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Evaluation of the nutritional qualities of edible portions of two commercially important prawns in southwest Nigeria

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Abstract
Nutritional qualities of the edible portions of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii* from Oluwa Creek, Ondo State and Asejire Reservoir, Oyo State respectively were evaluated for food security potential. Thirteen and twelve smoke dried samples of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii* were respectively selected for proximate and mineral analysis. The weight of the pawns ranged from 0.93 to 2.9g (1.97±0.62) for *Macrobrachium macrobrachion* and 5 to 24g (12.42±6.62) for *Macrobrachium vollenhovenii*. Biochemical and mineral analysis were done in duplicates using standard procedures, and data obtained were statistically analyzed. The values obtained for proximate and mineral analysis of *Macrobrachium vollenhovenii* and *Macrobrachium macrobrachion* were proteins (69.58±0.02 and 72.47±0.04%), carbohydrates (11.15±0.00% and 6.07±0.07%), fats (10.93±0.06% and 12.43±0.18%), moisture (4.79±0.01 and 5.49±0.15%), ash (3.21±0.01 and 3.17±0.01%) and crude fibers (0.33±0.01 and 0.37±0.01%), respectively. Significantly higher amount of magnesium (32.82±0.00mg/l), potassium (161.31±0.03mg/l) and sodium (90.17±0.04mg/l) were obtained in samples of *Macrobrachium macrobrachion* while, *Macrobrachium vollenhovenii*, showed higher amount of calcium (351.53±0.05mg/l), manganese (0.57±0.01mg/l), iron (4.32±0.04mg/l), zinc (1.12±0.00mg/l) and copper (0.38±0.00mg/l) The caloric energy value of 426.05kg/100g determined in *Macrobrachium macrobrachion* was higher than the value of 421.29kg/100g for *Macrobrachium vollenhovenii*. Values obtained for both species were significantly different ($P<0.05$) for the proximate and mineral compositions, with the exception of ash, moisture and crude fibre. The result affirmed that these shellfishes are nutritionally valuable, and are profitable for human consumption, not only as delicacy, but also for their nutritive qualities which compare favourably with other animal protein sources.

Keywords: asejire reservoir, *Macrobrachium macrobrachion*, *Macrobrachium vollenhovenii*, nutritive qualities, oluwa creek, proximate and mineral composition

Introduction
The continued rise in human population in the developing countries necessitates the need to establish additional sources of animal protein (El-Katcha *et al.*, 2015) [18]. In Nigeria, with a population of over 170million, there is deficiency of animal protein security with the consumption put at about less than 10g/head/day as against the minimum daily intake of 65g recommended by the Food and Agricultural Organization (FAO) to be the minimum requirement for the growth and development of the body (Adamu *et al.*, 2015; El-Katcha *et al.*, 2015) [2, 18]. An additional source has been found in shellfishes one of the foods derived from aquatic environment. Shellfishes contain varying levels of high quality protein rich in all the valuable dietary essential amino acids (Udo, 2004) [41], and are superior to those in meat and poultry (Ehigiator and Oterai, 2012) [16]. Shellfish is a fisheries and culinary term for exoskeleton-bearing aquatic invertebrates used as food. They can be divided into two groups, viz: molluscs and crustaceans. Crustaceans commonly eaten are shrimps, prawns, lobsters, crayfish and crabs.

Prawn is one of the popular crustaceans widely consumed in Nigeria mostly among the middle and low income groups (Abulude *et al*., 2006) [1]. Prawns that are caught in Nigerian waters are transported and concentrated in open and organized markets, where they are sold as cheap and affordable delicacies eaten either whole (shell with flesh) after drying or are processed flesh only (Udo, 2004) [41]. Its neutral flavour makes it a natural additive in food, such as salads, pastas, curry, soups, stew, stir-fried dishes, and are traditionally used as condiment. Apart from being a delicacy, they are valuable in the diet for supply of good quality proteins and vitamins, and are good source of dietary minerals such as calcium, phosphorus, iron, magnesium etc. which are beneficial to man and animals (Abulude *et al*., 2006) [1]. Freshwater prawns of the genus *Macrobrachium* are decapods crustaceans in the family Palaemonidae; this family, together with the family peneidae (marine shrimps), has been globally acknowledged for recruitment into aquaculture (New, 2002) [30]. They are usually found in lakes, rivers, swamps, irrigation ditches, canals, ponds, and estuarine areas (New, 2002) [30]. Out of the 200 species that make up the genus; only four have been reported in Nigeria, and the two largest species of them, *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii*, are commercially important shrimps/prawns which are extensively exploited in Nigeria (Hu *et al* 2002; Willet, 2007) [44].

