed having three replications for each samples value. The biochemical properties were identified and quantified by comparing with the retention times and peak areas of standards. Statistical analyses was performed using SPSS software, version 10.0, graphical presentation was prepared using Graph Pad Prism 6 and chromatographs were illustrated on the biochemical properties from the sampling sites.

Results and Discussion

Amino acids profiles of C. gasar

The results of Amino Acids (AAs) profiles of *C. gasar* flesh obtained from the study sites are presented in Table 2. Eighteen (18) amino acids; Ten (10) essential amino acids (EAAs)-Arginine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Tryptophan, Valine and Threonin; three (3) conditional essential amino acids (CEAAs) - Glutamine, Glycine and Proline and five (5) non-essential amino acids (NEAAs) - Alanine, Aspartic acid, Cysteine, Serine and Tyrosine were detected in the flesh of *C. gasar*. Deficiency in the essential amino acids may hinder healing recovery process of many body parts in humans.[32]Leucine promotes the therapeutic healing of bones, skins and muscle tissues in burns, trauma and sepsis,[33] Arginine helps in cell divisions, wound healings, hormone release and also acts as precursor for biological synthesis of nitric oxide which plays important roles in blood clotting and blood pressure maintenance while Methionine is used for treating liver disorders, depression, alcoholism, asthma, schizophrenia, drug withdrawal and so on.[34] Tryptophanis used for pain tolerance, treatment of insomnia, seasonal affective disorder, pre-menstrual dysphonic disorder, etc. It is also the precursor of melatonin, tryptamine and kynurenine. Histidine is needed for growth and repair of tissues while Lysine is extensively required for optimal growth and its deficiency leads to immunodeficiency.[35] Threonine is used for the treatment of various nervous system disorders like spinal spasticity, multiple sclerosis, etc and Isoleucine is needed for improved growth and muscle formation.[36]

Glutamic acid is very important because of its role in transamination reactions and synthesis of key molecules such as glutathione which are required for removal of highly toxic peroxides. Glycine is responsible for metabolic regulations, preventing tissue injury, enhancing anti-oxidant activity, disorder in obesity, diabetes, cancer and various inflammatory diseases.[9]

Although NEAAs are synthesized *de novo* in the body, they play important roles in regulating gene expression and micro-RNA levels, blood flow, nutrients transport and metabolism in animal cells.[8] Aspartic acid is the precursor of other amino acids like methionine,

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threonine, isoleucine and lysine. While serine is the precursor of glycine, cysteine and tryptophan, it is also used for the treatment of schizophrenia too.

The total EAAs, CEAAs and NEAAs in the flesh of *C. gasar* from Ebute-Oko (Table 2) was 81.43 g/100g, with Lysine (EAA) having the highest concentration of 11.70g/100g and the lowest concentration of NEAA in Glutamic acid (0.86 g/100 g); in Tomaro (Table 2), the total EAAs, CEAAs and NEAAs in the flesh of *C. gasar* was 51.03 g/100 g, 4.35 g/100 g and 25.59 g/100 g, respectively. Of the 51.03 g/100 g of the EAAS in the flesh of *C. gasar*, lysine had the highest concentration (11.53 g/100 g), while tryptophan had the lowest concentration (1.31 g/100 g). The highest values of CEAAs were in Glycine across the two sites with values ranging from 2.51g.100^{-g} – 2.54 g/100 gand the lowest values (0.92 – 0.94 g/100 g) were found in Proline.

Amino acids (AAs) have been classified basically into essential amino acids (EAAs), non-essential amino acids (NEAAs) and conditional essential amino acids (CEAAs).[8] However, the concept of functional amino acids (FAAs) has been proposed. FAAs are those amino acids that help in the regulation of major metabolic reactions that are involved in cellular processes (improve health, survival, growth, development, etc) apart from protein synthesis.[26] The essential amino acids cannot be synthesized in human bodies but can be obtained from food.

