SEASONAL VARIATION IN MACRO-MICRONUTRIENT COMPOSITIONS OF THE FLESH AND SHELL OF THE PORTUNID CRAB *Callinectes amnicola* (De Rochebrune, 1883) FROM THE COASTAL WATERS OF SOUTHWEST NIGERIA

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Abstract: Portunids are decapod crustaceans of high economic importance. Seasonal variation in macronutrient and micronutrients contents of *Callinectes amnicola* from three interconnecting lagoons were investigated using standard methods. The percentages of protein and moisture contents in the flesh were higher than that of the shell, while higher ash and nitrogen free extract were obtained in the shell. Crude fibres was not detected in flesh of *C. amnicola* but detected in shells with values ranging from 0.30 ±0.72 % (*C. amnicola* from Lagos Lagoon) to 0.55 ±2.15 % (*C. amnicola* from Badagry Lagoon). There were statistical differences ($P < 0.05$) in crude fibre and carbohydrate levels of the crab shell during wet and dry seasons while significant difference exist in protein level only in wet season. Protein showed negative correlations with all the minerals in crabs from Badagry and Epe Lagoons but positive correlation with all examined minerals in Lagos Lagoon crabs. The study demonstrated that *Callinectes amnicola* is rich in macro-micronutrients and characterized by low lipid content (< 3%). The nutrient biochemical constituents in the crab species vary with season.

Keywords: Proximate, Mineral, Ccorrelation, Crab, Lagoon

INTRODUCTION

One of the greatest problems facing the developing countries is that of providing sufficient food of adequate quality to its increasing populations. The malnutrition situation is more intense with low level of protein and mineral intake, calling for urge and urgent need to find a way of raising the protein and mineral intake of the average citizens from 5.5g/head/day as recommended by FAO (1998) to 35g/head/day as suggested by Idufweke (1994). In Nigeria, more than 41% of the total animal protein intake is obtained from fishery products because it is relatively cheaper than meat and the total fish consumption rate has risen to 2.66 million metric tons annually (Onyia et al., 2014). The Southern region of Nigeria is blessed with numerous species of shellfish which are nutritionally important in the supply of protein, the nine essential amino acids and minerals. Shellfish which include the crustaceans (crabs, lobsters, shrimps and crayfish) and molluscs (oysters, clams, snails and squids) are mostly marine/estuarine invertebrates but some forms can be found in the freshwater regions. They have been found to contain high level of protein, macro- minerals and trace elements such as copper, iron, zinc and manganese but low in fat and cholesterol which makes them healthy choices of diet to the general population at large (Martino and

Gracinda, 2004). King et al. (1990) also proclaimed shellfish as good source of Vitamin B_2, niacin, iron, purines, sodium, vitamin C, zinc, magnesium and Omega -3 fatty acids.

Macronutrients (except water) are also called energy-providing nutrients. They normally include water, carbohydrates, fat and protein. Unlike macronutrients which are needed in larger quantities, micronutrients (minerals and vitamin) are required in very minute amounts. Together, they are extremely important for the normal functioning of the body. Micronutrients do not function for the provision of energy. Preliminary investigations on the proximate composition of many commercially harvested species of shellfish in Nigeria have been partially described (Elegbede and Fashina-Bombata, 2013, Obande et al., 2013; Davies and Jamabo, 2016; Woke et al., 2016; Akinjogunla et al., 2017, Lawal-Are et al., 2018a; 2018b). However, dearth of information on seasonal variation of nutrient compositions of *Callinectes spp* has necessitated this research. Hence, the objective of this study is to examine the seasonal variations in the macronutrient and micronutrient contents of the flesh and shell of *Callinectes amnicola* from three interconnecting lagoons; Badagry, Lagos and Epe Lagoons in Southwest Nigeria.

MATERIALS AND METHODS

Sampling Sites and Samples collection

Samples of *Callinectes amnicola* were obtained from three interconnecting lagoons (Table 1) in southwestern part of Nigeria during wet (April – October) and dry seasons (November –March). The crabs were washed briefly with distilled de-ionised water to remove any adhering contamination, drained under folds of filter paper and identified using taxonomic keys of Schneider (1990). Samples were collected in crushed iced insulated containers and brought to the laboratory for frozen before analysis was carried out.

