PROXIMATE COMPOSITION, AMINO ACID AND FATTY ACID PROFILE OF AFRICAN RIVER PRAWN, *Macrobrachium vollenhovenii* (HERKLOTS, 1857) FROM ZURU RESERVOIR OF KEBBI STATE NIGERIA

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Abstract

Proximate composition, amino acid and fatty acid profile of *M. vollenhovenii* (Herklots, 1857) from Zuru reservoir were investigated. Prawn samples were collected from the artisanal catches of fisherfolks for amino acid and fatty acid profile analysis once between February and May, 2021 and 2022, and were subjected to multivariate analysis to determine the level of significant difference at 0.01 and 0.05 in different sexes and stages using R-Software version 1.1.648 and Statistical Package for Social Sciences version 16. There was significant difference ($P<0.05$) in the proximate composition among the stages and sexes of *M. vollenhovenii;* Post-larvae had highest (63.28±0.74g/100g) Crude Protein, Females had highest (10.81±0.01g/100g) Crude Fats, Males had highest (11.95±0.01g/100g) Crude Fibre, Males had highest (17.27±0.10 g/100g) Ash content during the study. The study identified 18 amino acids which include: Arginine, Asparagine, Alanine, Cystine, Glutamine, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, Cysteine and Valine in *M. vollenhovenii* from the study area. The study also identified eighteen (18) fatty acids which ranged from 3C to 27C carbon chain during the study: Oleic acid and Linoleic acid were found in both sexes and stages of *M. vollenhovenii*. Therefore, *M. vollenhovenii* contain high nutritional values in Nigeria. Hence, it should be explored due to its nutritive values.

Keywords: Amino acids, Artisanal fishery, *Macrobrachium vollenhovenii*, Post-larvae, Proximate, Zuru reservoir

Introduction

African river prawn, *M. vollenhovenii* contains potent source of nutrients required for the maintenance of growth of human body (Asiru and Fafioye, 2018). The proximate composition of the prawns, crustaceans and other aquatic organisms has found to be varied due to seasonal factors, climatic factors, geographic factors, habitat, developmental stage, sex, and sexual factors (Nwosu and Wolfi, 2006). Also, its biochemical composition may be affected by several factors as the species, environmental factors, size, age, natural diet and feed composition (Jike-Wai and Deekae, 2011). African river prawn, *M. vollenhovenii* contains proteins with 20 different amino acids including essential and non-essential amino acids of nutritional importance. Shellfishes contain varying levels of high quality protein rich in all the valuable dietary essential amino acids (Jimoh *et al.,* 2019). Amino acids are mainly obtained from proteins in diet therefore a sufficient quantity of dietary protein is required for growth, survival, development, reproduction and maintaining good health throughout life (Abdel-Salam, 2014).

African river prawn, *M. vollenhovenii* contains high levels of fatty acids which include oleic acids, linoleic acids, omega-3 fatty acids, cholesterol, and carotenoid (Jimoh *et al.,* 2019) which reduces hypertension, asthma, immune system disorders, susceptibility to mental illness, protection against heart disease, and improved brain and eye functions (Yerlikaya *et al.,* 2013). However, quantities of these constituents vary considerably within and between species, size, sexual condition, feeding season and physical activity (Tsape *et al.,* 2010). Polyunsaturated Fatty Acids (PUFAs) in *M. vollenhovenii* are essential dietary components. Consumption of *M. vollenhovenii* allows PUFA to result in lowering cholesterol in combination with a reduced saturated fatty acid intake (Tsape *et al.,* 2010). In the study, here are sparse in the studies on proximate composition, amino acids and fatty acids of the African River prawn, *M. vollenhovenii.* African River prawn, *M. vollenhovenii* could contain high amount of proteins and lipids, it has unique taste with high demands in national and international markets. Hence, this study aimed at determining the proximate composition, amino acids and fatty acids of *M. vollenhovenii* sampled from Zuru Reservoir of Kebbi State Nigeria.

Materials and Methods

Zuru is located in the Southeastern region of Kebbi State of Nigeria with a total land mass of 653km². It lies between latitude 10.8°4′0″N to 11.8°4′0″N and longitude 4.4°5′0″E to 6.0°0′E. Zuru is bounded in the west by Gwandu and Yauri while in the east it shares boarder with Kuyanbana. Zuru has a population of about 165,547 (National Population Commission (NPC), 2006). Zuru reservoir was constructed in 1978 for the purpose of irrigation and water supply with water capacity of 5.8 million m^3 (Surface area 2.25ha) at 11.4°1′6″N and 5.2°8′2″E coordinates across Girmache River.