Due to their economic importance, previous studies on these two species have been on the aspects of the abundance, meristic and morphological characterization, biology, food and feeding habits, and proximate and mineral composition of these Palaemonid prawns (Deekae and Abowei, 2010; Ehigiator and Nwangwu, 2011; Adebola and Olaniyan, 2012; Lawal-Are and Owolabi, 2012; Jimoh *et al*., 2012; Adite *et al*., 2013; Idung *et al*., 2013; Udo and Opeh, 2013; Olawusi-Peters and Ajibare, 2014; Arazu and Udo, 2015; Udo, 2015) [11, 3, 26, 25, 24, 15, 32, 43, 42].

The knowledge of the biochemical composition of any edible organism is extremely important since the nutritive value is reflected in biochemical contents, such as protein, amino acids, lipids, fatty acids, carbohydrates, vitamins and minerals (Nagabhushanam and Mane 1978) [29]. Studies on the biochemical composition have focused on species from the Southern and Eastern parts of the country; there is dearth of information on these species from Southwestern part, except the relatively few from Lagos Lagoon, hence, this study was conducted to provide information on the nutrient composition of the two Caridean prawns from other Southwestern parts of the country, Ondo and Oyo States.

Methodology

Sample Origin

Oluwa Creek in Igbokoda, lies in Latitude 6.2833°, and longitude 4.8167°. This area falls within the oil prospecting zone in Nigeria called Oluwa region. The river is in Ilaje Local Government Area, which is at the extreme southern part of Ondo State. It shares boundaries with Okitipupa Local Government Area in the North; the Atlantic Ocean in the South; Ijebu Waterside Local Government Area (Ogun State) in the West and Delta State in the East. This brackish water course is bounded by thick vegetation with low occurrence of rhizoid plants and a higher profile of salt marshes and surface macrophytes that extend into the tributaries and mark the breeding grounds for the prawns. Asejire reservoir lies between longitudes 4^{E} and $4^{0}07^{E}$ and latitudes 7^{0N} and $7^{0}21^{N}$. The reservoir took its source from Osun River and flows through Oluwo and Alaye-ala down to Asejire. Asejire reservoir is in Egbeda Local Government Area of Oyo State, Southwestern Nigeria. The reservoir supplies water to Ibadan in Oyo State and some towns and villages in Osun for domestic uses. The reservoir is bi-focated with two unequal arms surrounded by large mass of land. The left longer arm is fed by Rivers Oba and Osun while the right arm is supplied by River Agboiro. The catchment area of the reservoir is $78km^2$ and the impounded area is 2,342 hectares. The reservoir has a normal pool elevation (water level) of 150m and maximum flood elevation of 152.4m. The reservoir has an approximate gross storage of 7,403 million litres.

Collection of Samples

Thirteen and 12 prawn samples (*M. macrobrachion* and *M. vollenhovenii*) with weight ranging from 0.93 to 2.9g and 5 to 24g respectively were procured from prawn mongers at the landing sites at Oluwa Creek, Igbokoda, Ondo State and Asejire Reservoir, Oyo State. The prawn samples were transported to the laboratory of the Department of Animal and Environmental Biology, Adekunle Ajasin University, Akungba-Akoko, for further analysis.

