# COMPARATIVE STUDIES ON PROXIMATE COMPOSITION OF AFRICAN LUNG FISH (*Protopterus annectens* OWEN, 1839) AND AFRICAN BONYTONGUE (*Heterotis niloticus* CUVIER, 1829) FROM LAKE ALAU, MAIDUGURI, NORTHEAST NIGERIA

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**ABSTRACT**
*This study investigated the proximate composition of African Lung Fish (Protopterus annectens) and African Bonytongue (Heterotis niloticus) collected from Lake Alau, Maiduguri, northeast Nigeria. Specimens were analyzed for protein, fat, moisture, fibre, ash, and carbohydrate contents using standard procedures of AOAC. P. annectens showed significantly higher values for protein (30.02 ± 4.32%) and moisture (79.81 ± 0.12%), while H. niloticus exhibited higher ash (2.52 ± 0.21%) and carbohydrate (2.35 ± 1.01%) contents. Fat values were 11.83 ± 1.11% for P. annectens and 12.67 ± 1.08% for H. niloticus. Fibre was detected only in P. annectens (1.96 ± 0.13%), while it was below detection level in H. niloticus (0.00 ± 0.00%). The results were benchmarked against FAO standard ranges, indicating both species meet or exceed recommended values for human nutrition. These findings provide baseline data for nutritional assessment and support improved utilization and marketing of these commercially important species.*

**Keywords:** Proximate composition, *Protopterus annectens*, *Heterotis niloticus*, Lake Alau, nutritional quality, Northeast Nigeria

## INTRODUCTION

Fish is one of the most affordable and widely available sources of good-quality animal protein globally, especially in developing countries such as Nigeria. It supplies important nutrients such as vitamins A and D, calcium, iodine, phosphorus, magnesium, selenium, and polyunsaturated fatty acids (PUFAs), all of which are crucial for body growth, immune strength and general health (FAO, 2020; Steffens, 2006; Olapade *et al*., 2016). According to Tacon and Metian (2013), fish makes up more than 20% of the animal protein consumed in many low-income countries with food shortages.

Proximate composition of fish is key to understanding its nutritional value. This includes measuring components like moisture, protein, fat, fibre, ash, and carbohydrates (AOAC, 1995; Gokoglu and Yerlikaya, 2015). These nutritional values can vary greatly based on factors such as the species, habitat, sex, age, season, reproductive status and feeding habits (Olawale *et al.,* 2021; Erkan and Ozden, 2007).

The African Lungfish (*Protopterus annectens*) is known for its resilience in hypoxic environments and ability to aestivate, making it ecologically and commercially important (Purkerson *et al*., 2005). The African Bonytongue (*Heterotis niloticus*) is appreciated for its soft flesh, rapid growth, and increasing aquaculture potential in West and Central Africa (Teugels and Gourène, 1998; Okaeme *et al*., 2003).

Although *H. niloticus* is important both nutritionally and commercially, there is little comparative information despite their economic and nutritional value, limited data exist on the comparative proximate profiles of this species from Lake Alau, a critical inland water body in Borno State, Nigeria. Understanding their nutritional profile is vital for food security, dietary planning, and species prioritization in aquaculture and capture fisheries (FAO, 2020; Daniels, 2021).

This research was carried out to analyze and compare the proximate composition of *P. annectens* and *H. niloticus* from Lake Alau. The result will add to the existing nutritional knowledge and help support effort to promote their consumption, value addition, and potential for aquaculture development.

## MATERIALS AND METHODS

### Study Area

The research was conducted at the fish processing unit of the Federal College of Freshwater Fisheries Technology, Baga (Latitudes 11$^0$51'43" N and Longitudes 13$^0$13'36" E), Kukawa Local Government Area, Borno State. In its temporary site at 6km, Gamboru Ngala road, Lake Chad research institute, Maiduguri Borno state.

