ABSTRACT
The protein composition in the body component parts of three scaly fresh water fish species from Zaria was analyzed. Forty (40) samples each of the different sizes of Citharinus citharus, Distichodus rostratus and Alestes brevis were collected from Zaria fish landing sites. The component parts analyzed showed variations in the protein and the calorific values. Variations were also recorded among the species. The protein (and the calorific value) of the C. citharus analyzed, protein (calorific value) varied between 20.25% (111.38±2.30 Kcal/100g) in the viscera and 86.75% (477.13±2.03 Kcal/100g) in the flesh. For the D. rostratus, the lowest protein (calorific value) was obtained in the viscera 30.43% (167.37±2.02 Kcal/100g) and the highest in the flesh 81.56% (448.58±2.50 Kcal/100g). As for the Alestes brevis the protein (and the calorific value) ranged from 42.25% (232.38±3.25 Kcal/100g) in the bone to 83.25% (457.87±4.50 Kcal/100g) in the flesh. In the three scaly fish species investigated, the results showed that the flesh of C. citharus recorded the highest protein 86.75% and the calorific value of (477.13±2.03 Kcal/100g). The analysis of the component parts shows that the protein and as well as the calorific value of the flesh is the greatest, followed by the scale, the head, fin, bone and the least was the viscera. These highly rich protein component parts after processing can be utilized for local consumption.

Keywords: Assessment, Protein, Nutritional Composition, Component parts, Scaly fish.

INTRODUCTION
Fish is a major source of nutrition for people throughout the world as it provides adequate substances necessary for the growth of human body and also reduces the risk of various diseases. Increase in demand of fish from this north – western side of the country and especially in Nigeria has created gaps in local fish supplies and this raises concern since there are reports of limited animal-source food consumption, which may result in protein deficiencies in this region (Abolude and Abdullahi, 2003). To fill the gap, less-preferred scaly fish species such as Citharinus citharus, Distichodus rostratus and Alestes brevis with their body components which were commonly used for animal feeds, can as well be processed and marketed for direct human consumption (Abolude et al, 2006). The genus Citharinus are abundant and important in commercial catches. They are distinctive fishes, with strongly-compressed, silvery bodies having terminal or sub-inferior mouths. Citharinus inhabit rivers and swamps, but they seem to be more abundant in the latter habitat where they are reputed to spawn during the floods. Citharinus grow very rapidly. Those spawn during the floods could grow to 100-120 mm long after 2-3 months, and most especially where these have large areas of shallow water covering grassy banks (Reed et al., 1967). Citharinus has small cycloid scales with more than 60 along the longitudinal line and more than 12 of these scales are in between the lateral line and the pelvic fin. Citharinus citharus (Geoffrey Saint Hilaire, 1809) belongs to the family Citharidae. The family consists of members with broad body, small scales, naked heads, a small adipose fin, jaw bearing numerous minute ciliiform teeth and straight lateral line which passes through the middle of the flank (Adesulu and Sydenham, 2007). C. citharus English name is Moonfish and it is known to the natives as Falla (Hausa), Azumpete (Igbo), Ofou (Jaw), Fulful (Kanuri), Bobogi (Nupe), Osu (Yoruba), Parkato (Bacham) and Evruin in Urhobo (Olaosebikan and Raji, 2004). Its maximum size is 580mm. The base of adipose fin is shorter than the distance between the adipose and the dorsal fin. The anal fin has 26-30 rays. The species has 77-92 scales in the longitudinal line with 17-20 in between the lateral line and the pelvic fin. The species is widely distributed (Olaosebikan and Raji, 2004) and can grow to a maximum length of about 500mm and at least 4 Kg in weight (Reed et al., 1967).

The genus Distichodus, called Chichiyawa by the local Hausa, are commonly called the Grass eaters in English (Reed et al., 1967). Their body is more or less elevated and compressed (body depth 2-3 times in standard length). Distichodus rostratus (Gunther, 1864) belongs to the family Distichodontidae.
The teeth are small, notched or bicuspid. The species inhabit chiefly the grassy edges of rivers and swamps (Adesulu and Sydenham, 2007). Distichodus rostratus is known to the natives as Chihákú (Hausa), Ójo (Igbo), Ówerri (Ijaw), Kama’ (Kanuri), Diaka (Nupe), Epele (Yoruba) and Parkata-parkata to the Bachama tribe (Olaosebikan and Raji, 2004). The dark spots on the dorsal fin form parallel bands with an exceptionally long adipose dorsal fin. It has 11-12 scales between the lateral line and base of the pelvic fins, with about 75-86 scales along its lateral line. The mouth is inferior. The juveniles have numerous spots on the side and it is widely distributed (Olaosebikan and Raji, 2004). D. rostratus according to Reed et al. (1967) is probably the largest species of Distichodus, growing to a length of at least 600mm and a weight of 6 Kg or more.