African river prawn, *M. vollenhovenii* samples were collected from the artisanal catches of fisherfolks for amino acid and fatty acid profile analysis once between February and May, 2021 and 2022, and were subjected to multivariate analysis to determine the level of significant difference at 0.01 and 0.05 in different sexes and stages using R-Software version 1.1.648 and Statistical Package for Social Sciences version 16. The African river prawn, *M. vollenhovenii* samples were freeze dried to constant weight at - 75ºC (cold–air sterilizer GRX-9023A) for about 72 hours and samples were ground to fine powder, about 20g, for analysis. Thereafter, the powdered samples of the *M. vollenhovenii* were sealed in plastic bottles and properly labelled for

proximate analysis at National Research Institute for Chemical Technology, Zaria, Kaduna State, Nigeria for further nutritional analysis. Thereafter, the powdered samples of the *M. vollenhovenii* were transported in sealed plastic bottles properly labelled to Multi-user Laboratory of Chemistry Department, ABU Zaria for amino acid and fatty acid analysis.

Determination of moisture content:

The method described by AOAC (2010) was adopted. A clean crucible was dried to constant weight in an air oven at 105°C, cooled in a desiccator and weighed (W_1). Two grams of sample were accurately weighed into the previously labeled crucible and reweighed (W_2). The crucible was dried in oven to a constant weight (W_3). The percentage moisture content was calculated thus:

$$\% \text{ Moisture content} = \frac{W2-W3}{W2-W1} \times 100$$

Determination of ash content

Ash content was determined according to AOAC (2010) method where porcelain crucible was dried in an oven at 100°C for 10 minutes, cooled in a desiccator and weighed (W_1). Two grams of the sample was placed into the previously weighed porcelain crucible and weighed (W_2). The sample was first ignited and transferred into a furnace, which was then set at 550°C. The sample was left in the furnace for eight hours to ensure proper ashing. The crucible containing the ash was then removed, cooled in the desiccator and weighed W_3. The percentage ash content was calculated as:

$$\% \text{ Ash content} = \frac{W3-W1}{W2-W1} \times 100$$

Determination of crude lipid content

The lipid content was determined according to the method described by AOAC (2010). A clean, dried 500ml round bottom flask, containing few anti-bumping granules was weighed (W_1) and 300ml of Petroleum ether (40-60 °C) for extraction was poured into the flask fitted with soxhlet extraction unit. The extractor thimble containing twenty grams of the sample was fixed into the soxhlet extraction unit. The round bottom flask and a condenser were connected to the soxhlet extractor and cold water circulation was put on.

The heating mantle was switched on and the heating rate was adjusted until the solvent was refluxing at a steady rate. Extraction was carried out for six hours. The solvent was recovered and the oil was dried in the oven at 70 °C for one hour. The round bottom flask containing the oil was cooled in the desiccator and then weighed W_2. The lipid content was calculated thus

$$\% \text{ Crude Lipid Content} = \frac{W2-W1}{\text{Weight of sample}} \times 100$$

Determination of crude fibre content

The method described by AOAC (2010) was used. Two grams of sample was weighed out into a round bottom flask. 100ml of 0.25M Sulphuric acid Solution was added and the mixture boiled under reflux for 30mins. The hot solution was quickly filtered under suction. The insoluble matter was washed several times with hot water until it was acid free. It was quantitatively transferred into the flask and 100ml of hot 0.31M Sodium hydroxide solution was added and the mixture boiled again under reflux for 30 minutes and quickly filtered under suction. The insoluble residue was washed with boiling water until it was based free. It was dried to constant weight in the oven at 100 °C, cooled in a desiccator and weighed (C_1) was then incinerated in a muffle furnace at 550 °C for 2 hours, cooled in the desiccator and reweighed (C_2).

Calculated thus:

$$\text{The loss of weight on incineration} = \frac{C1 - C2}{\text{Weight of original sample}} \times 100$$

Determination of nitrogen and crude protein

Protein Digestion

The method of AOAC (2010) was used. Exactly 1.5g of the defatted sample in an ashless filter paper was dropped into 300ml Kjeldahl flask. Twenty five milliliters of H_2SO_4 and 3g of digesting mixed catalyst (weighed separately into an ashless filter paper) was dropped into the Kjeldahl flask. The flask was then transferred to the Kjeldahl digestion apparatus. The sample was digested until a clear green colour was obtained. The digest was cooled and diluted to 100ml with distilled water.

Distillation of the Digest

20ml of the diluted digest was measured into a 500ml Kjeldahl flask containing anti-bumping chips and 40ml of 40% NaOH was slowly added by the side of the flask. A 250ml conical flask containing a mixture of 50ml of 2% Boric acid and 4 drops of mixed indicator was used to trap the ammonia liberated.

The conical flask and the Kjeldahl flask were then placed on the Kjedahl distillation apparatus, with the tubes inserted into the conical flask and the Kjedahl flask. The flask was heated to distill out NH_3 evolved. The distillate was collected into the boric acid solution. From the point when the boric acid turned green, 10 minutes were allowed for complete distillation of the ammonia present in the digest. The distillate was the titrated with 0.1M HCl.

Calculated thus:

$$\% \text{ N} = \frac{14 \text{ x M x Vt x Tv}}{\text{Weight of sample (g) } x \text{ Va}} \times 100$$

% Crude protein = % Nitrogen (N_2) x 6.25

Determination of carbohydrate (nitrogen free extract)

Nitrogen Free Extract (total carbohydrate content) was determined by difference according to AOAC (2010). The sum of the percentage moisture, ash, crude lipid, crude protein and crude fibre was subtracted from 100.