Table 1

Global Positioning System (GPS) coordinates of sample locations

Locations	Longitude	Latitude
Lagos Lagoon	3°40’47″E	6°44’19″N
Badagry Lagoon	3°45′33″E	6°30′ 28″N
Epe Lagoon	5º40′ 18″E	6°34' 38"N

Laboratory procedure

The moisture content of crab soft tissue (flesh) and shell was determined using the air oven dry method with a known weight of the sample at 105°C until a constant weight was obtained as described by Association Official Analytical Chemist (AOAC, 2006). Ash content was determined by incineration of the dried sample obtained from moisture determination in a muffle furnace at 550°C for 24 hours. Crude protein content was calculated by converting the nitrogen content, determined by Kjeldahl’s method (6.25 × N). Fat content was determined using the method described by AOAC (2006) with slight modifications. The crude fibre content was determined using trichloroacetic acid method. Carbohydrate or Nitrogen Free Extract content was calculated by using the difference after analysis of all other proximate contents. Carbohydrate =100% - (% moisture + % ash + % crude protein + crude fibre + % fat).

The mineral content was determined by dissolving the ash obtained from the sample in standard flask with distilled de-ionized water. A few drops of concentrated hydrochloric acid were added. The mixture was warmed and evaporated on Bochy water bath and filtered

using a filter paper. The aliquots were taken for estimates of calcium, phosphorus, iron, sodium and potassium following the methods of AOAC (2006).

RESULTS AND DISCUSSION

Macronutrient Composition

Results of the seasonal variations in the macronutrient compositions of flesh and shell of *C. amnicola* from the coastal waters of Nigeria are shown in Table 2. During dry season, moisture, crude fat and nitrogen free extract (NFE) contents of the *C. amnicola* flesh ranged from 73.22 ±0.32 to 75.52 ± 0.56%, 1.78 ± 0.43% to 2.12 ±0.94 %, and 3.13 ± 0.66 % to 3.48 ±0.12 % respectively. The highest protein content of 19.39 ± 0.29% was obtained in the flesh of *C. amnicola* from Badagry Lagoon while the lowest mean protein content of 16.73 ± 0.74 % was obtained in crab from Epe Lagoon. *C. amnicola* shells had ≥ 55.02 ±10.47 % ash content while the ash contents in the flesh ranged from 2.14 ± 3.49 % to 2.22 ± 0.41 %.The percentages of protein and moisture contents in the flesh were higher than that of the shell, while higher ash and NFE contents were obtained in the shell. Crude fibre was not detected in the flesh of the *C. amnicola* but detected in it shells with values ranging from 0.30 ± 0.72 % (*C. amnicola* from Lagos Lagoon) to 0.55 ± 2.15 % (*C. amnicola* from Badagry Lagoon).

Table 2

Seasonal variation in macronutrient contents of *C. amnicola* from the coastal waters of Southwest Nigeria