The Genus Alestes has an adipose lid covering at least part of the eye. Alestes brevis (Boulenger, 1903) belong to the family Characidae. The characins usually move in schools (shoals). They are visual feeders and are usually found in clear, unshaded water surface. The main characteristic of this family is the possession of formidable set of teeth which make them pelagic predators. Cycloid scales cover their entire body except the head (Adesulu and Sydenham, 2007). Alestes brevis is commonly called the African tetras. It is known among the natives as Kawara (Hausa), Elei (Ijaw), Kaya (Kanuri), Egha’i (Nupe), Aj’arapo (Yoruba) and Bo-ngoto to the Bachama tribe according to Olaosebikan and Raji (2004). They are surface water dwelling fishes. The snout is long, with less than three times in the length of the head. The dorsal fin is behind the ventral fins. There is no sexual dimorphism. The body is deep, the depth is less than 3 times in the standard length for adults. It has 21-23 lateral line scales. The scales are very large. The body is olive-green dorsally, lighter laterally and yet lighter ventrally. The yellow tail is deeply forked. The species is widely distributed (Olaosebikan and Raji, 2004; Adesulu and Sydenham, 2007). Alestes brevis can grow to at least 250mm and a weight of more than 1 Kg (Reed et al., 1967).

The economic importance of fish is greater today than ever before and it is steadily growing. At present, approximately 25 million tonnes of fish are procured from the sea water each year. Investigations of ways and means to increase this yield are now being vigorously pursued in many parts of the world with the inclusion of freshwater fisheries. Proteins are the major organic materials in fish tissues, making up about 65 to 75% of the total on dry weight basis (Wilson, 1989). FAO (2012) puts human fish consumption at 130 million tonnes in 2011. In fish, as well as shell fish, a large proportion of the food substances present is protein, being the main source for a billion people. The biological value of fish protein, which is a measure of its usefulness in building the body tissues, is 83%. The proportion of fish protein varies with the fish, fish food, habitat and the component part of the fish concerned (Abolude, 2008). Fish protein is higher than meat and it’s exceeded only by milk and eggs. Low intake of proteins by young children results in Kwashiorkor and Marasmus (Eyo, 2001). Lack of suitable food containing protein of high quality to prevent and arrest these deleterious conditions, impaired health and growth rates are indicative of the protein-calorie malnutrition in Nigeria. The consumption of these fishes will ameliorate these conditions. Presently, there is dearth of information on the nutrient enrichment and calorific values of these three scaly fish species.

Analysis of trends in global animal source for food consumption indicate decreasing fish consumption in developing countries; yet these countries already had low per capita consumption of animal source foods (Speedy, 2003). This situation raises concern because less developed countries continue to record high prevalence of under-nutrition and this is partly attributed to limited dietary intake of nutrient dense foods such as animal-source food products (Kabahenda et al., 2011). Some of the strategies proposed to improve fish supply for human consumption include increased use of under-utilized species and reduction in fish wastage in form of un intended by-catches and post-harvest losses (Sverdrup-Jensen, 1997; Abolude, 2008) but these indigenous fishes are highly valued and fully utilized for local consumption (Abdullahi and Abolude, 2002; Abolude and Abdullahi, 2005).