Calculated thus:

% Total Carbohydrate

= 100 – (% Moiture + % Ash + % Fat + % Protein + % Fibre)

Determination of energy value or calorific value

The energy value was calculated using the factors reported by AOAC (2010). The value of protein content was multiplied by 4, that of Lipid by 9 and that of Total Carbohydrate by 4. The sum of these values was expressed in Kcal/100g sample.

Determination of Amino Acid and Fatty Acid Profile of African River Prawn, Macrobrachium vollenhovenii

Analysis and Extraction of Amino Acids Extraction and instrumentation were carried out following the modified Association of Official Analytical Chemists method (AOAC, 2010). The dried and pulverized sample was made to be free of water by ensuring constant weight for a period of time in the laboratory. The sample of 0.5g was weighed into 250ml conical flask capacity. The sample was defatted by extracting the fat content of the sample with 30ml of the petroleum spirit three times with Soxhlet extractor that was equipped with thimble. Then the sample was hydrolyzed three times for complete hydrolysis to be achieved for the totality of amino acids recovery. The pulverized and defatted sample was soaked with 30ml 1M potassium hydroxide solution and was incubated for 48hours at 110^{o}C in hermetically closed borosilicate glass container. After the alkaline hydrolysis, the hydrolysate was neutralized to get pH in the range of 2.5 - 5.0. The solution was purified by cation-exchange solid phase extraction. The amino acids in purified solution were derivatised with ethylchloroformate by the established mechanism. Amino acid profile analysis was carried out at the Multi-user Laboratory of Chemistry Department, ABU Zaria according to the methods described by AOAC (2010).

$$\text{Actual concentration (mg/100g)} = \frac{\text{digested concentration (mg/L) x Volume digested (L)}}{\text{Weight of dried original sample digested (g)}}$$

Fatty acid profile analysis was conducted a using GC-MS Machine according to Jimoh *et al.* (2019).

Results and Discussion

The results in Table 1 showed the proximate composition among the stages and sexes of *M. vollenhovenii* from the study area. There was significant difference (P<0.05) in the mean Moisture among the stages of *M. vollenhovenii*; males had the highest value (11.29±0.25g/100g) while Post-larvae had lowest mean value (9.51±0.05g/100g) during the study. The results on Crude Protein (CP) showed that Post-larvae had highest mean value (63.28±0.74g/100g) while Adults had the lowest mean value (40.11±0.73g/100g) among the stages of *M. vollenhovenii* during the study. There was statistical difference (P<0.05) in the mean Crude Fats among the stages of *M. vollenhovenii;* Females had the highest mean value (10.81±0.01g/100g) while Post-larvae had lowest mean value (4.84±0.13g/100g) during the study. There was significant difference (P<0.05) in the mean Crude Fibre (CF) among the stages of *M. vollenhovenii*; Males had the highest mean value (11.95±0.01g/100g) while Post-larvae had lowest mean value (5.35±0.06g/100g) of CF during the study. The results on Ash content showed that Post-larvae had lowest mean value (6.98±0.01g/100g) while Males had the highest mean value (17.27±0.10 g/100g) among the stages of *M. vollenhovenii* during the study. There was statistical difference (P<0.05) in the mean Nitrogen Free Extract (NFE) among the stages of *M. vollenhovenii;* Males had the highest mean value (13.63±0.56g/100g) while Post-larvae had lowest mean value (10.04±0.01g/100g) during the study. There was significant difference (P<0.05) in the mean Caloric value among the stages of *M. vollenhovenii*; Males had the highest (324.61±11.94Kcal/100g) while Post-larvae had lowest mean value (278.26±0.02Kcal/100g) during the study. The results on proximate composition of *M. vollenhovenii* were in line with the findings of Asiru and Fafioye (2018) who reported proximate compositions of giant African River prawn *Macrobrachium vollenhovenii*; Protein (45.85g/100g), Ash (13.70 g/100g), Fat (12.40 g/100g), Crude fibre (0.01 g/100g) and moisture contents (92.27 g/100g) in dried samples in River Osun, Nigeria at two landing sites Atan, while in Asejire Lake they reported proximate compositions as; Protein (46.55 g/100g), Ash (15.01 g/100g), Fat (11.20 g/100g), Crude fibre (0.01 g/100g) and moisture contents (92.59 g/100g) in dried samples, respectively. The results obtained were in line with the findings of Arazu and Udo (2012) who recorded protein content (45.69-46.55 g/100g) of *M. vollenhovenii* in Onisha Nigeria; Fasakin *et al.* (2000) for oven dried *M. Vollenhovenii* 49.61±0.27%, Ehigiator and Nwangwu (2011) for *M. Macrobrachion* 58.92±4.49% (edible portion) in Ovia River, Edo State Nigeria. However, it was lower than the values obtained by Devanathan *et al*. (2011) who reported 74.24 g/100g in *Microbrachium rosembergii* in Malaysia, and Ehigiator and Nwangwu (2011) who reported 53.38 g/100g level of the whole prawn and 53.85 g/100g edible portion in Ovia River, Edo State Nigeria but slightly lower than reports of Ehigiator and Oterai (2012) who reported 68.77-71.37 g/100g in Benin River Edo State Nigeria, and Bassey *et al*. (2011) who reported crude protein of 65.4-83.3 g/100g in South-South Nigeria, Ehigiator and Nwagwu (2011) reported crude protein of 67.68-68.46 g/100g for *Pomecia palludosa* (Gastropods) in Ovia River, Edo State Nigeria. However, the result in this study was higher than that crude protein reported for *Caridina africana* 18.98 g/100g by Bello-Olusoji and Oke (2005), for *M. vollenhovenii*, (16.99 g/100g) *M. Macrobrachion* (17.30 g/100g) *Penaeus notialis* (20.57 g/100g) and *Bachrus niger* (18.52 g/100g) by Arazu and Udo (2012). The high protein content in *M. vollenhovenii* can be attributed to its omnivorous feeding habit (Bello-Olusoji *et al.*, 2006) and also may be due to stress conditions caused by toxicity of heavy metals on protein metabolism or due to enhanced proteolytic activity as a consequence of increased metabolic demands following exposure to toxic pollutants in the freshwater environment. It might also be attributed to the nature of food available at a particular time (Ekpenyong *et al*., 2013). High protein content may be valuable for food formulation as protein replacement for other expensive animal protein source in feed production (Ehigiator and Nwangwu, 2011). The result of the mean ash content recorded from the study is lower than the earlier reports of Ehigiator and Nwangwu (2011) who reported 25.33 g/100g from *M. vollenhovenii* and 22.67 g/100g obtained from *M. macrobrahion* in the Southeastern Nigeria. However, it was higher than the findings of Bassey *et al*. (2011) who reported 10.50 g/100g in *Ergeria radiata*, a clam and higher than that