Sample Identification and Preparation

Samples were identified from taxa to species level using taxonomic keys from the Food and Agricultural Organization Identification sheets (FAO, 1981) [19] and Powell, (1982) [36]. The meristic and morphometric features such as colouration, shape of rostrum, and the number of spines on the rostrum of each species were used for the identification. The samples were further smoke-dried to constant weight and were separated into waste (head with carapace, all the limbs with the pleopods, exoskeleton (body sheath on the abdomen) and flesh. The prawn's flesh, whole body and exoskeleton were weighed with a digital weighing balance "Scout *Pro*" to the nearest .01gram. The prawn's flesh was ground into fine powder using a "MOERGOLD MGB—242" electric blender, packed in a hermetic nylon material with labels, and stored in the desiccator for biochemical analysis.

Proximate and Mineral Analysis

The proximate components of the samples were determined using methods described by Association of Official Analytical Chemist (AOAC), (2005). Moisture was determined by drying of samples for 24hrs at 105^{0}C, ash was determined from the residue left after incineration of a weighed portion of the sample at 550°C using a muffle furnace, Carbohydrate content of the samples was determined as difference from the total percentage (100%). Protein was determined by method described by Lowry *et al*. (1951), Fat was measured using method of Bligh and Dryer (1959), crude fibre was estimated by boiling the sample with 1.25% (w/v) sulphuric acid and then with 1.25% (w/v) sodium hydroxide and incinerating the residue at 550°C; the loss in weight represented the crude fibre content of the sample (Pearson, 1999) [35], Energy value of the prawns was calculated according to Palani *et al*. (2014) [34], using the crude values of protein, fat, and carbohydrate as obtained from the proximate analysis. Energy value kg/100g= P x 4.00 (protein) + C x 4.00 (carbohydrate) kcal/100g + F x 9.00 (fat) kcal/100g. Mineral components- Calcium, Magnesium, Potassium, Sodium, Manganese, Iron, Copper, and Zinc of the samples were determined by Atomic Absorption Spectrophotometric method at appropriate wavelengths. All analyses were done in duplicate, and all determinations were done on dry weight (matter) basis.

Statistical Analysis

The statistical interpretation of the data was performed using Statistical Package for Social Sciences (SPSS version 21.0) for the mean and standard deviation. Independent sample t-test at a confidence level of 95% was used to compare data to determine the significant differences between the values obtained from both species.

Results

Morphometric

The average weight composition of the prawn samples are presented in Table 1. For *M. vollenhovenii*, weight varied from 5 to 24g; 1 to 9g and 3g to 14g, respectively for the whole body, flesh and waste; whereas, weights obtained for the whole body, edible portion (flesh), and waste for *M.*

macrobrachion ranged from 0.93 to 2.9g; 0.29 to 0.88g, and 0.63 to 2.02g respectively.

Table 1: The Average Weight Composition of the Palaemonid Prawns (Mean ±SD)

Species	Whole prawn (g)	Edible portion (Flesh) (g)	Waste (g)
M. macrobrachion (n=13)	1.97±0.62	0.65±0.19	1.31±0.47
M. vollenhovenii (n=12)	12.42±6.62	4.35±2.52	7.92±4.18

Proximate

The proximate compositions (g $100g^{-1}$) of the prawn samples are shown in Table 2. Mean crude protein values of (69.58±0.02 and 72.47±0.042) were found to be the highest; and the least proximate values were obtained for crude fibre (0.33±0.01 and 0.37±0.01) in *M. vollenhovenii* and *M. macrobrachion* respectively. Values obtained for protein (72.47±0.042) and fat (12.43±0.18) were significantly higher in *M. macrobrachion* than in its freshwater counterpart. *M. vollenhovenii* had higher carbohydrate (11.15±0.00) and ash content (3.21±0.01), and lower moisture (4.79±0.01) and crude fibre (0.33±0.01) components than *M. macrobrachion.* However, statistically, there was no significant difference (P>0.05) in the moisture, ash and crude fibre values, as observed to have existed in other proximate parameters for both *Macrobrachium* species.