Season	Macronutrients (%)	Flesh			*P-value*	Shell			*P-value*
		Badagry Lagoon	Lagos Lagoon	Epe Lagoon		Badagry Lagoon	Lagos Lagoon	Epe Lagoon	
Dry	Moisture	73.22 ±0.32	75.05 ±0.76	75.52 ±0.56	0.338	16.89 ±9.75	17.32 ±6.91	16.49 ±9.01	0.242
	Crude Protein	19.39 ±0.29	17.18 ±1.57	16.73 ±0.74	0.137	4.92 ±0.9	4.7 ±0.75	4.03 ±0.24	0.092
	Crude Fat	2.12 ±0.94	1.78 ±0.43	2.05 ±0.44	0.318	ND	ND	ND	ND
	Crude Fibre	ND	ND	ND	ND	0.36 ±2.02	0.29 ±0.31	0.36 ±0.37	0.00*
	Total Ash	2.14 ±3.49	2.52 ±1.19	2.22 ±0.41	0.344	56.63 ±10.18	55.29 ±6.79	55.02 ±10.47	0.942
	NFE	3.13 ±0.66	3.47 ±0.14	3.48 ±0.12	0.48	21.2 ±0.19	22.4 ±0.14	24.1 ±0.18	0.038 *
Wet	Moisture	72.2 ±1	74.47 ±1.58	74.93 ±0.85	0.252	16.03 ±9.62	17.11 ±7.22	16.17 ±10.29	0.224
	Crude Protein	19.22 ±0.29	17.01 ±1.61	16.33 ±1.33	0.178	3.42 ±0.57	4.32 ±0.4	4 ±0.06	0.006 *
	Crude Fat	2.1 ±0.92	1.75 ±0.6	2.01 ±0.53	0.343	ND	ND	ND	ND
	Crude Fibre	ND	ND	ND	ND	0.55 ±2.15	0.30 ±0.72	0.46 ±0.17	0.00*
	Total Ash	2.09 ±3.79	2.49 ±1.63	2.2 ±0.4	0.45	56.29 ±10.05	52.91 ±6.79	54 ±9.82	0.954
	NFE	4.39 ±1.4	4.28 ±0.26	4.53 ±0.18	0.688	23.71 ±0.18	25.36 ±0.15	25.37 ±0.1	0.001 *

Keys: Mean±Standard Error, *: Significant difference, ND: Not detected, NFE: Nitrogen-Free Extract

There was statistical difference ($P < 0.05$) in the crude fibre and NFE compositions of the *C. amnicola* shell during wet and dry seasons while significant difference exist in protein level only in wet season.

The highest moisture content (75.52 ±0.56 %) obtained from the flesh of *C. amnicola* was found in Epe Lagoon during the dry season and was higher than the values of 70.1%, 72.1% and 70.4% that were reported by Davies and Jamabo (2016) on *Tympanptonus. fuscatus*, *Crassostrea. gasar* and *Callinectes amnicola* respectively. The knowledge of the moisture content in an organism would give useful information on how to preserve the qualities of the organisms and also their susceptibility to fungi infection (Adeyeye et al., 2013). The values of the macronutrients (Protein, fat and carbohydrate) in this study are similar to those found in other species of aquatic crab by Udo and Arazu (2012), Elegbede and Fashina-Bombata (2013) and Fagbuaro et al. (2013). According to Adebayo-tayo et al. (2006), lipids are highly productive sources of energy which also contain twice the energy of carbohydrates and proteins.

Micronutrient Composition

The result on Table 3 indicates the significant level of mineral contents of *C. amnicola* in mg per kg of sample. The shell was higher in mineral content than the flesh while the organism showed significantly different content of magnesium in flesh and shell for both seasons. During the wet season, there was an increase in the concentration of calcium, potassium and sodium for both flesh and shell of *C. amnicola* from Badagry Lagoon. The pattern of mineral contents in the flesh of the investigated crab was sodium > potassium > calcium > magnesium while in the shell; it was Calcium > Sodium > Potassium > Magnesium. *C. amnicola* show high value of sodium, potassium, calcium and magnesium.

Table 3

Seasonal variation in micronutrient content of *C. amnicola* from coastal waters of Southwest Nigeria

