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CHEMICAL COMPOSITION AND NUTRITIVE SIGNIFICANCE OF THE LAND CRAB, *CARDISOMA ARMATUM* (DECAPODA)

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ABSTRACT

The proximate, nutritionally valuable minerals and anti-nutrient compositions were determined in land crab, *Cardisoma armatum*. Results showed that ash was the highest with a value of 42.23±0.02% while protein, moisture, fat, fibre and carbohydrate levels were 33.30±1.20%, 9.60±0.06%, 5.35±0.01%, 8.31±0.01% and 1.23±0.02% respectively. Protein solubility was lowest at pH 4 and highest at pH 7 and 12. The isoelectric points were pH 4, and 10 indicating that *C. armatum* may be useful in food formulations involving beverages and meat products. Calcium recorded the highest value of 2157.86±1.01mg/100g while manganese recorded the lowest value of 0.39±0.01mg/100g. Phosphorus recorded 360.23±0.25mg/100g, cobalt recorded 0.01±0.00mg/100g, nickel recorded 4.53±0.10mg/100g while copper recorded 57.83±0.10mg/100g. Lead (Pb) and Cr were not detected. Water absorption capacity was 125.00±0.10%, oil absorption capacity, 535.33±0.21% while foaming stability was 3±0.02%. The results of the anti-nutritional analysis revealed that oxalate recorded 4.10±0.15mg/100g while phytic acid recorded 1.10±0.10mg/100g respectively. Tannin was not detected in the sample. The values observed for oxalate and phytic acid fall within the nutritionally accepted values. *C. armatum* is a rich source of animal nutrients and it could therefore be used in human diets and animal feeds formulations.

Key words: Proximate composition, *Cardisoma armatum*, antinutrients, solubility and isoelectric points

INTRODUCTION

The order Decapoda contains the familiar crustaceans such as lobsters, prawns, cray fishes, shrimps, hermit crabs and true crabs (Yoloye 1988). This order contains organisms with ten legs hence the name Decapoda. The order consists of two sub-oders (i) Natantia, which consists of swimmers such as the shrimps and prawns. (ii) Reptantia, which consists of the crawlers such as the lobsters, hermit crabs and true crabs.

Callinectes sapidus is a true crab, which is found in the marine environment. The diagnostic feature, which differentiates it from *C. armatum* is that the last pair of its legs terminate in broad, flat paddles for swimming.

Cardisoma armatum is a true crab, which belongs to sub-order Reptantia. The true crabs are also classified as belonging to the order Brachyura: short tail animal. The order is the most successful decapods with about 4500 species (Yoloye 1988). Crab is widely distributed in the tropics and it forms an important part of the diets of the people. Crab is a good source of cheap animal protein, which is either eaten as snacks or as part of main meals by the people of southern Nigeria.

Animal protein is very vital in the diet because of the various functions it performs. Fish, Beef, beacon, and poultry products are some of the good sources of animal protein which are used for growth and repair of body tissues (Ramalingam 2001). In developing countries the high cost of these highly valued animal proteins (i.e. fish, beef, beacon and poultry) have made it impossible for the less privileged to eat them. However, lesser-valued animal such as crab may be used to cater for the protein needs of the less privileged people.

Crabs are very popular with the people of the Delta regions as well as other communities in Nigeria. However, not much is known about the nutrient potentials of the organism. This paper reports on the proximate composition, minerals analysis, functional properties and anti-nutritional factors of *C. armatum*.

MATERIALS AND METHODS

C. armatum used for the work were purchased from Artisanal fishermen in Water Works in Ado-Ekiti, Ekiti State of Nigeria. Ten crabs (whose weight ranges between 50g and 100g) were carefully washed and their heads removed. The legs and other parts of the body were dried in an electric oven, which was maintained at 40^{0}C for 48 hours in the laboratory. The dried samples were ground into powder form with the laboratory pestle and mortar and kept until required.

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MINERAL ANALYSIS

Minerals were analyzed by using the method reported by Oshodi (1992). Minerals were analyzed by dry-ashing 1g of the sample at 550^{0}C in a furnace and the ash was dissolved in 10% HCl. The solution was later filtered with Whatman filter paper and made up to standard volume (i.e. 100ml) with dionised water purchased form the Department of Chemistry Federal University of Technology, Akure. Flame photometry method reported by AOAC (1990) was used to determine sodium and potassium contents of the sample. Corning 405 flame photometer was used. Calcium, Fe, Mg, Zn, Cu, Mn, Co, Pb, Ni and Cr. were determined using Alpha 4 atomic absorption spectrophotometer (AAS). Phosphorus was analyzed for by employing the method reported by Vanado Molybate and read on CECIL CE 3041 colorimeter, AOAC (1990). All determinations were in triplicates.

