JOURNAL OF FISHERIES INTERNATIONAL
MEDWELL PUBLICATIONS

Comparative Approximate, Protein and Inorganic Constituents in Freshwater Clariids (*Chrysichthys nigrodigitatus* and *Clarias gariepinus*) of Coastal Water

[1]Ayofe M. Hammed and [2]Albert O. Amosu
[1]*Department of Fisheries, Faculty of Science, Lagos State University, P.O. Box 0001, LASU Post Office, Ojo, Lagos, Nigeria*
[2]*Department of Agricultural Science, School of Vocational and Technical Education, Adeniran Ogunsanya College Education, Otto/Ijanikin, P.M.B. 007 Festac Town, Lagos, Nigeria*

Key words: Amino acid, catfish, clariid, fish species, freshwater, Nutrients, Proximate, *Chrysichthys nigrodigitatus*, *Clarias gariepinus*

Corresponding Author:
Albert O. Amosu
Department of Agricultural Science, School of Vocational and Technical Education, Adeniran Ogunsanya College Education, Otto/Ijanikin, P.M.B. 007 Festac Town, Lagos, Nigeria

Page No.: 14-21
Volume: 15, Issue 2, 2020
ISSN: 1817-3381
Journal of Fisheries International

Abstract: The approximate, protein and inorganic constituents of two economically important freshwater clariids were determined and their corresponding water quality of the habitat was conducted to investigate the environmental safety and the process of obtaining nutrition necessary for health and growth gains to consumers. The 50 fish samples of *Chrysichthys nigrodigitatus* (Silver catfish) and *Clarias gariepinus* (African Mud catfish) each with weight ranging from 500-800 g purchased at fish landing site in Ojo, Lagos Nigeria were examined for proximate, mineral and amino acid compositions determined by Atomic Absorption Spectrophotometer and Gas chromatography, alongside Association of Official Analytical Chemists (AOAC) methods, respectively. Highest values of 44.93±0.04 and 38.61±0.19 crude protein were found in them and the smallest worth of 3.96±0.02 and 3.77±0.02 ash found in *C. nigrodigitatus* and *C. gariepinus* separately. The natural oily deposits 9.38±0.03 and 10.42±0.04 were very high in both species. An important distinct ($p<0.05$) across Fe composition of *C. gariepinus* (2.18±0.04) and *C. nigrodigitatus* (1.14±0.16). Na (80.07±0.55) and Mg (74.55±1.00) constituents were high up for *C. gariepinus*. Pb and Cd differed significantly ($p<0.05$) along both species while Ni was not detected in both species. Tryptophan (Trp) and Cysteine (Cys) were found to be the lowest (1.66±0.05 and 0.04±0.01) and (1.51±0.05 and 1.22±0.03) for *C. nigrodigitatus* and *C. gariepinus*, respectively. Of the 18 detected amino acids, Pro (2.06±0.05 and 2.72±0.07), Thr (7.31±0.34 and 3.95±0.03), Gln (15.28±0.05 and 13.28±0.06) and Trp (1.66±0.05 and 0.04±0.01) were observed to be importantly distinct ($p<0.05$) for both fish species. The high fat and crude protein detected in *C. nigrodigitatus*

and *C. gariepinus* was an indication that they could be good sources of fish oil and protein and as such required for growth and normal body functions. The water quality indicates good indices that both catfishes reside in safe environment and within the FEPA, WHO and EU standards for freshwater. Therefore, both species are good sources of medicinal requirements, especially for people with critical nutritional imbalance.

INTRODUCTION

Fish is any renewable resource of water with varieties of different organisms residing in the saline and non saline waters[1]. Aquatic organisms comprise of significant sources of amino acids cum several excellent origin of important substances like vitamins and minerals eaten by humans in every continents[2-3]. Globally aquatic faunas account for about 14% of all animal protein in human diets and contribute well over 50% of the animal protein in Asian nations[4, 5]. West Africa coastal communities consumed fish as source of dietary animal protein between 30-80% in their food intake[6]. In Nigeria, fish compares favourably better than other livestock meat due to it availability, low cost and also constitutes about 40% of the dietary animal protein[4, 7]. Fish which accounts for approximately 36.6 g day^{-1} of net protein consumed in Nigerian diets is lower than dietary protein required standard prescribed by the World Health Organization (WHO) requirement of 46-52 g day^{-1}[8, 9]. Transitively, most citizens lack the required amount of protein mainly because of low consumption of animal sources of protein in their food.