reported by Bello-Olusoji *et al.* (2006) of 1.34 g/100g for *M. macrobrahion* in the Southwestern Nigeria. High level of ash has been observed in the exoskeleton of prawns especially the males in Zuru Reservoir. The high ash values of the *M. vollenhovenii* are not surprising as crustaceans have shells and these shells have been shown to contain more Ash than any other type of fish (Asiru and Fafioye, 2018). The high ash content was of significance in measuring the mineral content of the species as the amount of ash showed the richness of the food in terms of elemental composition in crustaceans (Jike-Wai and Deekae, 2011). The mean fat was higher compared to reports of Ehigiator and Oterai (2012) of 6.87-7.68 g/100g from *M. vollenhovenii* and Bassey *et al*. (2011) for *Pomecia palludosa*, a gastropod and *Ergeria radiata*, a clam which ranged from 6.03-7.60 g/100g and that recorded by Devanathan *et al*. (2011) which ranged from 6.2-7.6 g/100g. Fats are sources of energy and contain twice the energy of carbohydrates and proteins (Asiru and Fafioye, 2018). Fats along with proteins act as major food reserve and are subject to periodic fluctuations influenced by environmental variables like temperature (Akisani *et al.*, 2019). The crude fiber contents recorded in this study were higher compared to the findings of Ehigiator and Oterai (2012) who reported the fiber contents of 0.40-0.54 g/100g, and Bassey *et al*. (2011) who reported the crude fibre content of 0.28-0.32 g/100g, and Ehigiator and Nwangwu (2011) who recorded the crude fibre of 0.21-0.34 g/100g. Ehigiator and Akise (2013) reported that *M. vollenhovenii* had the levels of moisture (9.10± 0.33 g/100g), carbohydrates (62.66±0.54 g/100g), Fats (4.36± 0.14 g/100g), Ash (2.20± 0.05 g/100g) and crude fibre content (0.56±0.02%) in in Benin Nigeria. The high fat content variation observed in the female *M. vollenhovenii* this study agreed with that report of Devanathan *et al*. (2011) who observed that the females *M. rosenbergii* had higher fat content than their male counterparts. The variation in the proximate composition could be due to the age, feeding habit, sex of the prawns, season of the year and processing methods (Ehigiator and Obi, 2015).

The results in Table 2 showed the amino acid profile among the stages and sexes of *Macrobrachium vollenhovenii* from the study area. During the study, 18 amino acids were profiled which include: Arginine, Asparagine, Alanine, Cystine, Glutamine, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, Cysteine and Valine in *M. vollenhovenii* from the study area. The Essential Amino Acids (EAA) were arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine, while the Non-Essential Amino Acids (NEAA) were glycine, alanine, proline, aspartate, glutamate, tyrosine, cysteine and Cysteine. There were significant difference ($P<0.05$) in amino acid profile values among the stages and sexes of *M. vollenhovenii*; females had the highest mean value (2.95±0.83g/100g) of Asparagine, followed by Adults with the mean value of 1.28±0.59g/100g; the mean Glutamine among the stages and sexes of *M. vollenhovenii:* females had the higher mean value (39.49±0.20g/100g) while adults had lower mean value (33.76±0.01g/100g) of during the study.