PROXIMATE ANALYSIS

Proximate analysis of the sample for the moisture content, ash, ether extract and fibre content were done using the method reported by AOAC (1990). Nitrogen was determined by the micro-Kjeldahl method reported by Pearson (1976) and the crude protein was subsequently calculated by multiplying the nitrogen content by a factor of 6.25. The carbohydrate content was estimated by subtracting the sum of the weights of protein, fibre, ether extract and ash from the total dry matter and reported as nitrogen-free extractives (NFE by difference). All determinations were in triplicates.

FUNCTIONAL PROPERTIES

The modified methods of Adeyeye et al (2002) were used to determine the foaming capacity, emulsion stability and the least gelation capacity of the sample. The method reported by Beuchat (1977) was used to determine the oil absorption, water absorption and emulsion capacities, as well as the emulsion stability of the sample.

ANTI-NUTRITIONAL ANALYSIS

Oxalate content was determined according to the procedure of Day and Underwood (1986). Tannin content was determined by the qualitative method of Markkar and Goodchild (1996) as modified by Enujiugha and Ayodele-Oni (2003). The estimation of phytin-phosphorus (phytin-P) was by the colorimetric procedure of Wheeler and Ferrel (1971) as modified by Reddy et. al. (1978). Phytic acid was calculated by multiplying phytin-P by the factor of 3.55 as reported by Enujiugha and Olagundoye (2001). All determinations were in triplicates.

RESULTS AND DISCUSSION

The result of the proximate composition of *C. armatum* is shown in Table 1. The moisture content averaged 9.60±0.06% and this may be advantageous in terms of the shelf-life of the sample. Ash recorded the highest value of 42.23±0.02% while protein recorded 33.30±1.20%. The ash content is higher than the values obtained for termites, *Trinervitermes germinatus* (Ajakaiye and Bawo 1990). The ash content of a sample is a reflection of the amount of the minerals contained in the sample, thus, *C. armatum* is therefore very rich in minerals and could be particularly useful for pregnant and lactating women and children. The protein content of *C. armatum* is higher than the value reported for Bogong moths, *Agrotis infusa* (Irvine 1989) but lower than the value reported for cricket, *Acheta domesticus* (Pennino et. al. 1991).

The crude fat content was low, 5.35±0.01% and this value is lower than the values obtained for waxworms, *Galleria mellonella* (Pennino et. al. 1991). Fats are essential in the diets as they increase the palatability of foods by absorbing and retaining their flavours (Aiyesanmi and Oguntokun 1996). Fats are also vital in the structural and biological functioning of the cells and they help in the transportation of nutritionally essential fat-soluble vitamins (Martin et. al. 1981). Crude fibre averaged 8.31±0.01% while carbohydrate recorded 1.23±0.02% respectively. The amount of carbohydrate is lower than the amount observed in *Z. variegatus* (Adedire and Aiyesanmi 1999).

TABLE 1: PROXIMATE COMPOSITION OF LAND CRAB

Parameters	Percentage
Moisture content	9.60±0.06
Ash content	42.23±0.02
Protein content	33.30±1.20
Fat content	5.35±0.01
Fibre content	8.31±0.01
Cabohydrate (by diff.)	1.23±0.02

Mean ± SD of triplicate determinations

The result of the effect of pH on protein solubility is shown in Fig. 1. It is evident that the protein solubility is pH dependent with minimum and maximum solubilities at pH 4 and 12 respectively. The isoelectric points (IEP) values are 4 and 10.

The high solubility of *C. armatum* protein in alkaline media indicated that it might be useful in the formulation of food like meat products. The solubility of protein depends on hydration and the degree of hydrophobicity of the protein molecules (Sathe and Salunkhe 1981). The possession of 2

isoelectric points (IEP 4 and 10) suggests that *C. armatum* has more than one major protein constituents.