Fish and fisheries produce of water are the economic benefits of water bodies while fish farming is the application of technology in rearing of selected floral and faunas in water bodies[10]. Renewable aquatic resources of water are the important commercial activities of >3 billion population and global food in most coastal countries[11, 12]. Fish and fisheries resources are among the rapidly increasing enterprises for several decades with significant benefits required for the increasing population of the world if properly managed[13]. This sector is estimated to produce the global demand of food which is estimated to rise with about 50% in the year 2030[14] with finfish, crustaceans and molluscs as the most prominent contributors[15]. The world population is expected to increase geometrically while a required fish increases also need a long lasting quality of aquatic organisms production of high demandis envisaged[16, 17].

Details of nutritional constituents of non saline fish species is important to culturist with constant supply of diets composed of natural oil and good quality of amino acids[18-20]. Different fish species from specific and diverse environment may not supply the same required nutrition necessary for human body physiology[21, 22]. It is also valuable to dieticians that are keen about advancing good source of amino acids diets with guaranteed characteristics and well being blended highly deserved nutrient composition[23, 24]. These leads to nutritive values of several diversities of fishes that is ascribe to diet constituents, feeding behaviour, nutrition, ecology, sexes, growth, sizes, seasons, migration, geographical localities and genetic traits[25, 26]. The fatty species, like clariids, mackerel and herring are significant derivatives of natural oily compositions found in carboxylic acid consisting of hydrocarbon chain and terminal carboxylic group, mostly the esters and fats and oils such as Docosahexaenoic Acid (DHA) and Eicosa Pentaenoic Acid (EPA). Currently, research is geared towards the desirable fatty fish in human cardiovascular ailments such as preventive medicine and health promotion which can also reduces the problem of blood pressure and heart failure which may lead to death[27]. Nigeria is rich in renewable and non renewable water resources[28]. With an average annual import of over 700,000 mt of fish resources and around 0.5 million mt a^{-1} (P.A) deficit, Nigeria is currently ranked among developing nation with the highest dependant on import fisheries[29]. Therefore, the under-utilized water resources can be developed for fish production to meet the country's high fish requirements. Nigeria aquatic fish fauna resources include well above 210 fish species comprising of fin and shell fishes used as animal source of protein in most Nigerian diets which are made of 90% of economic importance fish species[30]. Among them are two economically significant fish species, namely, the *Chrysichthys nigrodigitatus* and *Clarias gariepinus* which are abundant in Nigerian coastal markets, Lagos, especially[10]. Their proteineous nature is derived from environment and feeding behaviour and generally regarded as a carnivorous cum omnivore feeding on bivalves, detritus, crustaceans, chironomid and vegetable matter[30, 31]. Both species are suitable species for aquaculture belonging to the family Clariidae, highly valued commercial fishes with fast growth rate, resistant to disease and are adaptable to adverse environmental conditions[10, 24, 29, 32].

The shelf life of both fatty fish can be prolonged with good processing and preservative methods, consumers of such aquatic organisms requires the best available standard in terms of quality, especially from it nutrition. The success of fishery sector may be gear by human and natural factors for a sustainable development of fish production, enriched as results of fisheries industries and academic collaborations.

Ojo coastal area is a coastline of freshwater with associated confluence of estuarine and the Atlantic Ocean

and diversity of renewable aquatic resources. *Chrysichthys nigrodigitatus* and *Clarias gariepinus* are freshwater clariids of economic importance to its neighbouring towns and communities. Our present study is to investigate the nutritional compositions of these fish species prior to consumption in association with the qualities of inhabiting water parameters. This knowledge will be of nutritional benefits and value to consumers as an aspects of environmental and health indices to the overwhelming population of this coastal state.

MATERIALS AND METHODS

Experimental: Experimental sampling station used is located in Ojo-Jetty, Ojo, Lagos, Nigeria with coordinates of 6.4668°N; 3.2232°E (Fig. 1). The coastal town is a commercial nerves centre picked due to it peri-urban status with the population density of about 2 million people coupled with lots of fishing and fishery activities. The distance from the landing site to the laboratory is 1 h: 16 min (30.7 km). The fishes and water samples were collected between the months of June-October, 2019. Both samples were analyzed in the Biochemistry Teaching Laboratory, Lagos University Teaching Hospital (LUTH), (6.5179°N; 3.3578°E) Idi-Araba, Surulere, Lagos, Nigeria.

Collection of fish and sample preparation: The freshly caught samples of the two clariids species *Chrysichthys nigrodigitatus* and *Clarias gariepinus* were purchased at the landing site. The fish were transported in plastic cooler filled with ice blocks to the laboratory for onward analysis. Samples was degutted with a knife, the fish tissue were removed into a standard crucible and properly labelled for analyses and examination.