There was significant difference ($P<0.05$) in Lysine among the stages and sexes of *M. vollenhovenii;* post-larvae had the higher mean value (34.52±0.98g/100g), followed by juveniles with the mean value of 26.89±0.90g/100g while females had the lowest mean value (14.085±0.01g/100g); the mean Methionine among the stages and sexes of *M. vollenhovenii;* juveniles had the higher mean value (9.46±0.12g/100g), followed by post-larvae with the mean value of 6.76±0.01g/100g while Males had lower mean value (4.69±5.00g/100g); the mean Phenylalanine among the stages and sexes of *M. vollenhovenii;* juveniles had the higher mean value (3.89±0.86g/100g) while males had lower mean value (1.54±0.20g/100g); the mean Proline among the stages and sexes of *M. vollenhovenii;* juveniles had the higher mean value (4.78±0.09g/100g) while males had lower mean value (0.28±0.03g/100g) during the study.

There was significant difference ($P<0.05$) in Serine among the stages and sexes of *M. vollenhovenii;* juveniles had the lower mean value (0.58±0.05g/100g) while post-larvae had higher mean value (0.77±0.08g/100g); the mean Tryptophan among the stages and sexes of *M. vollenhovenii;* males had the higher mean value (0.29±0.01g/100g) while females had lower mean value (0.09±0.01g/100g); the mean Valine among the stages and sexes of *M. vollenhovenii*: females had the higher mean value (0.28±0.08g/100g) while juveniles had lower mean value (0.09±0.01g/100g) during the study.

The results on amino acid profile among stages and sexes of *M. vollenhovenii* in this study area were in line the findings of Jimoh *et al.* (2019) who also reported eighteen (18) amino acids in *M. vollenhovenii* were made up of ten (10) EAA were arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine, and eight (8) NEAA were glycine, alanine, proline, aspartate, glutamate, tyrosine and cysteine from the Southwestern Nigeria. Bhavan *et al.* (2010) also isolated 18 amino acids from *Macrobrachium rosenbergii* in which were arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, glycine, alanine, proline, aspartate, glutamate, tyrosine and cysteine in India. Glutamate recorded the highest concentration while cystine recorded the lowest concentration in both crustaceans. Thus, these crustaceans probably play important roles in learning and sensitivity due to the concentration of glutamate which is a powerful excitatory neurotransmitter that is released by nerve cells in the brain. On the basis of nutrition and higher concentration of amino acids in *M. vollenhoveni* are better sources of protein and could serve as perfect substitute for other sources of proteins. However, Ehigiator and Oterai (2012) also reported thirteen amino acids made up of 8 EAA and 5 NEAA were isolated from *M. vollenhovenii* from Benin River, Nigeria while Abdel-Salam (2014) isolated 16 amino acids from 9 EAA and 7 NEAA in important crustaceans from Egyptian and Saudi Arabia coasts. The nutritive value of crustaceans was determined by (Sankar and Yogamoorthi, 2012) and found the presence of EAAs. Recently, the concept of functional amino acids (FAAs) participate and regulate key metabolic pathways to improve health, survival, growth, development, lactation and reproduction of the organisms (Wu, 2013) and FAAs also hold great promise in the prevention and treatment of metabolic diseases (Abdel-Salam, 2014) and are essential in human and animal nutrition. Thus, considering that major EAAs and NEAAs were isolated from *M. vollenhovenii* could be considered to

be highly nutritious food for consumption. Wu (2010) who reported that glutamic acid and aspartic acid were the most abundant non-essential amino acids in European green crab (*Carcinus maenas*). Glutamic acid was also reported to be the most abundant free amino acid in body meat of crab (Ehigiator and Oterai, 2012). Glutamate is a powerful excitatory neurotransmitter that is released by nerve cells in the brain (Sudhakar *et al*., 2011). It is responsible for sending signals between nerve cells, and under normal conditions, it plays an important role in learning and memory (Wu, 2013). Leucine is the only dietary amino acid that can stimulate muscle protein synthesis and has important therapeutic role in stress conditions like burn, trauma, and sepsis (Wu, 2013). As a dietary supplement, leucine has been found to slow the degradation of muscle tissue by increasing the synthesis of muscle proteins (Abdel-Salam, 2014). Aspartate stimulates a neural receptor called the NMDA receptor, which plays a role in memory and cognition. Aspartate can be used to make several other amino acids, making it useful for preventing amino acid deficiencies (Sankar and Yogamoorthi, 2012). According to Sudhakar *et al*. (2011), glycine, alanine, serine and threonine give sweet taste, while arginine, leucine, valine, methionine, phenylalanine and histidine give bitter taste. They constitute about 67% and 65% of the total amino acids in *M. vollenhoveni* and *C. amnicola* respectively and this agreed with results of the study by Babu *et al.* (2010). The amino acids content of *M. vollenhovenii* and *C. amnicola* were high and this can be attributed to its omnivorous feeding habit and also may be due to stress conditions caused by toxicity of heavy metals on protein metabolism (Wang *et al.*, 2019). The high amino acids composition of these crustaceans is an indication of their high nutritive quality. Thus, according to Ehigiator and Oterai (2012), the different amino acids might be associated with the varying tastes as well as textural properties of meat of the two species.