Scales, fins and visceral of fish normally considered as wastes (fish by-products or wastes), if not discarded can be incorporated into feedstuffs (fish meal) in animal husbandry and in compounding organic fertilizer (Abolude, 2008). Recently, fish-wastes and by-catches (offsals) are being converted into fish protein concentrate (FPC) in which the protein content is more concentrated than in the original fish and this is meant for human consumption (Windsor and Barlow, 1981). Fish consumption is said to have increased drastically thereby widening further the gap between production and demand. In view of the fact that majority of the investigations carried out on the chemical composition of fish were on foreign species and that little information is available on the nutritional values of the local fishes with special reference to the fish-products and fish-wastes of freshwater fishes on this side of the Guinea Savannah zone of Nigeria, it is therefore imperative to comparatively assess the protein nutritional values of the body component parts of Citharinus citharus, Distichodus rostratus and Alestes brevis so as to document their potential contribution to protein nutrient intake of individuals who depend on these products as their major animal source of food.
MATERIALS AND METHODS

Sample collection
Forty (40) samples each of different sizes of the three scaly fish species (Citharinus citharus, Distichodus rostratus and Alestes brevis) were purchased from Zaria fish landing and transported in an ice-box to the laboratory between April and July 2012.

Sample preparation
Whole fish were washed, gutted and oven dried at 105°C for three days. Each different fish sample component (Flesh, Head, Bone, Fin, Viscera and Scale) was crushed with mortar and pestle. The crushed pieces were ground to fine powder using electric blender. Blending was done for 8-10 seconds, stopped and repeated until fine homogeneous powder was obtained. Contamination of fish treated samples was avoided in each treatment. Each sample was packaged in separate labeled plastic bottles, covered and stored in the freezer for crude protein analysis within one week of collection.

Determination of crude protein
Crude protein determination of each fish organ (flesh, head, bone, fin, viscosa and scale) was determined by the Macro-Kjeldahl standard digestion procedure (AOAC, 1999) using sulphuric acid for sample digestion. Total nitrogen was quantified by titrating the distillate against 0.05M hydrochloric acid. Methyline blue and methyl red mixture was used as indicator. Crude protein was obtained by multiplying the nitrogen value (N) by the conversion factor of 6.25. The calorific value of each fish body component sample was also calculated using the Atwater (1880) conversion factor.

Statistical analysis
Data obtained from samples from different components were compared based on the similarity of their chemical compositions and drawn correlations between different concentrations of elements and within various elements. Mini-tab packaged statistical programmer was employed for this stage of work. Using descriptive statistical and F-Test (ANOVA)of the Statistical Package for the Social Science (SPSS, 1999) of the Vogel Back Computing Centre, North western University, Version 13.0 was employed in the analysis. The measure of central tendency used in the analysis was the Mean and Standard Error (S.E.). All data generated during the study were subjected to the analysis of variance as described by Steel and Torrie (1980).The homogeneity of the subsets was derived from the Least Significant Difference (LSD) at t₀.050 significant level. Using the equation:

\[
\text{LSD} = t_{0.050} \sqrt{\frac{2 \times \text{MS}}{\text{DF}}} 
\]

Where: DF = Degree of freedom within the groups.
MS = Mean of square within the groups.
n = number of observations within each species.
The level of significance was set at 95% confidence limit (P =0.05).

RESULTS AND DISCUSSION
The protein (g/100g dry weight) and the protein energy (Kcal/100g dry weight) values are given in Table 1. The average value of the protein in the flesh ranged from 79.85-88.05, head (51.45-57.50), bone (40.15-48.40), fin (47.85-56.55), viscosa (18.60-58.00) and the scale (58.10-68.90). The flesh protein of Citharinus citharus gave the highest protein value (83.25) while the least was obtained in the flesh of D. rostratus (81.56). Protein content is relatively constant in fish, and the variation between the lowest and highest protein content is never more than two times (Stansby, 1987). In terms of protein and calorific enrichment of the entire body components analyzed, Alestes brevis had the highest value. These results show that all the body components of these scaly fishes analyzed are very rich in protein. Ogbe et al. (2008) reported fish materials as the major food item in the stomach of Alestes species. Other food items found include Ephemeroptera larvae, Chironomidae larvae, Diptera, Hemiptera and worms. Citharinus species feeds on planktonic and epipelagic blue-green and green algae (Arowomo, 1976). These could have contributed to the high protein enrichment obtained in the stomach which could have also accounted for the lowest protein level obtained in the organs of these fish species. The low protein obtained in the stomach content analysis of D. rostratus is a pointer to the fact that have been established that D. rostratus feeds more on plant materials than on food of animal origin (Inyang and Nwani, 2004). The high protein composition obtained in the viscosa also point to the fact that while A. brevis is more of a carnivorous feeder, D. rostratus and C. citharus are herbivores, which could be a pointer to the high protein value obtained in A. brevis and low protein obtained in D. Rostratus and C. citharus respectively. The protein content of low-value fish product, Nile perch head has been analyzed (Kabahenda et al., 2011). Protein values (g/100g dry weight) from boiled, deep fried and salted sundried processing methods ranged between 27.26 and 29.38. Vignesh and Srinivasan (2012) also obtained the protein value (g/100g dry weight) of Oreochromis mossambicus head flour to be 32.59. The obtained protein values (g/100g dry weight) in this work varied with the head protein and ranged from 53.55 to 55.78 for A. brevis, C. citharus and D. rostratus.