Proximate composition analyses

Moisture: The determination of moisture content analytical procedures by AOAC[33] was embraced. This entails basically the principle of dehydration and extraction of H_2O from the prepared sample which is measured by weight loss. Appropriate purified crucible was measured and dehydrated in the oven (W1); about 1.0 g of each of the samples was measured into the crucible (W2) and dehydrated at 105°C in 20 h. From the oven crucible containing the samples was allowed to cool and re-measured (W3) in the desiccators. Moisture content was determined in % as thus:

$$\text{Moisture content}(\%) = 100 - \frac{(W3 - W1)}{(W2 \times 1000)}$$

Crude protein: Analyses of amino acids in both sampled tissue were carried out on the fish species as described by AOAC[34] kjeldahl method. About 2 g of each sample was added to 10 mL of concentrated H_2SO_4. About 2 g of Se catalyst included into mixture and allowed to dissolve. Distilled water was added inside the constituent of the digested sample. Subsequently, exactly 10 mL of the digested sample was included in NaOH (45%) and transferred to a kjeldahl hardware for distillation. About 3 drops of methyl red indicator was included to the solution, distilled with the distillate transferred to 4% boric acid mixture. Exactly 50 mL of the distillate was used for titration accordingly. The process and procedure was repeated appropriately and mean calculated. Percentage N content determined, multiplied by 6.25 to arrive at the amino acids (crude protein):

$$\text{The Nitogen}(\%) = \frac{(100 \times N \times 14 \times VF)T}{100 \times Va}$$

Where:
N = Normality of the titrate (0.1 N)
VF = Total volume of the digest = 100 mL
T = Titre value
Va = Aliquot Volume distilled

Totallipid (Bligh and Dyer method): About 5-10 g wet sample of fish tissue were weighed in a 100 mL conical

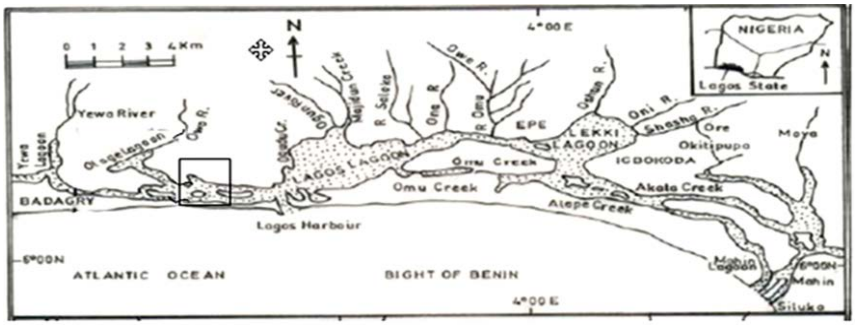

Fig. 1: Ojo coastal water and sample collection (□) and analyses laboratory (+)

flask. Exactly 20 mL of MeOH and 10 mL of $CHCI_3$ were added. The prepared sample was homogenized within 2 min with an Ultra Turrax mixer. About 10 mL of $CHCI_3$ was re-added which was thoroughly mixed for 1 min. Exactly 18 mL of distilled water was added (including water already in sample). The solution was re-Vortex in 1 min. Two layers in the sample were centrifugally demarcated within 10 min having 450 g in a thermostatic centrifuge at degree centigrade. The layer below was pipette (Pasteur) and transferred into pear-shaped flask. Vortexing of another extraction was done in 20 mL 10% (v/v) MeOH with $CHCI_3$ within 2 min. On centrifugation, the below ($CHCI_3$) layer was added into the initial extract. The solution was evaporated. The remnant was dehydrated for 1 h at 104°C. The extracted weight was recorded and calculation of the lipid content determined.

Crude fibre: The crude fibre was analyzed as described by AOAC[33] as used for this analysis. About 1.0 g of the powdered sample were measure including 100 mL of 1.25% sulphuric acid solution included, heated (Boiling point) for 30 min under a reflux. Immediately, the boiled mixture suctioned and sieved. The derived substance in hot water was washed, acid free after several times. It was poured into a flask, 100 mL of the hot NaOH (1.25%) solution included and the whole mixture re-heated for 30 min and suctioned under sieve. The residue (soluble) was then washed in hot water and free of base. Dehydrated to constant weight in the oven at 105°C, cooled in a desiccator and weighed (C1). The measured sample (C1) was incinerated in a muffle furnace at 300°C for about 30 min, cooled in the desiccator and weighed (C2):

- Loss in gramme of sample on incineration = C1-C2 ×100
- Weight of original sample = % crude fibre = C1-C2

Total ash: The AOAC[33] method was used to determined the total ash content. Porcelain crucible was dehydrated in an oven for 10 min at 100°C, cooled in a desiccator and Weighed (W1). The 2 g of the sample was transfered into the previously weighed porcelain crucible and reweighed (W2) and then put in a furnace at 600°C for 4 h to achieve proper ashing. Crucible containing the ash was removed cooled in a desiccator and Weighed (W3). The % ash content was computed as:

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

Total carbohydrate: Total carbohydrate was analysed using Anthrone method. Carbohydrates were initially hydrolysed to simple sugars by diluting HCl (Hydrochloric acid). In hot acidic medium glucose is hydrated to hydroxymethyl furfural. The solution forms with anthrone, a green colored product with an absorption maximum at 630 nm. Cool and green to dark green colour was read at 620 nm. The standard graph was achieved by plotting concentration of the standard on the x-axis with the absorbance on the y-axis. On the graph, compute the amount of carbohydrate present in the sample tube.