Season	Minerals (mg/kg)	Flesh			*P-value*	Shell			*P-value*
		Badagry Lagoon	Lagos Lagoon	Epe Lagoon		Badagry Lagoon	Lagos Lagoon	Epe Lagoon	
Dry	Calcium	10528.96 ±6936.47	1279.39 ±159.76	8205.93 ±132.34	0.732	106964.08 ±69041.07	256751.93 ±19259.06	38380.56 ±6408.82	0.458
	Potassium	32201.47 ±30949.32	3374.93 ±108.58	2299.97 ±65.63	0.455	140301.42 ±134485.7	3558.46 ±60.98	4414.63 ±156.49	0.413
	Magnesium	3610.64 ±31.04	1263.33 ±92.69	2402.37 ±32.4	0.00*	57706.8 ±23.37	1944.73 ±80.68	3035.25 ±393.45	0.00*
	Sodium	39547.47 ±37726.27	3713.46 ±89.77	2732.6 ±18.87	0.446	167947.91 ±106658.8	4120.26 ±57.25	33353.35 ±324.31	0.214
Wet	Calcium	10893.63 ±7303.76	1275.99 ±125.41	8122.1 ±124.65	0.747	111662.44 ±73754.36	256526.33 ±19237.87	37723.86 ±6752.71	0.464
	Potassium	34690.34 ±33454.85	3369.66 ±96.29	2218.75 ±41.22	0.452	158173.36 ±152375.8	3586.33 ±112.27	4359.86 ±199.3	0.414
	Magnesium	3599 ±24	1238.99 ±78.63	2262.24 ±79.17	0.00*	56958.03 ±41.02	1958.99 ±99.54	26643.71 ±1415.58	0.00*
	Sodium	42468.33 ±40665.84	3702.33 ±80.51	2462.53 ±140.34	0.442	179051.35 ±117768.8	4262.33 ±199.51	32010.6 ±345.74	0.228

Keys: Mean±Standard Error, * significant difference

The calcium content observed for *C. amnicola* in this study was high when compared to values for beef (7), liver (6) and egg (54) but lower than the value of 120 mg/100g obtained in milk or 129.18mg/100g obtained in freshwater snail as reported by Obande et al. (2013).

The high content of calcium suggests that the consumption of the shellfish can increase the calcium in the body and help in blood clotting process (Moruf and Akinjogunla, 2018). Magnesium, being the mineral with the lowest value in this study is lower than the value reported by Okaraonye and Ikewuchi (2009). According to Hambidge (2000), magnesium is an activator of the enzyme system which functions in the metabolism of carbohydrates to produce energy. Sodium and chlorine being found mainly in the body fluids while potassium occurring mainly in the cells. They are essential in the regulation of pH, osmotic pressure, acid-base equilibrium, water balance, nerve impulse transmission and active transport of glucose/amino acids (Asuquo et al., 2004).

Correlation between macro-micronutrients

The correlation analyses between the macro-micro nutrient compositions in the flesh of *C. amnicola* are shown in Tables 4 to 9. During the dry season (Table 4-6), protein showed negative correlations with all the minerals in crabs from Badagry and Epe Lagoons but positive correlation with all minerals in Lagos Lagoon crabs. During the wet season (Table 7 - 9), protein was positively correlated with all minerals except with Mg (-0.013) in Badagry Lagoon crabs and negative correlation with all the minerals in crabs from Epe Lagoon.

Table 4

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Flesh) from Badagry Lagoon during dry season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	-0.676	1								
Fat	-0.957	0.861	1							
Fibre	-0.995	0.601	0.924	1						
Ash	-0.992	0.579	0.913	1.000	1					
NFE	-0.996	0.740	0.979	0.982	0.977	1				
Ca	0.996	-0.604	-0.925	-1.000	-1.000	-0.983	1			
K	0.997	-0.616	-0.931	-1.000	-0.999	-0.986	1.000	1		
Mg	0.355	0.449	-0.067	-0.445	-0.469	-0.269	0.441	0.428	1	
Na	0.997	-0.617	-0.931	-1.000	-0.999	-0.986	1.000	1.000	0.426	1

Table 5.

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Flesh) from Lagos Lagoon during dry season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.619	1								
Fat	-0.227	-0.905	1							
Fibre	-0.870	-0.926	0.678	1						
Ash	-0.951	-0.831	0.516	0.979	1					
NFE	0.616	-0.237	0.627	-0.148	-0.344	1				
Ca	0.950	0.342	0.089	-0.672	-0.807	0.832	1			
K	0.998	0.564	-0.160	-0.834	-0.928	0.669	0.969	1		
Mg	0.985	0.746	-0.392	-0.942	-0.990	0.470	0.881	0.971	1	
Na	0.956	0.823	-0.504	-0.977	-1.000	0.357	0.816	0.933	0.992	1