Table 2: Proximate Composition of Prawn Samples (g 100g-1)

Parameter %	*Macrobrachium macrobrachion*	*Macrobrachium vollenhovenii*
Protein	72.47 ± 0.04	69.58 ± 0.02
Moisture	5.49 ± 0.15	4.79 ± 0.01
Fat	12.43 ± 0.18	10.93 ± 0.06
Ash	3.17 ± 0.01	3.21 ± 0.01
Crude fibre	0.37 ± 0.01	0.33 ± 0.01
Carbohydrate	6.07 ± 0.07	11.15 ± 0.00
Dry Matter	94.51 ± 0.15	95.21± 0.01
Means ± SD are values of duplicate determination		

Mineral Composition

In Table 3 are some macro and micro mineral components (mg/l) contained in the prawn samples. For macro minerals, the result showed that calcium had the highest mean values of (351.53±0.05 and 179.67±0.176mg/l), with magnesium recording the least values of (22.75±0.00 and 32.82±0.002mg/l) in *M. vollenhovenii* and *M. macrobrachion* respectively. Iron showed the highest values (4.32±0.04 and 3.02±0.035mg/l), and the values obtained for copper (0.38±0.00 and 0.24±0.001mg/l) were respectively the least for micro minerals. *M. vollenhovenii* showed statistically higher amount of micro minerals: Mn (0.57±0.01), Fe (4.32±0.04), Cu (0.38±0.00), and Zn (1.12±0.00); conversely, with the exception of calcium, significantly higher macro minerals values for Mg (32.82±0.00), K (161.31±0.03), and Na (90.17±0.04) were obtained for *M. macrobrachion.*

Table 3: Mineral Contents of Prawn Samples

Minerals (mg/l)	*Macrobrachium macrobrachion*	*Macrobrachiun vollenhovenii*
Calcium	$179.67±0.17^b$	$351.53±0.05^a$
Magnesium	$32.82±0.00^a$	$22.75±0.00^b$
Potassium	$161.31±0.03^a$	$117.60±0.02^b$
Sodium	$90.17±0.04^a$	$55.68±0.01^b$
Manganese	$0.37±0.00^b$	$0.57±0.01^a$
Iron	$3.02±0.03^b$	$4.32±0.04_a$
Copper	$0.24±0.00^b$	$0.38±0.00^a$
Zinc	$0.93±0.02^b$	$1.12±0.00^a$

Means ± SD are values of duplicate determination

Discussion

The protein content obtained in M. vollenhovenii and M. macrobrachion were high in relation to other biochemical compositions, corroborating assertions by Yanar and Celik, (2005) [45] that shrimp meat is an excellent source of protein, Dayal *et al*., (2013) [10] that nearly 80% of the portion (dry matter) of prawns comprises of protein, and Dinakaran *et al*., (2009) [13] which stated that protein is the most prominent biochemical component of crustaceans. However, protein content of M. vollenhovenii (69.58%) was significantly lower compared to (72.47%) obtained for M. macrobrachion, (p<0.05). The protein content of both species compares favourably with Ehigiator and Oterai (2012) [16] for M. vollenhovenii (71.37%), and Reddy and Reddy (2014) [37] for cultured M. rosenbergii (72.24%), but is higher than Udo (2015) [42] for M. vollenhovenii (22.63%) and M. macrobrachion (20.30%), Ehigiator and Nwangwu (2011) [15] for edible portion of M. vollenhovenii (53.85%) and M. macrobrachion (58.92%), Arazu and Udo (2015) [42] for dried M. macrobrachion (27.68%), Dinakaran *et al*., (2009) [13] for M. idae (57.32%), Fasakin *et al*. (2000) [20] for M. vollenhovenii, (16.99%), M. rosenbergii (17.30%), Omomo *et al*., (2014) [33] for Chokor smoke-dried (55.88%), and for the Altona smoke-dried (58.87%) M. vollenhovenii, and Asaikkutti *et al*., (2016) for edible portion of wild M. rosenbergii (52.74%). Protein is essential for normal function, growth and maintenance of body tissues. Its content is considered to be an important tool for the evaluation of physiological standards (Diana, 1982) [12].