Nutrient analyses

Sample preparation: Mineral samples were processed in accordance with the recommendations of Perkin Elmer's procedures in Atomic Absorption Spectrometer in 1996. The muscle tissue of about 2 g each fish sample was taken and dehydrated for 2 h at 135°C and weighed. The sample was heated up to 500-550°C in a muffle furnace and the ash cooled overnight to room temperature. About 2 mL of H_2NO was added and evaporated to dryness, it was re-heated to 500°C for 1 h to achieve a clean carbon free ash. About 10 mL H_2NO_3 was included and dissolved ash with continuous hot plate heating. The sample was transferred to a 50 mL volumetric flask with inclusion of HCl as required, diluted to volume with deionised distilled water. Precautions were followed to achieve non-contamination and cleanness.

Amino acids analyses: The amino acid extraction methods along the instrumentation process were utilized as described Hammed *et al*.[20] as described in the modified method AOAC, 2006 in the "Simultaneous Identification and Determination of Total Content of Amino Acids in Food Supplements-Tablets by Gas Chromatography as published by Obreshkova *et al*.[35].

Water and heavy metals analyses: Water samples were collected at 10:00 am in triplicates; once every week from each of the eight sample stations to determine the suitability and status of physiochemical parameter of the water body. Water parameters were analyzed as pH, Temperature (°C), Salinity (%), DO, TDS, CO_2 (mg L^{-1}) and one important inorganic nutrients was measured; Ammonium (NH_4^+) and measured by Spectroquant® Pharo 300 M. The analytical methods used were achieved photometrically as indicated by the manufacturer's specification and guideline Merck KGaA (Germany).

On the determination of mineral elements Ca, Cd, Fe, K, Mg, Na, Ni and Pb were analysed by Atomic Absorption Spectrometer (USA) on analyst Version'06, 2007, Perkin-Elmer Inca. with regards to process described by Perkin-Elmer. Majority of the inorganic elements like Ca, K, Na, etc. analysed were determined using Hollow Cathode Lamps (HCL). Lanthanum oxide was used for Na, K to depress chemical interferences.

Heavy metals such as Cd and Pb were analysed using Electrodeless Discharge Lamps (EDL). While Acetylene act as fuel in the determination of mineral elements with hallows cathode lamps. Measurement of Phosphorus (P) content in the samples was analyzed using the ammonium molybdate method with the aid of spectrophotometer (Systronics company, India)[36].

Statistical analyses: Experimental data obtained from the research were expressed as mean±SD with alpha level at $p<0.05$ while Analysis of Variance (ANOVA) was done with Graph Pad Prism V analytical package. Inferential deductions observed in treatments were analyzed using Duncan's New Multiple Range Test (DNMRT) and Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Results of physical and chemical characteristics (Table 1) showed that pH value (8.22±0.10) of the sample station is within the range prescribed in Federal Environmental Protection Agency (FEPA), World Health Organization (WHO) and European Union (EU) permissible limit. Significant reduction was however observed in the temperature of Ojo compare to WHO while EU has no definite value for temperature range. Proximate composition of *C. nigrodigitatus* and *C. gariepinus* is presented in Table 2. With the exception of Ash contents of the two species that importantly distinct at $p>0.05$, every other approximate parameters tested shows important distinct at $p<0.05$ accompanied by moisture (20.80±0.04 and 21.71±0.07), protein (44.93±0.04 and 38.61±0.19), carbohydrates (17.31±0.04 and 18.15±0.03), crude fat (9.38±0.03 and 10.42±0.04) and crude fibre (3.63±0.02 and 7.35±0.04) for *C. nigrodigitatus* and *C. gariepinus*, respectively. Significant difference ($p>0.05$) was not recorded for Pb, Cd and Ni in the analysed percentage mineral content of the two species (Table 2) while significant difference were noticed in Na, Ca, Mg, K and Fe. The (18) amino acids were detected in both fish species (Table 3). All amino acids with the exception of leucine as partate, glutamate and histidine showed no important distinct at $p>0.05$. Eight mineral elements were analysed (Table 3), Nickel was however not detected in both species, Pb and Cd were not significantly different ($p>0.05$) but Na, Ca, Mg, K and Fe were important distinct at $p<0.05$. Apart from threonine (7.31±0.34 and 3.95±0.03), glutamine (15.28±0.05 and 13.28±0.06) and tryptophan (1.66±0.05 and 0.04±0.01), other amino acids components of both *C. nigrodigitatus* and *C. gariepinus* were of no important distinct at $p>0.05$.