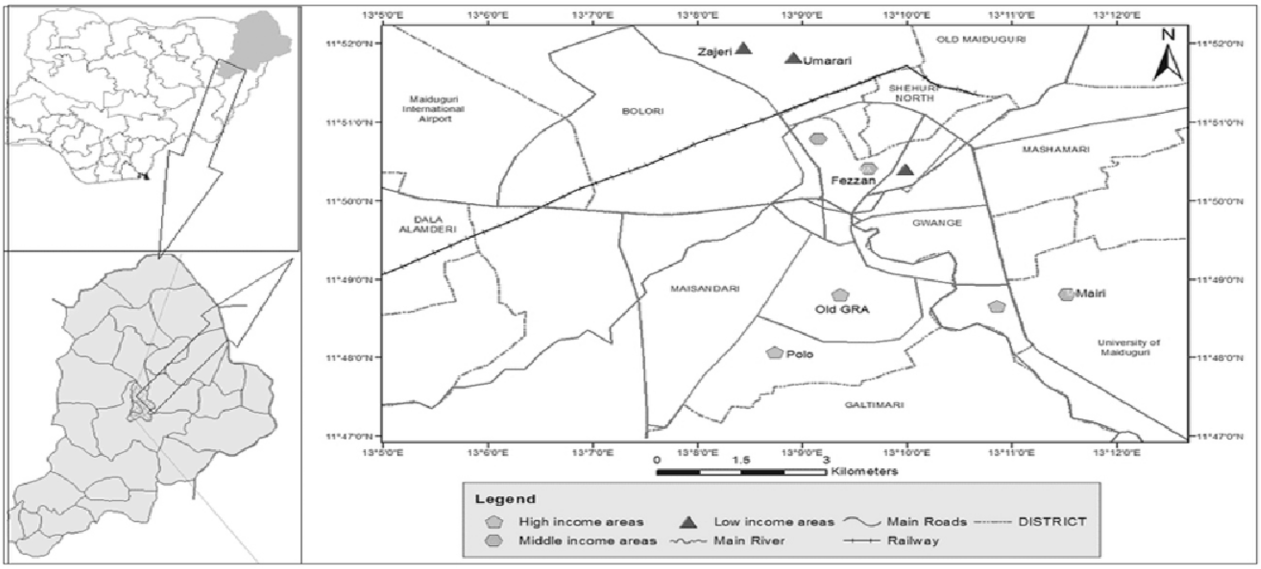


**Figure 1:** Map of Maiduguri showing the study area

**Sample Collection and Preparation**

Nine specimens each of *P. annectens* and *H. niloticus* of smokable sizes with average weight of 353.33 ± 1.61g and 380.29 ± 35.88g respectively were collected directly from fish landings at Lake Alau in August 2024. Fish were weighed and measured using digital weighing scale (Scout Pro SPU202 Model) before being filleted and preserved in ice. Samples were then taken to the University of Maiduguri's Animal Science Laboratory for proximate analysis.

**Proximate Analysis**

Proximate parameters (moisture, crude protein, fat, ash, crude fibre, and carbohydrate) were determined using standard AOAC (1995) methods. Each parameter was computed using appropriate formulas,

**Statistical Analysis**

The data obtained from the proximate analysis were analyzed using ANOVA and Duncan's Multiple Range Test (DMRT) at $p<0.05$ significance level.

**RESULTS**

**Morphometric Characteristics**

Table 1 presents the biometric data of the sampled species were *H. niloticus* had a slightly higher mean weight (380.29±35.88g) compared to *P. annectens* (353.33±1.61g), while the latter had a longer mean length. Both are within the acceptable sizes for smoking.

**Table 1:** Biometric Measurements of *P. annectens and H. niloticus* caught from Lake Alau

| Species | Weight (g) Range | Mean Weight (g) | Length (cm) Range | Mean Length (cm) |
|---|---|---|---|---|
| *P. annectens* | 253.33–453.33 | 353.33 ± 1.61 | 34.66–45.66 | 40.16 ± 1.52 |
| *H. niloticus* | 310.33–450.25 | 380.29 ± 35.88 | 35.01–40.10 | 37.55 ± 1.01 |

**Proximate Composition**

Significant differences ($p<0.05$) were observed in proximate compositions between the two species (Table 2). *P. annectens* had significantly higher protein and moisture content, while *H. niloticus* had higher ash and carbohydrate content. However, fibre was only detected in *P. annectens* and all the results obtained were within the range recommended by FAO.

**Table 2:** Proximate Composition (%) of *P. annectens and H. niloticus* caught from Lake Alau

| Parameter | *P. annectens* | *H. niloticus* | FAO Standard Range (%) |
|---|---|---|---|
| Protein | $30.02 \pm 4.32^{a}$ | $20.56 \pm 0.56^{b}$ | 15 – 24 |
| Fat | $11.83 \pm 1.11^{ab}$ | $12.67 \pm 1.08^{a}$ | 2 – 15 |
| Moisture | $79.81 + 0.12^{a}$ | $61.62 + 1.90^{b}$ | 60 80 |
| Fibre | $1.96 \pm 0.13^{a}$ | $0.00 \pm 0.00^{b}$ | 0 – 2 |
| Ash | $0.66 \pm 0.10^{b}$ | $2.52 \pm 0.21^{a}$ | 1 – 5 |
| Carbohydrate | $0.00 \pm 0.00^{b}$ | $2.35 \pm 1.01^{a}$ | 0 – 3 |

*Means with different superscripts (a, b) across rows are significantly different (p<0.05).*

