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Protein, amino acid and fatty acid profiles of two edible crabs of Lagos coast, Nigeria

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ABSTRACT

Edible crabs constitute one of the major sources of nutritious food for human nutrition. The study was aimed to examine the protein, amino acid and fatty acid compositions of two edible crabs (*Callinectes amnicola* and *Portunus validus*) of Lagos coast, Nigeria. Samples were obtained from the water body, transported in crushed iced insulated containers and analyzed in the laboratory using standard methods. Crude protein varied from 55 - 68.92% (*C. amnicola*) and 51.9 - 67.51% (*P. validus*) on dry matter basis. Leucine (8.63 - 9.73g/100 g crude protein) and glutamic acid (12.71 - 16.19g/100 g crude protein) were the highest concentrated essential and non-essential amino acids, respectively. The coefficient of variation of the amino acid values indicated that *C. amnicola* has more variations, relative to its mean. The most concentrated saturated fatty acid was palmitic acid in the samples with significantly different ($P < 0.05$) values of 14.32±1.05% (*C. amnicola*) and 24.52±0.00% (*P. validus*). With the exception of lauric, arachidic and lignoceric, all saturated fatty acids were more concentrated in *P. validus* than in *C. amnicola*. Oleic acid among the monounsaturated fatty acids occupied the highest position in *C. amnicola* (17.6233±0.04%) and in *P. validus* (12.4682±0.25%); whereas timnodenic acid was the most concentrated among the polyunsaturated fatty acids, with values of 23.9744±0.48 % (*C. amnicola*) and 15.7234±0.25 % (*P. validus*). Both species have reasonable levels of dietary protein and lipid quality.

Introduction

Aquatic foods are the chief sources of animal protein in the diets of the rural communities especially in the southern states of Nigeria. It is a broad component with major categories, finfish and shellfish, aquatic foods most especially sea-foods are nutritionally important in the supply of protein, especially the nine essential amino acids (Elegbede and Fashina-Bombata, 2013). 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 (Lawal-Are *et al*., 2018a). The most common nutrient deficiency is that of proteins. Proteins are organic compounds that contain carbon, hydrogen, oxygen, and nitrogen and sometimes iron, phosphorus, and sulfur. Amino acids are the building blocks of proteins. The lipid content of sea foods is primarily in the form of triglycerides or triacyglycerols and is the only major source of highly unsaturated fatty acids (Adeyeye, 2002). Fatty acids are a class of biomolecules that possess a wide diversity of functions in structure and biological process through interactions with proteins (Dowhan *et al*., 2008; Sul and Smith, 2008).

In fish species, lipids and proteins are the main organic constituents, and play many important roles in the fish's life history and physiology, which includes growth, movement, reproduction and migration (Tocher, 2003). Generally, shellfishes vary in their nutrients and can excrete some toxic metals out of the systems (Abolude *et al*., 2009; Moruf and Akinjogunla, 2018). As most shellfishes contain low level of lipid; however, omega-3 polyunsaturated fatty acid presented the majority of the total lipid (Lawal-Are *et al*., 2018b). Crab is one of the cheapest of shellfish resources that can serve as an alternative source of animal protein especially among coastal dwellers. Due to the meat quality of shellfishes, abundance scoop of inquisitiveness in nutritional values of crabs are generated in recent times. However, there are few detailed information on protein, amino acid and fatty

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acid profiles of the two most economically important crabs in South-West Nigeria. Hence, the purpose of this paper is to document and give available background information on protein, amino acid and fatty acid profiles of *Callinectes amnicola* and *Portunus validus* which could be included in food composition and nutrition tables.