In this present study, among all the essential amino acids, *C. gasar* collected from Ebute–Oko contained highest value of lysine (11.70 g/100 g), followed by threonine 10.27 g/100 g) while aspartic acid (11.2g/100g) was present in high concentration among the non-essential amino acids. These results are in line with [27] who worked on three local Malaysian *Channa* spp because they are low-fat fish species with high water content. The results on the conditional essential amino acids reported here are similar to that found by [28] in finfish. It was also in line with reports of Martins *et al*.,[29] and .[30] who both worked on Iberian hams but have higher value contents (650 mg/100g and 1269 mg/100g respectively) of the conditional essential amino acid - Glutamic acid.

Concentration of Different Groups of Amino Acids in the Flesh of C. gasar

The variability in the concentrations of different groups of AAs in *C. gasar* flesh from Lagos Lagoon is presented in Table 3. The results showed that *C. gasar* flesh from Ebute-Oko had the highest total acidic amino acids (TAAA) of 12.06 g/100 g while *C. gasar* flesh from Tomaro had the lowest TAAAs of 11.90 g/100 g. The total basic amino acids (TBAAs) ranged between 20.79 g/100 g (*C. gasar* flesh from Tomaro) to 20.8 g/100 g (*C. gasar* flesh from Ebute-Oko). The total amino acids with neutral polar (TAAsNP) in *C. gasar* flesh from Ebute-Oko was 21.1 g/100g while the TAAsNP in *C. gasar* flesh from Tomaro was 20.95 g.100^{-g}. In the *C. gasar* flesh, the group of AAs with the highest concentration were the amino acids with neutral non-polar (AAsNNP) having concentration of 28.96 g/100 g in *C. gasar* flesh from Ebute-Oko and 28.95 g.100^{-g} in *C. gasar* flesh from Tomaro. The TAAs with sulphur-group was ≤ 6 g/100 g, while the TAAs with aromatic-group was ≤ 9 g.100^{-g} in the flesh of *C.gasar* obtained in the two sites. The *C. gasar* flesh from Ebute-Oko had the highest total AAs with aliphatic-group of 18.86 g/100 g, followed by *C. gasar* flesh from Tomaro with 18.83 g/100 g, (Table 3). There was no appreciable variation in amino acids composition of the *C. gasar* collected from the two sampling stations.

Fatty Acids Profiles of C. gasar Flesh

The results of fatty acids compositions of *C. gasar* flesh obtained from Lagos Lagoon are shown in Table 4. The *C. gasar* flesh from Lagos Lagoon had seventeen (17) fatty acids comprising of ten (10) Saturated Fatty Acids (SFAs), three (3) Mono-Unsaturated Fatty Acids (MUFAs) and four (4) Poly-Unsaturated Fatty Acids (PUFAs). The SFAs from the flesh of *C. gasar* collected from Ebute-Oko with the highest percentage was Palmitic acid (33.9%) and the lowest percentages were: Caprylic acid (0.01%), Capric acid (0.01%) and Lauric acid (0.01%).

Table 2: Amino Acids Profiles of *C. gasar* Flesh

Amino Acid Profiles (g/100g)		**Flesh**	
		Ebute-Oko	**Tomaro**
Essential	Arginine*	5.21	5.36
	Histidine	3.89	3.90
	Isoleucine	1.58	1.52
	Leucine	5.89	5.9
	Lysine	11.70	11.53
	Methionine*	4.59	4.65
	Phenylalanine	4.21	4.16
	Tryptophan*	1.30	1.31
	Valine	2.72	2.60
	Arginine*	5.21	5.36
	Threonine	10.16	10.10
	Total EAAs	**51.25**	**51.03**
Conditional	Glutamic Acid*	0.86	0.90
Essential	Glycine*	2.54	2.51
	Proline*	0.92	0.94
	Total CEAAs	**4.32**	**4.35**
Non Essentials	Alanine	3.72	3.77
	Aspartic Acid*	11.2	11.0
	Cysteine*	0.98	0.95
	Serine	7.34	7.27
	Tyrosine*	2.62	2.60
	Total NEAAs	**25.86**	**25.59**
	Total AAs	**81.43**	**80.89**