The correlation analyses between the macro-micro nutrient compositions in the shell of *C. amnicola* during the dry and wet seasons are shown in Tables 10 to 15. During the dry

season (Table 10 - 12), protein showed significant positive correlation with all the minerals except with Mg (-0.392 in Badagry Lagoon crabs) and Na (-0.313 in Epe Lagoon crabs). During wet season (Table 13 - 15), protein showed negative correlations with minerals like Mg (-0.994) in crabs from Badagry Lagoon and all the minerals in Epe Lagoon crabs which is in tandem with the report of Akinjogunla et al., (2017) which revealed corrections between protein and some macro and micro minerals in mangrove oyster. The authors further stated that environmental influences could be responsible for the variations in the values of these examined minerals in macroinveterbrates.

Table 6

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Flesh) from Epe Lagoon during dry season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.538	1								
Fat	-0.864	-0.889	1							
Fibre	-0.675	-0.985	0.955	1						
Ash	-0.904	-0.846	0.996	0.925	1					
NFE	-0.665	-0.987	0.951	1.000	0.920	1				
Ca	-0.570	-0.999	0.906	0.991	0.866	0.993	1			
K	-0.569	-0.999	0.906	0.991	0.866	0.993	1.000	1		
Mg	-0.570	-0.999	0.906	0.991	0.866	0.993	1.000	1.000	1	
Na	-0.569	-0.999	0.906	0.991	0.866	0.993	1.000	1.000	1.000	1

Table 7

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Flesh) from Badagry Lagoon during wet season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.976	1								
Fat	-0.920	-0.983	1.000							
Fibre	-1.000	-0.978	0.924	1						
Ash	-0.999	-0.964	0.898	0.998	1					
NFE	-0.997	-0.956	0.886	0.996	1.000	1				
Ca	0.976	0.906	-0.813	-0.974	-0.986	-0.990	1			
K	0.978	0.911	-0.820	-0.976	-0.988	-0.992	1.000	1		
Mg	0.203	-0.013	0.196	-0.193	-0.254	-0.280	0.412	0.401	1	
Na	0.979	0.911	-0.820	-0.976	-0.988	-0.992	1.000	1.000	0.400	1

Table 8

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Flesh) from Lagos Lagoon during wet season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.989	1								
Fat	-0.779	-0.864	1							
Fibre	-1.000	-0.984	0.761	1						
Ash	-1.000	-0.987	0.770	1.000	1					
NFE	-0.937	-0.874	0.511	0.947	0.942	1				
Ca	0.363	0.219	0.302	-0.389	-0.375	-0.665	1			
K	0.740	0.631	-0.155	-0.759	-0.749	-0.928	0.895	1		
Mg	0.789	0.688	-0.229	-0.806	-0.797	-0.954	0.859	0.997	1	
Na	0.835	0.742	-0.305	-0.850	-0.842	-0.974	0.816	0.988	0.997	1

Table 9

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Flesh) from Epe Lagoon during wet season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	-0.233	1								
Fat	-0.376	-0.813	1							
Fibre	-0.523	-0.707	0.986	1						
Ash	-0.310	-0.853	0.997	0.972	1					
NFE	-0.353	-0.828	1.000	0.982	0.999	1				
Ca	0.374	-0.989	0.719	0.595	0.766	0.736	1			
K	0.247	-1.000	0.805	0.696	0.845	0.819	0.991	1		
Mg	0.801	-0.768	0.253	0.091	0.321	0.277	0.854	0.778	1	
Na	0.888	-0.653	0.091	-0.073	0.162	0.116	0.758	0.665	0.987	1

Table 10

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Shell) from Badagry Lagoon during dry season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.419	1								
Fat	-0.914	-0.751	1							
Fibre	0.323	-0.724	0.089	1						
Ash	-0.992	-0.302	0.856	-0.438	1					
NFE	-0.983	-0.244	0.823	-0.492	0.998	1				
Ca	-0.319	0.727	-0.093	-1.000	0.434	0.488	1			
K	-0.318	0.728	-0.094	-1.000	0.433	0.487	1.000	1		
Mg	-1.000	-0.392	0.902	-0.350	0.995	0.988	0.346	0.345	1	
Na	-0.317	0.728	-0.095	-1.000	0.433	0.487	1.000	1	0.345	1