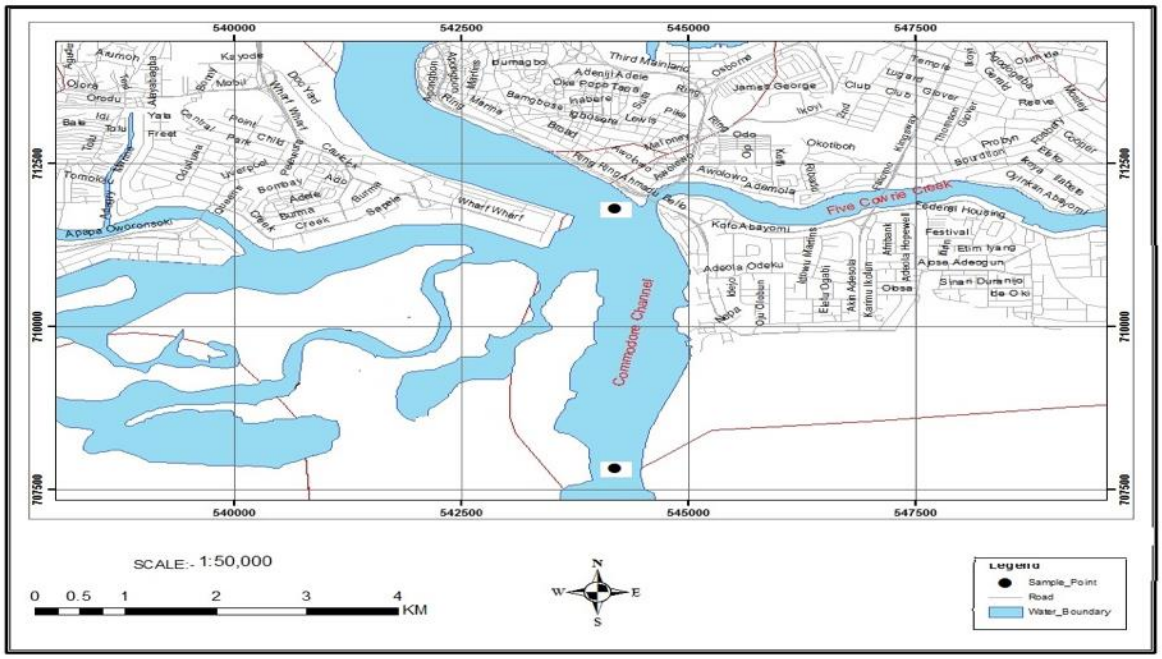

Fig.1 Map showing the sampling sites. Source: Akinjogunla *et al*. (2017)

Materials and Methods

Study area and sample collection

Market-sized samples of the crabs were obtained between the month of April to September (2017), from fishing trawlers operating around the Lagos Coast as by-catch. The sampling sites are geographically located at 6°24'N and 3°23'E for *C. amnicola* while 6°39' 56″N and 3°39'37″E for *P. validus* (Figure 1). The crabs were washed briefly with distilled de-ionized water to remove any adhering contamination, drained under folds of filter paper and identified. Samples were collected in crushed ice in insulated containers and brought to the laboratory for frozen at -4^{o}C before analysis.

Laboratory analyses

After removing from the freezer, samples were defrosted for about one hour, fillet extract obtained from the crab samples. The fillets were dried at 105^{o}C and homogenized. The analysis of the crude protein contents was determined using the methods described by AOAC (2007). The method of amino acid analysis was by ion-exchange chromatography (FAO/WHO, 1991) using the Technicon Sequential Multisample Amino Acid Analyzer (TSM). For fatty acid analysis, an aliquot (0.25 g) of each sample was prepared and extraction was done using a soxhlet extractor. A 50 mg aliquot of the dried oil was saponified and then neutralized by 0.7M HCl and 3 ml of 14% boron trifluoride in methanol. The fatty acid methyl esters were analyzed using an HP 5890 gas chromatograph. Nitrogen was used as the carrier gas with a flow rate of 20-60ml/min. The identification of fatty acid methyl esters was performed by external standards submitted to the same processes of manipulation as the experimental samples. Determinations were in triplicate.

Data analysis

Descriptive statistics used in this study were mean, standard error and coefficient of variation. Results obtained were subjected to analysis of variance (ANOVA) at significant difference of $P \leq 0.05$.

Results

Protein level

As indicated by the result in Figure 2, protein level in *Callinectes amnicola* is higher than the values in *Portunus validus* throughout the study period. The highest crude protein content of 68.92 ± 0.12% (Dry matter basis) was obtained from *C. amnicola* in the month of April.

Amino acid profile

The amino acids composition of two edible crabs in g/100g crude protein (cp) can be seen in Table 1.