Keys: EAAs – Essential Amino Acids; Conditional Essential Amino Acids – CEAA; NEAAs – Non Essential Amino Acids; AAs – Amino Acids*functional amino acids (Wu, 2013)

Table 3: The Concentrations of different groups of Amino Acids in *C. gasar* Flesh

Amino Acid Groups	**Flesh (g/100g)**	
	Ebute-Oko	**Tomaro**
TAAs	81.43	80.89
TAAAs	12.06	11.90
TBAAs	20.8	20.79
TAAs with Neutral Polar	21.1	20.95
TAAs with Neutral non-Polar	28.96	28.95
TAAs with Sulphur-group	5.57	5.6
TAAs with Aromatic-group	8.13	8.07
TAAs with Aliphatic-group	18.86	18.83

Keys; TAAs**:** Total Amino Acids; TAAAs: Total Acidic Amino Acids; TBAAs: Total Basic Amino Acids

The MUFAs with the highest percentage was Oleic acid (29.4%) while the lowest percentage was recorded in Erucic acid with 0.01%. The PUFAs had the highest percentage in Docosahexanoic acid (8.6%) while the lowest was Linolenic acid with 0.7%.

The *C. gasar* flesh from Tomaro had the predominant SFA as Palmitic acid (35.5%), while the least occurring SFAs were Caprylic acid

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(0.01%) and Lauric acid (0.01%). The highest percentage of MUFAs obtained was found in Oleic acid (29.2%) and the least concentration was Erucic acid (0.02%), while the highest the PUFAs ranged from 0.59% (Linolenic acid) to 8.4% (Docosahexanoic acid) (Table 4).

In this study, Saturated Fatty Acid (SFA) in the *C. gasar* from Lagos Lagoon constituted the majority of the fatty acids pool, followed by Mono- Unsaturated Fatty Acids ((MUFA) and Poly-Unsaturated Fatty Acids (PUFA). However,[2]reported a contrary view where MUFA were the lowest fatty acid group found in the oysters, *C. rhizophorae* collected from Rio de Janeiro, Brazil. According to,[12]Palmitic acid (C16:0) has been commonly found to have the highest value in marine species and considered this fatty acid as the key for many metabolic processes in aquatic animal species. Concentrations of all fatty acids recorded in this study were similar to concentrations reported by [36] for 15 indigenous Brazilian marine fish species and [37] who worked on two freshwater fishes but contradicts the reports of [27] who worked on three local Malaysian *Channa* spp fish. All the species analyzed were excellent sources of Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) as they were within the recommended ratio of 1:1 or 1:5 [36] Moreover, the ratio of Omega-3: Omega-6 fatty acids (ω3: ω6) found in this study was similar to the ratio reported by[39] for some species of fish from temperate regions. Results of clinical and epidemiological research suggest that EPA and DHA, found only in fish and sea foods, possess extremely beneficial properties for the prevention of human coronary artery disease.[40]

Chromatograms of free amino acids detected in oysters flesh samples collected from the two sampling sites in the Lagos Lagoon are presented in Figures 1 and 2. The reactions of the free fatty acids were monitored by GC and the condition which gave maximum response (peak height/area) was considered optimum.