The proximate constituents of freshwater fish species is a function of its diversity as regards age and maturity, habitat, availability of food, sex[25]. Some other associated factors which can dictate nutrient composition are food and feeding habit, spawning and sexual changes[22, 36]. Our research with Ojo landing site and population of the environs coupled with the economic significant of the catfishes investigated gives it a good justification. The nutrimental composition of nutrients in both clariids proved that there exist variation within the catfish except ash which showed no significant difference and amino acid showing the highest values and ash having the smallest value. *Clarias gariepinus* were recorded to have the highest moisture content 21.71±0.07 with *Chrysichthys nigrodigitatus* having a moisture content of 20.80±0.04.

Generally, amino acids are important for the usual purpose, development and keeping up of body tissue along with protein constituent suggest a significant mechanism for the appraisal of biochemical and

Table 1: Average values of the physicochemical parameters compared to selected standard guidelines

Parameters	Mean concentrations (OJO)	Standards	
		FEPA/FMEnv	WHO/EEC
pH	8.22 ± 0.10	6-9	6.5-8.5
Temperature (°C)	26.9± 1.05	30-35	25
DO (mg L^{-1})	7.32± 0.33	7.5	5.0
Salinity (%)	0.15±0.02	0.00-0.05	0.00-0.05
TDS (mg L^{-1})	88.9±16.69	2000	500-1000
CO_2 (mg L^{-1})	17.51±5.11	-	10
NH_{4+} (mg L^{-1})	7.53±0.70	1.0	0.5

Variables are expressed as means±standard error and compared with FEPA/FMEnv, WHO/EEC standards Guidelines in 1988; WHO: World Health Organization in 1984, 2006 Guidelines; EEC: European Economic Community Guidelines in 1975; NL = No Limit

Table 2: Mean proximate composition of *C. nigrodigitatus* and *C. gariepinus* in the study area

Composition (%)	Species	
	Chrysichthys nigrodigitatus	*Clarias gariepinus*
Moisture	20.80±0.04[b]	21.71±0.07[a]
Protein	44.93±0.04[a]	38.61±0.19[b]
Carbohydrate	17.31±0.04[b]	18.15±0.03[a]
Crude fat	9.38±0.03[a]	10.42±0.04[b]
Ash	3.96±0.02[a]	3.77±0.02[a]
Crude fibre	3.63±0.02[a]	7.35±0.04[b]

Data showing different superscript for each parameter in the same row are significantly different at $p<0.05$

Table 3: Mean mineral composition of *Chrysichthys nigrodigitatus* and *Clarias gariepinus* in the study area

Composition (%)	Species	
	Chrysichthys nigrodigitatus	*Clarias gariepinus*
Sodium (Na)	77.17±0.60[b]	80.07±0.55[a]
Calcium (Ca)	0.1591±0.01[b]	0.5611±0.05[a]
Magnesium (Mg)	70.57±0.50[b]	74.55±1.00[a]
Potassium (K)	25.55±1.10[b]	44.02±0.50[a]
Iron (Fe)	1.144±0.16[b]	2.179±0.04[a]
Lead (Pb)	0.3105±0.07[a]	0.2014±0.00[a]
Cadmium (Cd)	0.4533±0.00[a]	0.5087±0.02[a]
Nickel (Ni)	ND	ND

ND = Not Detected; Average data showing different superscript on each parameter in the same row are significantly different at $p<0.05$

Table 4: Mean amino acid profile of C. *nigrodigitatus* and *C. gariepinus* in the coastal water

	Species	
Composition (%)	*Chrysichthys nigrodigitatus*	*Clarias gariepinus*
Glycine	3.41±0.09[a]	3.68±0.02[a]
Alanine	2.72±0.04[a]	2.87±0.11[a]
Serine	2.81±0.04[a]	3.46±0.07[a]
Proline	2.06±0.05[a]	2.72±0.07[a]
Valine	3.99±0.42[a]	4.21±0.11[a]
Threonine	7.31±0.34[a]	3.95±0.03[b]
Isoleucine	4.44±0.46[a]	3.51±0.03[a]
Leucine	7.35±0.47[a]	8.49±0.05[a]
Aspartate	7.75±0.14[a]	6.93±0.04[a]
Lysine	8.04±0.59[a]	7.29±0.09[a]
Glutamine	15.28±0.05[a]	13.28±0.06[b]
Methionine	2.74±0.19[a]	2.50±0.05[a]
Phenylalanine	4.41±0.45[a]	5.28±0.50[a]
Histidine	3.08±0.04[a]	2.52±0.02[a]
Arginine	4.98±0.02[a]	5.79±0.55[a]
Tyrosine	3.05±0.05[a]	2.55±0.05[a]
Tryptophan	1.66±0.05[a]	0.04±0.01[b]
Cysteine	1.51±0.05[a]	1.22±0.03[a]