These values are higher than the obtained head proteins by Kabahenda et al. (2011) and Vignesh and Srinivasan (2012). The proportion of fish protein varies with the fish, fish food, habitat, habitat, the state of the fish and the component part of the fish concerned (Abolude, 2008). The test for significant difference between the protein enrichment in the flesh using the least significant difference at 0.05 level shows that C. citharus had the highest protein followed by A. brevis and lastly by D. rostratus.
The high level of protein obtained in the scale after the flesh of these fishes points to the fact that scales are protective and keratinized in structure (Abolude, 2008). As a whole, *A. brevis* was significantly higher in protein nutritional content, followed by *D. rostratus* and lastly by *C. citharus* (P<0.05) and as for the protein composition of the component parts examined, the flesh > scale > head > fin > bone > viscera. Similar observations have been pointed out (Abolude, 2008).

### Table 1: Protein content (g/100g dry weight) of body component parts of three scaly freshwater fishes from Zaria, Kaduna State, Nigeria

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Flesh (Cal. value)</th>
<th>Head (Cal. value)</th>
<th>Bone (Cal. value)</th>
<th>Fin (Cal. value)</th>
<th>Viscera (Cal. value)</th>
<th>Scale (Cal. value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A. brevis</em></td>
<td>83.25±0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.55±0.55&lt;sup&gt;b&lt;/sup&gt;</td>
<td>42.25±0.45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>52.75±0.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.32±0.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>66.82±0.55&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(457.87±4.50)</td>
<td>(294.53±2.24)</td>
<td>(232.38±3.25)</td>
<td>(29013±3.28)</td>
<td>(309.76±4.20)</td>
<td>(367.51±4.50)</td>
</tr>
<tr>
<td><em>C. citharus</em></td>
<td>86.75±1.32&lt;sup&gt;c&lt;/sup&gt;</td>
<td>53.75±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>46.72±0.40&lt;sup&gt;c&lt;/sup&gt;</td>
<td>49.78±0.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20.25±0.42&lt;sup&gt;c&lt;/sup&gt;</td>
<td>63.20±0.55&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(477.13±2.03)</td>
<td>(295.63±3.53)</td>
<td>(256.96±3.25)</td>
<td>(273.79±3.76)</td>
<td>(111.38±2.30)</td>
<td>(347.60±4.35)</td>
</tr>
<tr>
<td><em>D. rostratus</em></td>
<td>81.56±0.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>55.78±0.45&lt;sup&gt;c&lt;/sup&gt;</td>
<td>43.65±0.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>51.32±0.35&lt;sup&gt;c&lt;/sup&gt;</td>
<td>30.43±0.35&lt;sup&gt;c&lt;/sup&gt;</td>
<td>60.22±0.35&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(448.58±2.50)</td>
<td>(306.79±4.50)</td>
<td>(240.08±2.55)</td>
<td>(282.26±3.02)</td>
<td>(167.37±2.02)</td>
<td>(331.21±3.50)</td>
</tr>
</tbody>
</table>

*Data represent means of triplicate determinations and standard errors.*

<sup>a,b,c</sup>*Same superscript for each component per column are not significantly different (P>0.05).*

Cal. Value = Protein calorific value.

### CONCLUSION AND RECOMMENDATION

These scaly fish species are very rich in protein contents. Their body components are also rich in protein contents and as well as the caloric values. Since the strategies proposed to improve the fish supply for human consumption include increasing the use of underutilized species like *Citharinus citharus, Distichodus rostratus* and *Alestes brevis* and reduction in fish wastages, the high protein percentage composition of these fish component parts point to the fact that these fish (*Citharinus citharus, Distichodus rostratus* and *Alestes brevis*) could be utilized for local consumption after processing.

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