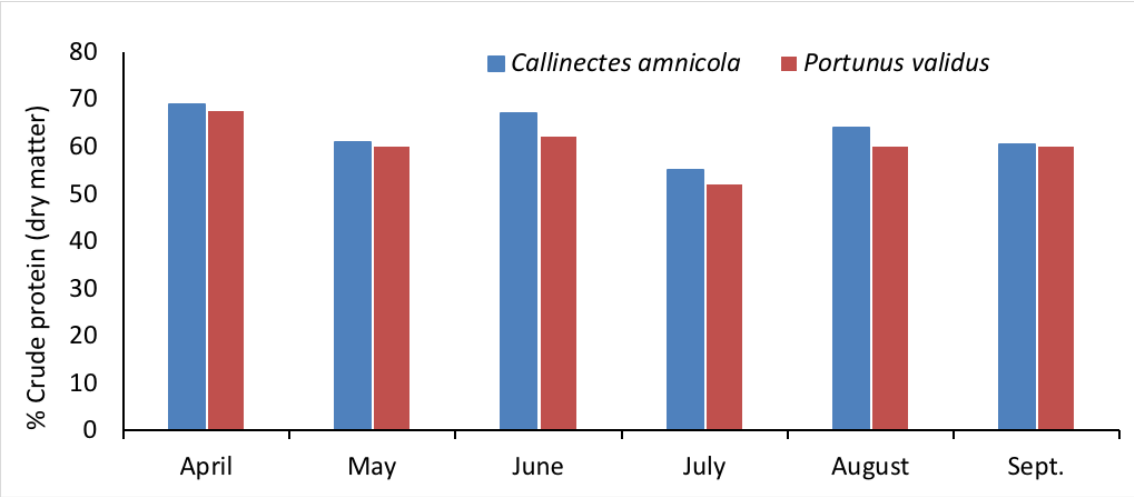

Fig. 2 Protein contents in two edible crabs of Lagos coast

Table 1. Amino acid profiles of two edible crabs of Lagos coast

Amino acid (g/100 g crude protein)		*Callinectes amnicola*			*Portunus validus*			P value
		Mean±SEM	SD	CV%	Mean±SEM	SD	CV%	
Essential	Histidine	3.25±0.01	0.01	0.31	2.46±0.02	0.03	1.22	0.00*
	Isoleucine	5.07±0.40	0.69	13.61	3.87±0.25	0.44	11.37	0.06
	Leucine	9.73±0.62	1.08	11.1	8.63±0.25	0.44	5.1	0.18
	Lysine	8.27±0.36	0.62	7.5	8.5±0.16	0.28	3.29	0.59
	Methionine	2.84±0.48	0.83	29.23	2.76±0.25	0.44	15.94	0.89
	Phenylalanine	5.18±0.31	0.54	10.42	3.96±0.23	0.4	10.1	0.04*
	Threonine	3.42±0.65	1.13	33.04	4.08±0.02	0.03	0.74	0.37
	Tryptophan	1.18±0.07	0.13	11.02	1.05±0.25	0.44	41.9	0.65
	Valine	5.43±0.31	0.54	9.94	4.3±0.23	0.4	9.3	0.04*
Non-Essential	Alanine	5.3±0.00	0.01	0.19	5.52±0.01	0.02	0.36	0.00*
	Arginine	7.81±0.00	0.01	0.13	6.94±0.01	0.02	0.29	0.00*
	Aspartic acid	11.64±0.06	0.11	0.95	11.28±0.06	0.1	0.89	0.01*
	Cystine	1.8±0.40	0.69	38.33	1.35±0.25	0.44	32.59	0.39
	Glutamic acid	12.71±0.40	0.69	5.43	16.19±0.25	0.44	2.72	0.00*
	Glycine	4.76±0.01	0.01	0.21	4.66±0.02	0.03	0.64	0.01*
	Proline	3.17±0.40	0.69	21.77	3.31±0.25	0.44	13.29	0.78
	Serine	3.53±1.05	1.82	51.56	3.92±0.25	0.44	11.22	0.74
	Tyrosine	2.35±0.40	0.69	29.36	3.67±0.25	0.44	11.99	0.05*

The highest concentrated essential amino acid was non-polar aliphatic amino acid, leucine in *C. amnicola* and *P. validus* with respective values of 9.73±0.62 and 8.63±0.25g/100g cp. Tryptophan was the lowest concentrated essential amino acid in both species with values of 1.18±0.07 and 1.05±0.25g/100g cp for *C. amnicola* and *P. validus* respectively. Histidine, phenylalanine and valine were significantly different ($P<0.05$) between both species. The highest concentrated non-essential amino acid was an acidic amino acid, glutamic acid in *C. amnicola* and *P. validus* with respective values of 12.71±0.40 and 16.19±0.25g/100g cp. Cystine was the lowest concentrated non-essential amino acid in both species with values of 1.8±0.40 and 1.35±0.25g/100g cp for *C. amnicola* and *P. validus* respectively. The organisms exhibited significant differences in all the non-essential acids with the exception of cystine, proline and serine. Most values of coefficient of variation (CV) indicated that *C. amnicola* has more variations, relative to its mean.