Data showing different superscript in each composition in the same row are significantly different at $p<0.05$

physiological level of a specific organism[37]. Protein content was slightly higher in *Chrysichthys nigrodigitatus* than in *Clarias gariepinus*. In spite of simple differences were noticed for the amino acids quantity and there was statistically appreciable difference at $p<0.05$, stipulating that amino acids quantity were different in both species. Protein analysis showed that both *Chrysichthys nigrodigitatus* and *Clarias gariepinus* contained all needed amino acids required towards proper growth and maturity development of fish. The elevated amino acids compositions of the fish species in our present findings could be similar to the excessive amino acids constituents of their usual diets as they consume mainly fin fish, shellfishes, algae and diatoms[30].

According to Ackman[38], classification of fish species may be categorised into four divisions as indicated in their fat composition such as lean fish (<2%), shallow fat (2-4%), average fat (4-8%) and intense fat (>8%). It can be deduced from our results that the mean natural oil constituents in *C. nigrodigitatus* and *C. gariepinus* indicated a high fatty acids fish with *C. gariepinus* having the highest fat content of 10.42±0.04. This revealed that *C. gariepinus* are superior derivation of fatty acids origin for a normal fish physiology. It is also a manifestation that the fish species might have very appropriate cause of fish oil. This is required for food therapy in humans as reported by Karacabey and Ozdemir[39]. Excessive fatty acids may result to low water and great amino acids compared to fishes with low fatty acid, this corroborates the findings by Steffens[40] that amino acids formation translate to the highest amount of dry matter in fish. The variation in the efficacy of crude fat quantity in the fish species could be due to water temperature variation, phase of development, salinity of the water, feeding habit and species[41]. Table 2 shows the ash composition of both fish species analysed were not exceptionally different at $p>0.05$ and the benefits were not higher than the World Health permissible limit.

According to our analysis concentrations of calcium, phosphorus, potassium, magnesium and sodium shows substantial level in all the fish samples, however, indicating that both fishes can be quality originator of essential of minerals. The difference observed in the concentration of the various mineral contents in the fish analysed could have be due to the occurrence of the mineral components in the water body[42]. It is also as a result of the capacity of the fish to mop up and transform the needed nutrients both from diet and specific domain. This is in line with the finding by Fawole *et al*.[43] that the abundant of phosphorus in both fish species is a function and indication of phosphorous composition in the amino acids profile. The concentration of Fe content were examined for the fish samples were not extraordinarily different at $p>0.05$ on either species. Fe is a required constituent of the respiratory tissue and significant composition of haemoglobin[44]. Fe as a mineral is essentially required in little quantity as detected in our present study but is deleterious if their concentration is high in the tissues or exceeds the required for the specific fish species[45]. The Fe contents observed in the fish samples are within the World Health Organisation permissible limit. Carbohydrate was slightly higher in *Clarias gariepinus* than in *Chrysichthys nigrodigitatus*.

CONCLUSION

Our research gives elucidated philosophy of mineral constituents of both *Chrysichthys nigrodigitatus* and *Clarias gariepinus* with regards to consumers and market preference as a function of food safety and permissible levels of the various bodies monitoring agencies. As discovered in this experiment the consumers can deduce the nutritional value of both clariids and the associated benefits. Our findings also revealed a fundamental contribution to knowledge in the nutritional composition of minerals and amino acid profiles of the economic significant catfish species.

ACKNOWLEDGEMENTS

In appreciation, the researchers need to thank the Department of fisheries, Faculty of Science, Lagos State University, Ojo, Lagos, Nigeria. We also appreciate the contribution and efforts of Mr. Adeniyi Togunde at the Department of Agricultural Science, Adeniran Ogunsanya College of Education, Lagos, Nigeria.