Vitamin profiles of C. gasar flesh

Eleven (11) vitamins concentration were found in the flesh of *C. gasar* from Ebute-Oko and Tomaro of Lagos Lagoon. The observed water soluble vitamins in the flesh of *C. gasar* from Ebute-Oko were:

Table 4: Fatty Acids Composition of *Crassostrea gasar* flesh from Lagos Lagoon

Fatty Acid Profiles		Flesh (%)	
		Ebute-Oko	**Tomaro**
Saturated Fatty Acid	Caprylic C8.0	0.01	0.01
	Capric C10.0	0.01	0.00
	Lauric C12.0	0.01	0.01
	Myristic C14.0	3.8	3.67
	Palmitic C16.0	33.9	35.5
	Margaric C17.0	0.7	0.64
	Stearic C18.0	5.4	5.0
	Arachidic C20.0	0.6	0.53
	Behenic C22.0	1.11	1.0
	Lignoceric C24.0	0.64	0.59
	Total (%)	**46.18**	**46.95**
Mono-unsaturated Fatty Acid	Palmitoleic C16.1	11.72	11.8
	Oleic C18.1	29.4	29.2
	Erucic C22.1	0.01	0.02
	Total (%)	**41.15**	**41.02**
Poly-unsaturated Fatty Acid	Linoleic C18.2	2.4	2.14
	Linolenic C18.3	0.7	0.59
	Arachidonic C20.4	1.0	0.9
	Docosahexanoic C22.4	8.6	8.4
	Total (%)	**12.7**	**12.03**