Table 11

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Shell) from Lagos Lagoon during dry season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.307	1.000								
Fat	0.036	-0.940	1.000							
Fibre	-0.998	-0.368	0.029	1.000						
Ash	-0.995	-0.400	0.063	0.999	1.000					
NFE	-0.646	0.528	-0.786	0.595	0.567	1.000				
Ca	-0.449	0.712	-0.909	0.391	0.359	0.972	1.000			
K	-0.869	0.204	-0.526	0.835	0.815	0.939	0.833	1.000		
Mg	-0.675	0.495	-0.761	0.626	0.599	0.999	0.962	0.952	1.000	
Na	-0.685	0.482	-0.752	0.637	0.610	0.999	0.959	0.956	1.000	1.000

Table 12

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Shell) from Epe Lagoon during dry season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.722	1								
Fat	-0.863	-0.973	1							
Fibre	-0.420	-0.931	0.821	1						
Ash	-0.999	-0.687	0.837	0.375	1					
NFE	-0.842	-0.981	0.999	0.843	0.814	1				
Ca	-0.489	0.251	-0.020	-0.587	0.531	-0.060	1			
K	-0.655	0.050	0.183	-0.412	0.691	0.143	0.979	1		
Mg	-0.524	0.210	0.022	-0.553	0.565	-0.019	0.999	0.987	1	
Na	0.431	-0.313	0.084	0.638	-0.475	0.124	-0.998	-0.964	-0.994	1

Table 13

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Shell) from Badagry Lagoon during wet season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.328	1								
Fat	-0.752	-0.870	1							
Fibre	0.234	-0.842	0.466	1						
Ash	-0.986	-0.168	0.633	-0.391	1					
NFE	-0.613	0.545	-0.060	-0.911	0.735	1				
Ca	-0.305	0.799	-0.399	-0.997	0.458	0.939	1			
K	-0.304	0.800	-0.400	-0.997	0.457	0.939	1.000	1		
Mg	-0.430	-0.994	0.919	0.777	0.275	-0.450	-0.728	-0.729	1	
Na	-0.304	0.800	-0.400	-0.997	0.457	0.939	1.000	1.000	-0.729	1

Table 14

Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Shell) from Lagos Lagoon during wet season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	-0.814	1								
Fat	-0.420	-0.185	1							
Fibre	0.080	-0.644	0.871	1						
Ash	-0.997	0.856	0.350	-0.155	1					
NFE	-0.958	0.946	0.143	-0.362	0.977	1				
Ca	-0.327	0.815	-0.720	-0.968	0.397	0.584	1			
K	-0.760	0.996	-0.271	-0.709	0.807	0.914	0.863	1		
Mg	-0.580	0.945	-0.496	-0.859	0.640	0.789	0.960	0.970	1	
Na	-0.403	0.859	-0.661	-0.945	0.471	0.648	0.997	0.901	0.979	1

Table 15
Correlation coefficient among the macro-micro nutrients of *C. amnicola* (Shell) from Epe Lagoon during wet season

	Moisture	Protein	Fat	Fibre	Ash	NFE	Ca	K	Mg	Na
Moisture	1									
Protein	0.918	1								
Fat	-0.848	-0.568	1							
Fibre	-0.835	-0.549	1.000	1						
Ash	-0.999	-0.931	0.829	0.816	1					
NFE	-0.912	-0.674	0.991	0.987	0.897	1				
Ca	-0.515	-0.813	-0.017	-0.041	0.545	0.118	1			
K	-0.727	-0.940	0.252	0.229	0.750	0.381	0.963	1		
Mg	-0.518	-0.815	-0.014	-0.038	0.547	0.121	1.000	0.964	1	
Na	-0.541	-0.830	0.013	-0.010	0.570	0.148	1.000	0.971	1.000	1

CONCLUSION

The present study demonstrated that *Callinectes amnicola* is rich in macro-micronutrients and characterized by low lipid content (< 3%). It was established that the nutrient biochemical constituents in the crab species vary with season.

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