Dayal *et al*., (2013) [10] had reported that three-fourth of the edible portion of shrimp is water. The content of moisture obtained in the flesh of M. macrobrachion (5.49 %) was higher than M. vollenhovenii (4.79 %), but were not significantly different from each other (p>0.05). These are however, low in comparison with Reddy *et al*., (2013) [38] for average moisture content of 10 female and male M. rosenbergii (74.89% and 74.98%), Ekpenyong *et al*., (2013) [17] for flesh of M. macrobrachion (58.40%) done on wet

weight basis, Ehigiator and Oterai (2012) [16] for flesh of M. Vollenhovenii (10.71%), Ehigiator and Nwangwu (2011) [15] for edible portion of M. Vollenhovenii 5.87±0.67%, Ehigiator and Akise (2013) [14] for M. Vollenhovenii (8.39%), Udo (2015) [42] for M. vollenhovenii and M. macrobrachion (10.23% and 11.76%), Arazu and Udo (2015) [42] for fresh and dried samples of M. macrobrachion respectively (66.01% and 21.79%). The low content of moisture may be due to smoke-drying method, since drying reduces the moisture content level of any sample. The low moisture content of the prawns is advantageous especially in a country like Nigeria where high humidity prevails, thus the low moisture will reduce microbial activity and ultimately enhance the shelf life of the prawn during storage which will increase the availability of the prawn during off-season.

Carbohydrate contents (6.07 ± 0.07 and 11.15 ± 0.00) determined for the species in this study deviates from findings of Udo (2015) [6] for the flesh of M. vollenhovenii (49.00%) and M. macrobrachion (48.20%) from culture system, Arazu and Udo (2015) [6] for fresh (8.20%) and dried (21.79%) samples of M. macrobrachion, and Annamalai *et al*., (2016) [4] for edible portion of wild M. rosenbergii (31.45%) but compares favourably with Ehigiator and Nwangwu, (2011) [15] for flesh of M. vollenhovenii (9.48%) and M. macrobrachion (8.41%), and Reddy and Reddy (2014) [37] for cultured M. rosenbergii (5.50%). The low carbohydrate content recorded in this study agrees with Okuzumi and Fujii (2000) which stated that carbohydrates constitutes only a minor percentage of total biochemical composition, and are considered to be the first among the organic nutrients to be utilized to generate required energy (Heath, 1987). The low carbohydrates content of the prawns makes them choice diet components for weight control and possibly diabetics

The fat contents contained in the prawn samples was similar to Udo (2015) [6] for M. vollenhovenii (15.333%) and M. macrobrachion (16.10%) from artificial culture system, Ehigiator and Nwangwu, (2011) [15] for the edible portion of M. vollenhovenii (15.67%), and M. macrobrachion (10.67%), and Fasakin *et al*. (2000) [20] for M. macrobrachion (17.97%), but are in contrary with Reddy *et al*., (2013) [38], Ehigiator and Akise (2013) [14], Ekpenyong *et al*., (2013) [17], and Bello-Olusoji *et al*., (2006), that recorded lower values for M. rosenbergii (3.98%), M. vollenhovenii (4.36%), M. macrobrachion (7.70%) and M. vollenhovenii (7.62%) respectively. The low fat content is seen as one of the advantages of eating shrimps, as no other meaty food can claim such a low lipid level as fresh shrimp Dayal *et al*. (2013) [10] coupled with this is the enhancement of keeping quality as low fat foods do not become rancid easily during storage (Deekae and Idoniboye, 2005).