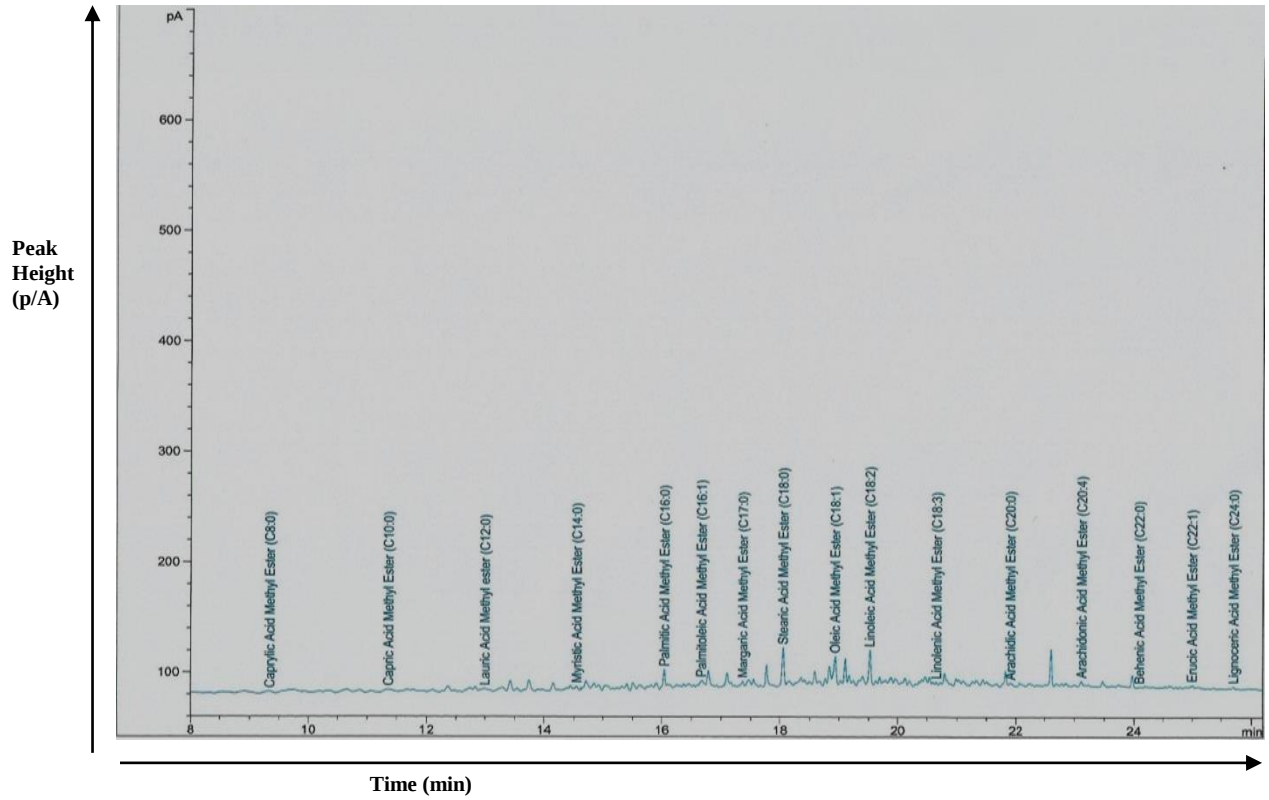

Figure 1: GC chromatogram of the fatty acids detected in the flesh of *C. gasar* (Ebute –Oko)

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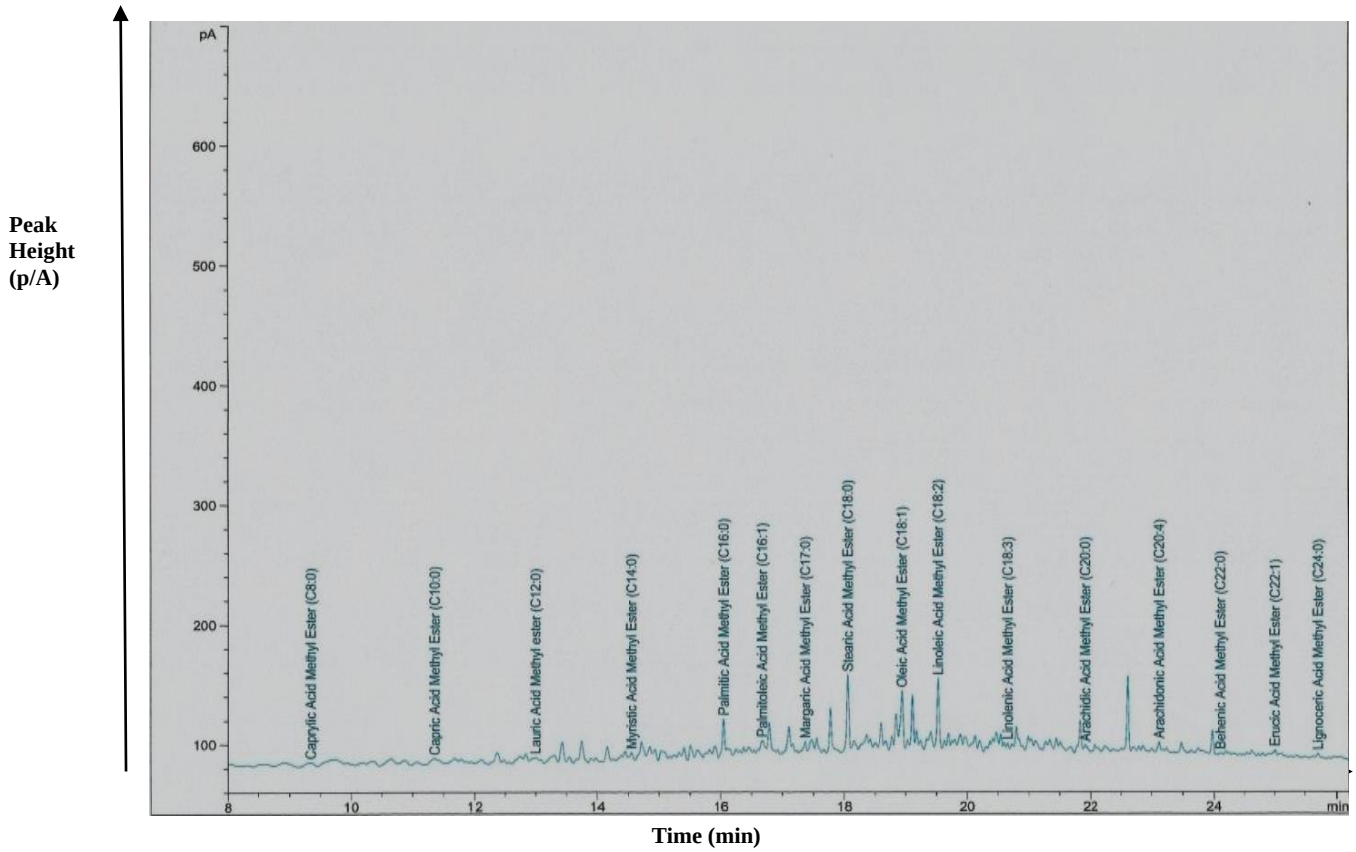