REFERENCES

01. Amosu, A.O., O.W. Bashorun, O.O. Babalola, R.A. Olowu and K.A. Togunde, 2012. Impact of climate change and anthropogenic activities on renewable coastal resources and biodiversity in Nigeria. J. Ecol. Nat. Environ., 4: 201-211.
02. Abolude, D.S. and S.A. Abdullahi, 2005. Proximate and mineral contents in component parts of *Clarias gariepinus* and. Niger. Food J., 23: 1-7.
03. Bene, C., R. Arthur, H. Norbury, E.H. Allison and M. Beveridge *et al*., 2016. Contribution of fisheries and aquaculture to food security and poverty reduction: Assessing the current evidence. World Dev., 79: 177-196.
04. Abolagba, O.J. and O.O. Melle, 2008. Chemical composition and keeping qualities of a scaly fish tilapia, *Oreochromis niloticus* smoked with two energy sources. Afr. J. Gen. Agric., 4: 113-117.
05. FAO., 2016. The State of World Fisheries and Aquaculture: Opportunities and Challenges. FAO., Rome, Italy.
06. Nelson, J.S., 2006. Fishes of the World. 4th Edn., John Wiley and Sons, New York, ISBN: 0471250317, pp: 262-263.
07. Eyo, A.A., 2001. Fish Processing Technology in the Tropics. National Institute for Freshwater Fisheries Research, New Bussa, Nigeria, ISBN-13: 9781770457, Pages: 403.
08. Bilsborough, S. and N. Mann, 2006. A review of issues of dietary protein intake in humans. Int. J. Sport Nutr. Exercise Metab., 16: 129-152.
09. Hammed, A.M., F.G. Owodeinde, A.O. Amosu, F.A. Awe and H.A. Fashina-Bombata, 2019. Chemical and microbial quality assessments of some economic important artisanal fresh water fish species (*Tilapia zilli*, *Clarias gariepinus*, *Chrysichthys nigrodigitatus* and *S. melanotheron*) in selected coastal markets of Lagos State, Nigeria. Fish Aquac J., Vol. 10, No. 2. 10.35248/2150-3508.19.10.268.
10. Lorentzen, K., U.S. Amarasinghe, D.M. Bartley, J.D. Bell and M. Bilio *et al*., 2001. Strategic review of enhancement and culturebased fisheries. Proceedings of the Conference on Aquaculture in the Third Millennium, February 20-25, 2001, NACA, Bangkok, Thailand, pp: 211-237.
11. FAO, 2009. The State of World Fisheries and Aquaculture 2008. Food and Agricultural Organization, Rome, Italy.
12. Smith, M.D., C.A. Roheim, L.B. Crowder, B.S. Halpern and M. Turnipseed *et al*., 2010. Sustainability and global seafood. Science, 327: 784-786.
13. OECD., 2013. Oecd-fao agricultural outlook 2013-2022. Organisation for Economic Co-operation and Development, Paris, France.
14. FAO., 2018. The State of Food Security and Nutrition in the World: Building Climate Resilience for Food Security and Nutrition. Food and Agriculture Organizationm, Rome, Italy, ISBN: 9789251305713, Pages: 202.
15. FAO., 2014. OECD and FAO see lower farm prices-livestock and biofuels outpacing crop production. FAO., Rome, Italy.
16. Hixson, S.M., 2014. Fish nutrition and current issues in aquaculture: The balance in providing safe and nutritious seafood, in an environmentally sustainable manner. J. Aquacult. Res. Dev., Vol. 5. 10.4172/2155-9546.1000234 .
17. FAO., 2018. The State of World Fisheries and Aquaculture 2018: Meeting the Sustainable Development Goals. Food and Agriculture Organization, Rome, Italy, ISBN-13: 9789251305621, Pages: 227.
18. Mozaffarian, D., R.N. Lemaitre, L.H. Kuller, G.L. Burke, R.P. Tracy and D.S. Siscovick, 2003. Cardiac benefits of fish consumption may depend on the type of fish meal consumed: The cardiovascular health study. Circulation, 107: 1372-1377.
19. Foran, J.A., D.O. Carpenter, M.C. Hamilton, B.A. Knuth and S.J. Schwager, 2005. Risk-based consumption advice for farmed Atlantic and wild pacific salmon contaminated with dioxins and dioxin-like compounds. Environ. Health Perspect., 133: 552-556.
20. Hammed, A.M., F.A. Awe, A.O. Amosu and U.B. Ibrahim, 2020. Evaluation of the nutritional composition (proximate, mineral and amino acids) of Tilapinis (*Tilapia zillii* and *Sarotherodon galilaeaus*) in Badagry creek, Lagos, Nigeria. J. Fish. Aquacult. Res., 5: 64-71.
21. Siddique, M.A.M., P. Mojumder and H. Zamal, 2012. Proximate composition of three commercially available marine dry fishes (*Harpodon nehereus*, *Johnius dussumieri* and *Lepturacanthus savala*). Am. J. Food Technol., 7: 429-436.
22. Solomon, R.J. and A.R. Oluchi, 2018. Proximate analysis and nutritional value of African catfish (*Clarias gariepinus*) fed with local (*Telferia occidentals* and *Moringa olefera*) and industrial feed (Coppens). J. Fish. Livestock Prod., Vol. 6, 10.4172/2332-2608.1000267 .
23. Mohamed, H.A.E., R. Al-Maqbaly and H.M. Mansour, 2010. Proximate composition, amino acid and mineral contents of five commercial Nile fishes in Sudan. Afr. J. Food Sci., 4: 650-654.
24. Keremah, R.I. and G. Amakiri, 2017. Proximate composition of nutrients in fresh adult catfishes: *Chrysichthys nigrodigitatus*, *Heterobranchus bidorsalis* and *Clarias gariepinus* in Yenagoa, Nigeria. Greener J. Agric. Sci., 3: 291-294.