The results in Table 3 showed the fatty acid profile among sexes and stages of *Macrobrachium vollenhovenii* from the study area where 18 fatty acids were identified during the study which include: Acetic acid, Succinic acid, Indoles, Caprylic acid, Capric acid, Myristic acid, Myristoleic acid, Acrylic acid, Cetene, Oleic acid, Elaidic acid, Linoleic acid, Palmitoleic acid, Stearic acid, Icosane, Permethrin, Pregnane-3, 20-dione (Steroids) and Cholesterol during the study. However, the study revealed that Cholesterol was found in males, females, adults and juveniles while Oleic acid and Linoleic acid were found in both sexes and stages of *M. vollenhovenii* during the study in the study area. Palmitoleic acid was found in Males, *M. vollenhovenii* only during the study. Indoles was common in adult, males and females *M. vollenhovenii* in the study area. Permethrin and Pregnane-3, 20-dione (Steroids) were only found in post-larvae of *M. vollenhovenii* during the study in the study area. Icosane was found in Juvenile *M. vollenhovenii* only during the study. The results were in line with findings of Yerlikaya *et al*. (2013) who identified Saturated Fatty Acids (SFAs) ranged from 12C to 24C including lauric acid (C12), myristic acid (C14), palmitic acid (C16:0), stearic acid (C18:0), aracidic acid (C20), behenic acid (C22) and lignoceric acid (C24) in shallow water shrimp species from the Gulf of Antalya. Tsape *et al*. (2010) also reported that the main SFAs in shrimp species such as myristic acid (C14), aracidic acid (C20), behenic acid (C22), and lignoceric acid (C24) were not found in P. edwardsi. Lignoceric acid (C24) was only found in four species (*Aristeus antennatus*, *Aristeomorpha foliacea*, *Penaeus japonicus*, and *Penaeus semisulcatus*) and the lowest concentration of fatty acids was lauric acid (C12). Palmitic (C16:0) and stearic (C18:0) acids were reported to be the most abundant SFAs in *P. vulgaris*, *P. brasiliensis*, *P. schimitti*, *P. vannamei*, *P. monodon*, and *X. kroyeri* (Sriket *et al.*, 2007). The Monounsaturated Fatty Acids (MUFAs) identified in *M. vollenhoveni* during the study include Oleic acid, Elaidic acid, Palmitoleic acid and Stearic acid was higher than the findings of Tsape *et al*. (2010) reported MUFA such as Oleic acid (C18:1) and palmitoleic acid (C16:1) were dominated in Shrimp species, *P. monodon* and *P. vannamei*. The level of total MUFA was influenced by the levels of these two fatty acid contents. In this study, the major Polyunsaturated Fatty Acids (PUFAs) in *M. vollenhoveni* were Linoleic acid and Icosane. However, Yerlikaya *et al.* (2013) identified PUFA content arachidonic acid in *P. kerathurus* and *M. monoceros*.

Conclusion

African river prawn, *M. vollenhovenii* has high nutritional value with high concentration of various essential amino acids (EAA) and non-essential amino acids (NEAA) and high enough to satisfy the WHO-recommended daily requirements for humans and livestock because their nutritive quality. Hence, it should be explored due to its nutritive value in Nigeria.

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References

Abdel-Salam, H.A. (2014). Amino acid composition in the muscles of male and female commercially important crustaceans from Egyptian and Saudi Arabia coasts. *American Journal of Bioscience, 2*(2), 70–78.

Akisani, C. A., Annune, P. A. and Solomon, S. G. (2019). Proximate and mineral content of *Atya gabonensis and Macrobracium felicinum* Hothuis, 1049 from River Benue and River Niger, Nigeria. *International Journal of Fisheries and Aquatic Studies*, 7 (6): 255 – 259.

Arazu V. N. and Udo P. J. (2015). Pre-dredging Evaluation of the Proximate and Mineral Composition of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii* of River Niger at Onitsha, Nigeria. *AASCIT Journal of Bioscience*; 1(4): 72-77.

Association of Official Analytical Chemist (AOAC), (2010). Official methods of analysis (18th ed.). Washington DC.

Asiru, R.A. and Fafioye, O.O. (2018). Proximate Composition of the Giant River Prawn, *Macrobrachium vollenhovenii* from River Osun, Southwestern Nigeria. *Journal of Fisheries and Livestock Production,* 6: 285. doi: 10.4172/2332-2608.1000285

Babu, K.K., Arnadurai, D., & Rajagopal, S. (2010). *Bursa spinosa* - A megastropod fit for human consumption. *Journal of Food Science and Technology*, 2, 79-83.