Fatty acid profile

In Table 2, saturated fatty acid profiles of two edible crabs of Lagos coast are shown. The following fatty acids had 0.00% total fatty acid each: Hexanoic acid (C6:0), octanoic acid (C8:0) and decanoic acid (C10:0) in both samples. The most concentrated saturated fatty acid was palmitic acid (C16:0) in the samples with significantly different values of 14.32±1.05% (*C. amnicola*) and

Table 2. Saturated fatty acid profiles of two edible crabs of Lagos coast

Fatty acid (% total fatty acid weight)	*Callinectes amnicola*			*Portunus validus*			P value
	Mean±SEM	SD	CV%	Mean±SEM	SD	CV%	
Hexanoic acid (C6:0)	0	-	-	0	-	-	-
Octanoic acid (C8:0)	0	-	-	0	-	-	-
Decanoic acid (C10:0)	0	-	-	0	-	-	-
Lauric acid (C12:0)	0.0072±0.00	0	0	0.0045±0.00	0	0	0.00*
Myristic acid (C14:0)	0.3589±0.00	0	0	1.3835±0.00	0	0	0.00*
Palmitic acid (C16:0)	14.3201±1.05	1.82	12.71	24.5248±0.00	0	0	0.00*
Stearic acid (C18:0)	9.4579±0.4	0.69	7.3	14.5279±0.25	0.44	3.03	0.00*
Arachidic acid (C20:0)	0.0168±0.00	0.01	59.52	0.0105±0.00	0	0	0.18
Behenic acid (C22:0)	0.0155±0.01	0.01	64.52	8.8818±0.02	0.03	0.34	0.00*
Lignoceric acid (C24:0)	0.0019±0.00	0	0	0.0012±0.00	0	0	0.2

Table 3. Unsaturated fatty acid profiles of two edible crabs of Lagos coast

Fatty acid (% total fatty acid weight)	*Callinectes amnicola*			*Portunus validus*			P value
	Mean±SEM	SD	CV%	Mean±SEM	SD	CV%	
Mono-Unsaturated							
Myristoleic acid (C14:1cis-9)	0.0089±0.00	0	0	0.0056±0.00	0	0	0.02*
Palmitoleic acid (C16:1cis-9)	0.013±0.00	0.01	76.92	0.0081±0.00	0	0	0.29
Petroselinic acid (C18:1cis-6)	3.0799±0.48	0.83	26.95	3.1219±0.25	0.44	14.09	0.94
Oleic acid (C18:1 cis -9)	17.6233±0.04	0.69	3.92	12.4682±0.25	0.44	3.53	0.00*
Gondoic acid (C22:1 cis-11)	0.0282±0.00	0.01	35.46	0.0176±0.00	0	0	0.05*
Erucic acid (C22:1 cis-13)	0.5376±0.01	0.01	1.86	0.5268±0.02	0.03	5.69	0.58
Nervonic acid (C24:1 cis-15)	0.0019±0.00	0	0	0.0012±0.00	0	0	0.38
Trans-Petroselinic acid (C18:1 trans-6)	0.006±0.00	0	0	0.0038±0.00	0	0	0.04*
Elaidic acid (C18:1 trans-9)	0.0005±0.00	0	0	0.0003±0.00	0	0	0.04*
Vaccenic acid (C18:1 trans-11)	0.0324±0.00	0.01	30.86	0.0203±0.00	0	0	0.03*
Poly-Unsaturated							
Linoleic acid (C18:2 cis-9,12)	6.6924±0.48	0.83	12.4	0.5011±0.02	0.03	5.99	0.00*
Gamma-linolenic acid (C18:3 cis-6,9,12)	0.4919±0.06	0.11	22.36	0.264±0.06	0.1	37.88	0.05*
Eicosadienoic acid (C20:2 cis -11,14)	2.8439±0.36	0.62	21.8	1.7594±0.16	0.28	15.91	0.05*
Dihomo-γ-linolenic acid (C20:3 cis 5, 8,11,14)	0.2954±0.05	0.08	27.08	0.1294±0.03	0.04	30.91	0.04*
Arachidonic acid (C20:4 cis-5,8,11,14)	11.8484±0.4	0.69	5.82	5.7834±0.25	0.44	7.61	0.00*
Docosadienoic acid (C22:2 cis-13,16)	0.104±0.03	0.05	48.08	0.0681±0.02	0.04	58.74	0.41
Rumenic acid (C18:2 cis-9, trans-11)	0.0071±0.00	0	0	0.0044±0.00	0	0	0.1
Alpha-linolenic acid (C18:3 cis-9,12,15)	1.1614±0.06	0.11	9.47	0.5934±0.06	0.1	16.85	0.00*
Eicosatrienoic acid (C20:3 cis-11, 14,17)	0.0103±0.01	0.01	97.09	0.0064±0.00	0	0	0.39
Timnodenic acid (C20:5 cis-5,8,11,14,17)	23.9744±0.48	0.83	3.46	15.7234±0.25	0.44	2.8	0.00*
Cervonic acid (C22:6 cis-4,7,10,13,16,19)	7.0608±0.4	0.69	9.77	9.66±0.25	0.44	4.55	0.01*