25. Zenebe, T., G. Ahigren and M. Boberg, 1998. Fatty acid content of some freshwater fish of commercial importance from tropical lakes in the Ethiopian Rift Valley. J. Fish Biol., 53: 987-1005.
26. Abdullahi, S.A., 2001. Investigation of Nutritional status of *Chrysichthys nigrodigitatus*, *Bagrus filamentous* and *Auchenoglanis occidentalis*: Family Bagridae. J. Arid Zone Fish., 1: 39-50.
27. Peter, S., S. Chopra and J.J. Jacob, 2013. A fish a day, keeps the cardiologist away!-a review of the effect of omega-3 fatty acids in the cardiovascular system. Indian J. Endocrinol. Metab., 17: 422-429.
28. Ayanwale, A.B., L.O. Olarinde, O.A. Oladunni, K.S. Nokoe, A.A. Adekunle and O. Fatunbi, 2013. Enhancing smallholder farmers income and food security through agricultural research and development in West Africa: Impact of the IAR4D1 in the KKM PLS. Proceedings 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia, pp: 1-25.
29. Amosu, A.O., A.M. Hammed, K.A. Togunde, O.O. Joseph and A. Adekoya, 2017. Possible aquaculture development in Nigeria: Evidence for commercial prospects. J. Agric. Sci. Technol. B, 7: 194-205.
30. Osibona, A.O., 2011. Comparative study of proximate composition, amino and fatty acids of some economically important fish species in Lagos, Nigeria. Afr. J. Food Sci., 5: 581-588.
31. Bankole, N., I. Yem and O. Olowosegun, 2011. Fish resources of lake Kainji, Nigeria. Forty Years on Lake Kainji Fisheries Research, National Institute for Freshwater Fisheries Research, New Bussa, Nigeria.
32. Sarma, D., P.D. Das, P. Das, H.C.S. Bisht, M.S. Akhtar and A. Ciji, 2015. Fatty acid, amino acid and mineral composition of rainbow trout (*Oncorhynchus mykiss*) of Indian Himalaya. Indian J. Anim. Res., 49: 399-404.
33. AOAC., 1995. Official Methods of Analysis. 6th Edn., Association of Official Analytical Chemists, Washington, DC., USA.
34. AOAC., 1990. Official Methods of Analysis. 16th Edn., AOAC., Washington, DC. USA., Pages: 1298.
35. Obreshkova, D.P., K.V. Ivanov, D.D. Tsvetkova and S.A. Pankova, 2012. Quality control of aminoacids in organic foods and food supplements. Int. J. Pharm. Pharm. Sci., 4: 404-409.
36. Watts, S.A., M. Powell and L.R. D'Abramo, 2012. Fundamental approaches to the study of Zebrafi sh Nutrition. ILAR. J., 53: 144-160.
37. Banu, S.S., K. Hareesh and M.S. Reddy, 2016. Evaluation of nutritional status of penaeid prawns through proximate composition studies. Int. J. Fish. Aquat. Stud., 4: 13-19.
38. Ackman, R.G., 1989. Nutritional composition of fats in seafood. Progress Food Nutr. Sci., 13: 161-289.
39. Karacabey, K. and N. Ozdemir, 2013. The effect of nutritional elements on the immune system. J. Obesity Weight Loss Therapy, Vol. 2, 10.4172/2165-7904.1000152 .
40. Steffens, W., 2006. Freshwater fish-wholesome foodstuffs. Bulg. J. Agric. Sci., 12: 320-328.
41. Fatma, S. and I. Ahmed, 2020. Effect of water temperature on protein requirement of Heteropneustes fossilis (Bloch) fry as determined by nutrient deposition, hemato-biochemical parameters and stress resistance response. Fish Aqua. Sci., 10.1186/s41240-020-0147-y
42. Yeannes, M.I. and M.E. Almandos, 2003. Estimation of fish proximate composition starting from water content. J. Food Compos. Anal., 16: 81-92.
43. Fawole, O.O., M.A. Ogundiran, T.A. Ayandiran and O.F. Olagunju, 2007. Proximate and mineral composition in some selected fresh water fishes in Nigeria. Internet J. Food Saf., 9: 52-55.
44. Onwordi, C.T., A.M. Ogungbade and A.D. Wusu, 2009. The proximate and mineral composition of three leafy vegetables commonly consumed in Lagos, Nigeria. Afr. J. Pure Applied Chem., 3: 102-107.
45. Lilly, T.T., J.K. Immaculate and P. Jamila, 2017. Macro and micronutrients of selected marine fishes in Tuticorin, South East coast of India. Int. Food Res. J., 24: 191-201.