Bassey SCO, Eteng MU, Eyong EU, Ofem OE, Akunyoung EO, et al. (2011) Comparative nutritional and biochemical evaluation of *Ergeria radiata* (Clams) and *Pomecia palludosa* (Gastropods). *Research Journal of Agricultural and Biological Sciences,* 7: 98-104.

Bello-Olusoji, A.O & Oke, A. (2005). Chemical index and organoleptic assessment of freshness of frozen and oven dried African River Prawn *Macrobrachium vollehovenii* during storage. *Journal of Tropical Biosciences*, 5(1): 154-157.

Bello-Olusoji, O.A., Bankole, M, Sheu, A., and Oyekanmi, F. B. (2006). Availability, diet composition and feeding behaviors of some commercially important Palaemonidae prawns in fresh and brackish water of Nigeria. *Journal of Biological Sciences,* 6: 15-21.

Devanathan, K., Srinivasan, M., Periyasamy, N. and Balakrishnan, S. (2011) Nutritional value of gastropod *Babylonia spirata* from Thazhanguda, Southeast Coast of India. *Asian Pacific Journal of Tropical Biology;* 3: 249-252.

Ehigiator, F.A.R. and Nwangwu, I.M. (2011) Comparative studies of the proximate composition of three body parts of two freshwater prawns species from Ovia River, Edo State, Nigeria. *Australian Journal of Basic and Applied Sci*ences; 5: 2899-2903.

Ehigiator, F.A.R. and Oterai, E.A. (2012) Chemical composition and amino acid profile of a Caridean prawn (*Macrobrachium vollenhovenii*) from Ovia River and tropical periwinkle (*Tympanotonus fuscatus*) from Benin River Edo state Nigeria. IJRRAS 11: 162-167.

Ehigiator, F.A.R. and Akise, O.G. (2013). Proximate Composition, Macro and Trace Mineral Compositions of Different Body Parts of *Macrobrachium Vollenhovenii* from Ovia River in Edo State, Nigeria. *Tropical Freshwater Biology*, 22: 1 - 11 1http://www.ajol.info/index.php/tfb; DOI: http://dx.doi.org/10.4314/tfb.v22i1.1

Ehigiator, F.A.R. and Obi, A. (2015). Chemical constituents of freshwater prawn habitat in the Niger Delta, Nigeria. *International Journal of Applied and Natural Sciences,* 4(2): 35-46.

Ekpenyong, E., Wlliams, I.O. and Osakpa, U.U. (2013). Variation in the proximate, energy and mineral compositions of different body parts of *Macrobrachium macrobrachion* (Prawn). *Journal of Food Research*, 2(2): 150-156.

Fasakin, E. A., Bello-Olusoji, O. A. &Oyekanmi, F. B. (2000). Nutritional value of flesh and water composition of some processed important crustaceans in Nigeria. *Applied Tropical Agriculture,* 5(2): 148-153.

Jike-Wai, O. and Deekae, S. N. (2011) Chemical and mineral compositions of commercially important Shellfish in Rivers State, Nigeria. *Am-Euras. Journal Agriculture and Environmental Sciences,* 10: 752-754.

Jimoh, A.A., Clarke, E.O. and Akanbi, A. (2019) Amino Acid Composition of *Macrobrachium vollenhovenii* and *Callinectes amnicola* from Badagry Creek, Lagos, Nigeria. *South Asian Research Journal of Agriculture and Fisheries*, 1(4): 132-136.Nwosu F, Wolfi M (2006) Population dynamics of the giant African river prawn *Macrobrachium vollenhovenii* Herklots 1857 (Crustacea, Palaemonidae) in the Cross River estuary, Nigeria. *West African Journal Applied Ecology*, 9: 1-18.

Sankar, R. S. and Yogamoorthi, A. (2012). Free amino acid composition in haemolymph and muscles of the ghost crab *Ocypoda platytarsis*. *Pakistan Journal of Biological Sciences,* 15(10), 490-495.

Sriket, P., Benjakul, S., Visessanguan, W., and Kijroongrojana, K. (2007). Comparative studies on chemical composition and thermal properties of Black Tiger Shrimp (*Penaeus monodon*) and White Shrimp (*Penaeus vannamei*) meats. *Food Chemistry*, 103: 1199–1207.

Sudhakar, M., Rafa, K., Anathan, G. and Sampathkaumar, P. (2011). Compositional characteristics and nutritional quality of *Podopthalamus vigil* (Fabricius). .*Asian Journal of Science*, 4(2), 166-174.

Tsape, K., Sinanoglou, V. J., and Miniadis-Meimaroglou, S. (2010). Comparative analysis of the fatty acid and sterol profiles of widely consumed Mediterranean crustacean species. *Food Chemistry*, 122: 292–299.

Wang, W., Wu, Z., Dai, Z., Yang, Y., Wang, J., & Wu, G. (2013). Glycine metabolism in animals and humans: Implications for nutrition and health. *Amino Acids*, 45(3), 463-477.

Wu, G. (2013). Functional amino acids in nutrition and health, Amino Acid. *Advances in Nutrition*, 45(3): 407-411.