24.52±0.00% (*P. validus*). With the exception of lauric acid (C12:0), arachidic acid (C20:0) and lignoceric acid (C24:0), all other saturated fatty acids were more concentrated in *P. validus* than in *C. amnicola*. When compared to *P. validus*, most values of coefficient of variation indicated that *C. amnicola* has more variations, relative to its mean. The values in % total fatty acid for unsaturated fatty acid profiles of two edible crabs of Lagos Coast are shown in Table 3. Among the monounsaturated fatty acids, oleic acid (C18:1 cis -9) occupied the highest position both in *C. amnicola* (17.6233 ± 0.04%) and *P. validus* (12.4682 ± 0.25%); whereas elaidic acid (C18:1 trans-9) occupied the least position both in *C. amnicola* and *P. validus* with values of 0.0005 ± 0.00% and 0.0003 ± 0.00%, respectively. Both crabs showed significant differences in all the mono-unsaturated fatty acids (MUFA) except in palmitoleic acid (C16:1cis-9), petroselinic acid (C18:1cis-6) and nervonic acid (C24:1 cis-15). Among the polyunsaturated fatty acids, timnodenic acid (C20:5 cis-5,8,11,14,17) was the most concentrated with values of 23.9744 ± 0.48% (*C. amnicola*) and 15.7234 ± 0.25% (*P. validus*); whereas rumenic acid (C18:2 cis-9, trans-11) was the least with 0.0071±0.00% (*C. amnicola*) and

0.0044±0.00% (*P. validus*). There were no significant differences between both organisms in values obtained for docosadienoic acid (C22:2 cis-13, 16), rumenic acid (C18:2 cis-9, trans-11) and eicosatrienoic acid (C20:3 cis-11, 14, 17).

Discussion

The crude protein values obtained in this study were much lower than the values reported for edible molluscs like *Crassostrea gasar* (73.67%), fresh water snail (76.32%), *Tympanptonus. fuscatus* (70.1%) and *Sepia officinalis* (78.55%) by Woke *et al.* (2016), Obande *et al*. (2013), Davies and Jamabo (2016) and Lawal-Are *et al*. (2018b) respectively. The highest crude protein content in this study was obtained in the peak of dry month (April). According to Rosa and Nunes (2003), the quantity of protein content varies considerably within and between the species, size, sex, sexual condition, feeding season, molting stage, reproductive stage of the life cycle etc.

The percentage essential amino acid in *C. amnicola and P. validus* could be favourably compared with other animal protein sources: 45.9-47.1% in meat organs of turkey-hen (Adeyeye and Ibigbami, 2012); 46.2% in *Zonocerus variegatus* (Adeyeye, 2005a); 43.7% in *Macrotermes bellicosus* (Adeyeye, 2005b); 54.8% in *Gymnarchus niloticus* (Adeyeye and Adamu, 2005) and 48.1-49.9% in brain and eyes of African giant pouch rat (Oyarekua and Adeyeye, 2011), whereas it is 50% for egg (FAO/WHO, 1990). Most animal proteins are low in cysteine with male fresh water crab body parts (13.3-15.9%) (Adeyeye and Kenni, 2008) and female fresh water crab body parts (27.3-32.8%) (Adeyeye, 2008).

In the present study, hexanoic, octanoic and decanoic acids had 0.00% total fatty acid in both *C. amnicola and P. validus*. This is similar to the report of Adeyeye (2015) on the fatty acid composition of lagoon and freshwater crabs of Nigeria. Both organisms showed significant differences in all the mono-unsaturated fatty acids except in palmitoleic, petroselinic and nervonic acids. According to Enig and Fallon (2000), palmitoleic acid found almost exclusively in animal fats has strong antimicrobial properties. This MUFA is beneficial in reducing bad cholesterol (LDL) and it behaves like a saturated and not as an unsaturated fatty acid in its effect on HDL cholesterol (Nestel *et al*., 1994). It also reduces the fat deposition in blood vessels and reduces blood clot formation (Grundy, 1994).

Conclusion

Callinectes amnicola and *Portunus validus* are good sources of protein particularly the essential amino acids. Dominant in both edible crabs were leucine (essential amino acid), glutamic acid (non-essential amino acid), palmitic acid (saturated fatty acid), oleic acid (monounsaturated fatty acid) and timnodenic acid (polyunsaturated fatty acid). The study revealed that *C. amnicola* has more quality parameters, although both species contain healthy dietary protein and fat.

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