Figure 2: GC chromatogram of the fatty acids detected in the flesh of *C. gasar* (Tomaro)

Figure 3: GC Chromatogram of Vitamins in Oyster Flesh at Ebute-Oko

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Figure 4: GC Chromatogram of Vitamins in Oyster Flesh at Tomaro

*GC conditions : column HP – 5 (30m ✕ 0.25mm i.d) with film thickness of 0.25 µm at column temperature 50°C for 4 min with ramping of 10°C/min up to 250°C and stay maximum temperature for 4 minutes. Both The injector and detector temperatures were at 280°c.

thiamine (1.07 mg/100g), riboflavin (2.35 mg/100 g), niacin (2.84 mg/100g), adenine (3.23 mg/100 g), pantothenic acid (3.27 mg/100 g), pyridoxine (1.25 mg/100 g), folic acid (3.86 mg/100 g) and ascorbic acid (6.68 mg/100 g), while the fat soluble vitamins were retinol (5.55 mg/100 g), tocophenol (1.14 mg/100g) and phytonadione (7.89 mg/100 g) (Table 5).

Of the eight (8) water soluble vitamins in the *C. gasar* flesh from Tomaro, ascorbic acid had the highest concentration of 6.60 mg/100 g, followed by folic acid with 3.86 mg/100g, while thiamine had the lowest concentration of 1.1 mg/100 g. The concentrations of other water soluble vitamins in increasing order were as follows: pyridoxine (1.19 mg/100 g), riboflavin (2.4 mg/100g), niacin (2.8 mg/100 g), pantothenic acid (3.25 mg/100 g) and adenine (3.4 mg/100 g). Three fat soluble vitamins (retinol. tocophenol and phytonadione) were also observed in the flesh of *C. gasar* collected from Tomaro. The concentration (mg/100 g) of Retinol, Tocophenol and phytonadione was 5.6, 1.12 and 7.9, respectively (Table 5). Oysters are excellent sources of Vitamin A, B complex, C, E, K; making them a great food for supporting thyroid function and protecting the body against damage from free radicals.[41] Vitamins C (Ascorbic Acid) had the highest concentration in the flesh of *C. gasar* from the two sampling sites in the Lagos Lagoon, followed closely by Vitamin A (Retinol). Vitamin B_{12} helps the body maintain sheathes around nerve fibers, to activate another B-vitamin called folic acids and participates in many cellular processes.[42]

Conclusion

Crassostrea gasar, a mangrove oyster in comparison with fin fish with respect to its fatty acids, amino acids and vitamin contents is a better source of Omega-3 (n-3) and Omega-6(n-6) fatty acids which are needed for proper human growth. The high levels of essential amino acids present in the oysters will make it a good food source in complementing cereal products (which contains majorly carbohydrates) and serves as a regular 'get-to' food for several homes in Nigeria. The oyster can be used generously in the diets to avoid excessive consumption of saturated fat. The availability of the concentration of biochemical composition of *C. gasar* can also serve as an important guide on its benefits for future policy regarding exploitation of this species.

Conflict of Interest

The authors declare no conflict of interest.

Author's Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the contents of this article will be borne by them.

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