Wu, G. (2010). Functional amino acids in growth, reproduction, and health. *Advances in Nutrition*, 1(1): 31-37.

Yerlikaya, P., Topuz, O. K., Buyukbenli, H. A. and Gokoglu, N (2013). Fatty Acid Profiles of Different Shrimp Species: Effects of Depth of Catching. *Journal of Aquatic Food Product Technology*, 22:290–297, 1049-8850 print/1547-0636 online DOI: 10.1080/10498850.2011.646388

Table 1: Proximate composition of *Macrobrachium vollenhovenii* from the study area

Variables	Adults	Males	Females	Juveniles	Post-larvae
Moisture (g/100g)	11.05±0.73^{a}	11.29±0.25^{a}	11.24±0.99^{a}	10.27±0.51^{b}	9.51±0.05^{b}
CP (g/100g)	40.11±0.73^{d}	43.40±0.16^{c}	42.22±1.01^{c}	58.34±0.76^{b}	62.38±0.74^{a}
Crude fats (g/100g)	9.61±0.08^{b}	6.11±0.11^{bc}	10.81±0.01^{a}	5.34±0.01^{c}	4.84±0.13^{d}
Crude fibre (g/100g)	10.38±1.20^{b}	11.95±0.01^{a}	9.66±0.10^{b}	6.50±0.80^{c}	5.35±0.06^{c}
Crude Ash (g/100g)	16.85±0.09^{b}	17.27±0.10^{a}	15.35±0.01^{c}	8.65±0.04^{d}	6.98±0.01^{e}
NFE (g/100g)	12.93±1.37^{a}	10.03±0.56^{a}	10.72±0.10^{bc}	10.90±1.03^{b}	10.94±0.01^{c}
Caloric value (Kcal/100g)	305.18±0.03^{ab}	316.09±6.53^{ab}	324.61±11.94^{a}	298.88±0.02^{bc}	278.26±0.02^{c}

Means with the same superscripts are not significantly different (P>0.05) across the rows
Keys: CP = Crude Protein, NFE = Nitrogen Free Extracts

Table 2: Amino Acid Profile (g/100g of Protein) among the Stages and Sexes of *Macrobrachium vollenhovenii* in the Study Area

Amino acids	Adults	Males	Females	Juveniles	Post-larvae	P-Value
Arginine	0	0	0	0	0	0
Asparagine	1.28±0.59	0	2.95±0.83	0	0	0.00
Alanine	0	0	0	0	0	0
Cystine	0	0	0	0	0	0
Glutamine	33.76±0.01	0	39.49±0.20	0	0	0.02
Glycine	0	0	0	0	0	0
Histidine	0	0	0	0	0	0
Isoleucine	0	0	0	0	0	0
Leucine	0	0	0	0	0	0
Lysine	21.42±0.05	16.76±0.02	14.085±0.01	26.89±0.90	**34.52±0.98**	0.03
Methionine	5.53±0.00	4.69±5.00	5.84±0.02	**9.46±0.12**	6.76±0.01	0.01
Phenylalanine	1.95±0.01	1.54±0.20	2.41±0.06	**3.89±0.86**	2.31±0.01	0.03
Proline	0.37±0.08	0.28±0.03	3.79±0.05	**4.78±0.09**	3.89±0.52	0.01
Serine	0	0	0	0.58±0.05	**0.77±0.08**	0.04
Threonine	0	0	0	0	0	0
Tryptophan	0.17±0.09	**0.29±0.01**	0.09±0.01	0	0	0.00
Cysteine	0	0	0	0	0	0
Valine			**0.28±0.08**	0.09±0.01	0	0.02

Table 3: Fatty Acid Profile among Sexes and Stages of *Macrobrachium vollenhovenii* in the Study Area

Components	Fatty acid	Males	Females	Adults	Juveniles	Post-larvae
C3	Acetic acid	Acetic acid		Acetic acid		
C4	Succinic acid		Succinic acid	Succinic acid		
C8	Indoles	Indoles	Indoles	Indoles		
C8	Caprylic acid		Caprylic acid	Caprylic acid		
C10	Capric acid					
C14	Myristic acid	Myristic acid	Myristic acid	Myristic acid	Myristic acid	
C14	Myristoleic acid			Myristoleic acid	Myristoleic acid	
C15	Acrylic acid		Acrylic acid	Acrylic acid		
C16	Cetene	Cetene		Cetene		
C16	Palmitoleic acid	Palmitoleic acid				
C18:1	Oleic acid	Oleic acid	Oleic acid	Oleic acid	Oleic acid	Oleic acid
C18	Elaidic acid		Elaidic acid	Elaidic acid		
C18:2	Linoleic acid	Linoleic acid	Linoleic acid	Linoleic acid	Linoleic acid	Linoleic acid
C18	Stearic acid		Stearic acid	Stearic acid		
C20	Icosane				Icosane	
C21	Permethrin					Permethrin
C21	Pregnane-3, 20-dione (Steroids)					Pregnane-3, 20-dione (Steroids)
C27	Cholesterol	Cholesterol	Cholesterol	Cholesterol		