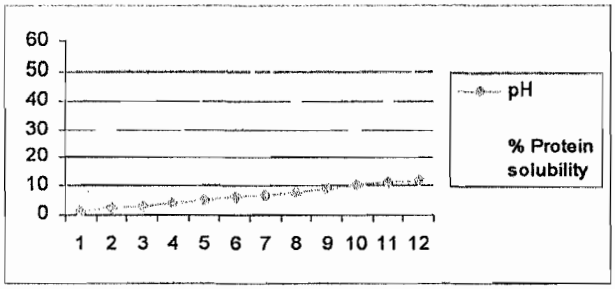

FIG 1: PROTEIN SOLUBILITY AS A FUNCTION OF PH EFFECTS ON LAND CRAB

The mineral element composition of *C. armatum* is shown in Table 2. Calcium recorded the highest value of 2157.86±1.01mg/100g. Potassium recorded 367.19±0.01mg/100g, while cobalt recorded the lowest value of 0.01±0.00mg/100g. The next abundant mineral element was ' phosphorus which recorded 360.23±0.25mg/100g). Calcium averaged 33.16±0.01mg/100g. Zinc and iron content are 15.23±0.11mg/100g and 27.95±0.10mg/100g respectively. Dunkei (1996) reported that giant cricket, *Brachytrupes membranaceus* has 9.5mg/100g of zinc while silkworm, *Bombyx mori* has 1.8mg/100g of iron respectively. *C. armatum* is very rich in iron, thus, it would be desirable for human and animal consumption. Lead and chromium were not available in *C.armatum*. The daily amounts of macro minerals recommended for adult males can be obtained by consuming *C. armatum*.

TABLE 2: MINERAL COMPOSITION OF LAND CRAB

Minerals	Amount (mg/100g)
Sodium	297.80±0.01
Potassium	367.19±0.01
Calcium	2157.86±1.01
Magnesium	51.66±0.20
Phosphorus	360.23±0.25
Zinc	15.23±0.11
Iron	27.95±0.10
Manganese	0.39±0.01
Copper	57.83±0.10
Cobalt	0.01±0.00
Nickel	4.53±0.10
Lead	ND
Chromium	ND

Mean ± SD of triplicate determinations

The result of the functional properties of *C. armatum* is shown in Table 3. The water absorption capacity was 125.00±0.10% while oil absorption capacity was 535.33±0.21%. Oil absorption capacity is important since oil acts as flavour retainer and increases the mouth feel of foods (Kinsella 1976). The emulsion capacity averaged 47.50±0.11% while emulsion stability was 45.00±0.00% respectively. These higher levels of emulsion capacity and emulsion stability suggest that *C. armatum* would be highly desirable for preparing comminuted meats. The least gelation concentrate of *C. armatum* was 8.00±0.01%. This value is lower than the value reported for fluted pumpkin seed flour, *Telfairia occidentalis* (Fagbemi and Oshodi 1991). This result will enhance the use of *C. armatum* in various food applications such as in comminuted sausage products and in new product developments where gelation may be needed to provide increased gel strength.

TABLE 3: FUNCTIONAL PROPERTIES OF LAND CRAB

Parameter	Percentage
Water absorption capacity	125.00±0.10
Oil absorption capacity	535.33±0.21
Emulsion capacity	47.50±0.11
Emulsion stability	45.00±0.00
Foaming capacity	11.00±0.10
Foaming stability	3.00±0.02
Least gelation	8.00±0.01

Mean ± SD of triplicate determinations

Foam formation and foam stability are a function of the type of protein, pH, processing methods, viscosity and surface tension (Yasumatsu et. al. 1972). The foaming capacity and foaming stability of *C. armatum* were 11.00±0.10% and 3.00±0.02% respectively. Akubor and Chukwu (1999) reported that foams are used to improve the texture, consistency and appearance of foods.

The result of the anti-nutrient composition of *C. armatum* is shown in Table 4. The oxalate content of *C. armatum* was 4.10±0.15mg/ml while its phytic acid content was 1.10±0.10mg/ml. These values are lower than what have been reported in some proteinous foods. Aiyesanmi and Oguntokun (1996) reported that the tannins and phytic acid contents of *Dioclea reflexa* seeds are 151.80±0.20mg/100g and 318.40±0.30mg/100g respectively. Vijayakumari et. al. (1997) reported that 513mg of phytic acid is present in 100g of *P. chilensis*. Tannin was not detected in *C.armatum*. The lower values of phytic acid and oxalate suggest that the nutritive value of *C. armatum*

would be impaired to a comparatively lesser extent.

From the observed proximate, mineral composition and functional properties, *C. armatum* is a rich source of nutrients and essential minerals. It is therefore advocated for consumption by economically weaker sections of population throughout the developing countries, most especially in Africa and Asia, to alleviate the problem of nutrient/protein malnutrition. Further work is geared towards ascertaining the amino acid composition of *C. armatum.*

TABLE 4. ANTI-NUTRIENT COMPOSITION OF LAND CRAB

Anti-nutrient	Amount (mg/100g)
Phytic acid	1.10±0.10
Oxalate	4.10±0.15
Tannin	Not detected

Mean ± SD of triplicate determinations

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