The ash content of any sample is a measure of the likely mineral content of such a sample. The ash contents, (3.17% and 3.21%) contained in M. macrobrachion and M. vollenhovenii are respectively within the range of (2.30% and 3.20%) reported for M. vollenhovenii and M. macrobrachion from artificial culture system, by (Udo 2015) [42], but lower than 20.00% recorded by Ehigiator and Nwangwu (2011) [15] for the edible portion of M. vollenhovenii, Omomo *et al*., (2014) [33] for Chokor smoke-dried (19.76%), and Altona smoke-dried (15.88%) M. vollenhovenii, Reddy and Reddy (2014) [37] for cultured M. rosenbergii (9.71%). This difference as reported by Rosa and Nunes (2003) may be as a result of size. The not significantly different ($p>0.05$) crude fibre obtained for M. vollenhovenii (0.33%) and M. macrobrachion (0.37%) were lower than what was recorded for M. macrobrachion (1%) and M. vollenhovenii (1%) by Ehigiator and Nwangwu (2011) [15], Omomo *et al*., (2014) [33] for Chokor and Altona smoke dried M. vollenhovenii (21.12% and 13.11%) respectively, but similar to Ekpenyong *et al*., (2013) [17] for M. macrobrachion (0.03%) and Ehigiator and Oterai (2012) [16] for edible portion of M. vollenhovenii (0.45%). The fiber in prawns has a nutritional advantage in that it will assist in reducing constipation and other attendant problems in human consumer (Bhavan *et al*. 2010) [8].

Minerals make up the micronutrients that are necessary for physiological and biochemical processes by which the human body takes in and utilizes food to maintain health and activity (Mohapatra *et al*., 2009). The calcium content recorded for M. vollenhovenii (351.53mg/l) was significantly higher than that of M. macrobrachion (171.67mg/l). However, both species' calcium contents were lower than (Abulude, *et al., (*2006) [1], Ekpenyong *et al.*, (2013) [17] and Arazu and Udo (2015) [6]. Nonetheless, the value obtained for *M. vollenhovenii* was higher than Arazu and Udo (2015) [6] for fresh (33.0mg/100g) and dried (28.8mg/100g) samples of *M. macrobrachion*, Omomo *et al*., (2014) [33] for Chokor smoke-dried (5.66%), and Altona smoke-dried (4.20%) *M. vollenhovenii*, and Ehigiator and Akise (2013) [14] for *M. vollenhovenii* (8.86mg/100g).

Macro minerals: potassium, sodium, and magnesium obtained in *M. macrobrachion* were higher, statistically than what was contained in its freshwater counterpart. These are found to be lower than Abulude *et al.,* (2006) [1] for *M. vollenhovenii* (176mg/100g), (165mg/100g), and (330mg/100g) respectively. They are however, higher than Ehigiator and Akise (2013) [14] for *M. vollenhovenii* (11.94mg/100g and 15.17mg/100g) respectively and Ehigiator and Oterai (2012) [16] for *M. vollenhovenii.* Significantly higher micro minerals: Mn (0.57mg/l), Fe (4.32mg/l), Cu (0.38mg/l) and Zn (1.12mg/l) were obtained for *M. vollenhovenii*, when compared with values obtained for *M. machrobrachion* however, the values are still lower than Ehigiator and Akise (2013) [14] that recorded Mn (4.33mg/100g), Fe (40.44mg/100g), Cu (2.22mg/100g), and Zn (11.93mg/100g) for flesh of *M. vollenhovenii*. Notwithstanding, the prawn samples contained considerable amount of essential minerals, and its consumption will help, among their numerous functions, regulate fluid balance (Sandstead, 1997), enzyme production, blood clotting (Abulude *et al*., 2006) [1], metabolism of carbohydrates to produce energy (Hambidge, 2000), maintain blood pressure, transportation of oxygen, normal function of muscles, nerves, bones and promote good health.

Conclusion

From nutritional perspective, these prawns' flesh are excellent sources of high quality protein which is superior to those in meat and poultry; other varying inherent and essential nutrients can also compete favourably with those in meat from other animal sources. They also contain considerable amount

of macro and micro minerals. The result further showed *Macrobrachium macrobrachion* to be richer in protein, fat, and some macro minerals than *Macrobrachium vollenhovenii*. Conclusively, consumption of the prawns, apart from being a delicacy, could also enhance food security because of their nutritional value.

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