## DISCUSSION

The results reveal substantial differences in proximate compositions between *P. annectens* and *H. niloticus*. The significantly higher protein content in *P. annectens* aligns with reports by Otuogbai and Ikhenoba (2009 suggesting its suitability for protein-enriched diets. Similar findings were observed by Eyo (2001), who emphasised lungfish as a high-protein species. Higher values of crude protein were observed in scaleless fish compared to scaled fish samples. This result also agrees with Ogbonnaya and Ibrahim, 2009 who worked on proximate composition of catfish *Clarias lazera*. Akter (2015) observed protein content of 12.13±0.01—16.04±0.02% in pre- rainy season and 14.74±0.02—17.92±0.02% in post rainy season for wild and cultured fishes respectively. Olagunju *et al.* (2012) and Fashina *et al.* (2012) recorded 18.80% protein for *Tilapia zilli* as well as 18.71 and 18.08% for *Tilapia guineensis* and *Tilapia mariae*, respectively without probiotics, which are slightly lower than the findings of the present study. High crude Protein value may be due to season of the year, effect of spawning, migration and food availability (Abdullahi 2001). Crude protein content in fish could be affected by physiological condition, nutrition, age and genetic factors.

Moisture content is termed as the amount of water as a percentage (%) and the remaining portion is dry matter content. The major component of fish muscle is moisture. Moisture content was also significantly higher in *P. annectens*, which could be attributed to its physiological adaptations to aestivation. High moisture implies lower shelf life and greater susceptibility to spoilage, corroborating the assertions of Aberoumad and Pourshafi (2010). And again, after this experiment, the weight loss observed in the fresh fish after smoking was as a result of moisture evaporation. This agrees with the finding of Davies and Davies (2009) reported that weight loss during smoking of fish was due to evaporation. Olaniyan and Omodara (2012) reported that drying rate increases with increase in drying temperature showing that temperature is a major factor affecting the drying rate of a product. Consequently, in this study, the percentage weight loss for *H. niloticus* was higher than that of *P. annectens,* and this may be because the lipid content of *H. niloticus is* higher than that of *P. annectens*. In fish there is a vise versa relationship between lipid and moisture, when moisture is low, the lipid will be high (Nestel, 2000).

Ash is a measure of the mineral content of a food item. Conversely, the higher ash and carbohydrate levels in *H. niloticus* suggest better mineral availability, the range of the ash content in this study is an indication that the fish samples may be sources of minerals such as calcium, potassium, zinc, iron and magnesium (Bhandary, 2008) and (Andrew, 2011). It has been reported that high ash content to lower bacterial and fungal activities leading to better shelf life in fishes (Draught, 2014). Which supports the findings by Aberoumad and Pourshafi (2010) on the nutritional richness of *Heterotis niloticus*. The presence of carbohydrates in *H. niloticus* could be linked to its herbivorous tendencies, as diet directly influences biochemical composition.

Fat content did not vary significantly between the two species, indicating similar lipid storage mechanisms. Crude fibre was detected only in *P. annectens*, possibly due to differences in digestive tract structure and feeding habits. These findings are consistent with those reported for freshwater fish species in other African water bodies, including *Clarias gariepinus*, where variations in proximate compositions are influenced by habitat, diet, and reproductive stages (Adewoye and Omotosho, 1997; Moghaddam *et al*., 2007. Fat serves as source of energy during fasting of fish and starvation (Bhandary 2008). The lipid level in the fish tissue is under direct influence of their food and feeding habits (ARL 2012). It was observed, according to Egun *et al.,* 2023, fishes are often classified based on their fat contents, that is, lean fish (< 5 %), medium fat fish (5 –10 %) and fatty fish (> 10 % by weight). Based on this classification, fish species under the present study both *H. niloticus* and *H. niloticus* were classified as fatty fish, Heinz and Hautzinger 2007. It was also reported that the fat level in the fish could have been due to the impact of the feed. There was a difference in the fat content of all the fresh fish because the lipid content of the samples increased as the fish dried.

## CONCLUSION

This study provides a comparative nutritional profile of two commercially important freshwater fish species African Lungfish (*Protopterus annectens*) and African Bonytongue (*Heterotis niloticus*) from Lake Alau, Maiduguri, Northeast Nigeria. The results revealed species-specific differences in proximate composition, with *P. annectens* exhibiting significantly higher protein (30.02 ± 4.32%) and moisture (79.81 ± 0.12%) contents, indicating its superior value as a high-protein, hydrating dietary resource. On the other hand, *H. niloticus* showed higher ash (2.52 ± 0.21%) and carbohydrate (2.35 ± 1.01%) contents, suggesting its mineral richness and potential energy contribution. Notably, fibre was present only in *P. annectens* (1.96 ± 0.13%), while it was absent in *H. niloticus*, likely due to differences in digestive physiology and diet. Fat content was comparable between both species and fell within the acceptable range, supporting their role as sources of essential lipids. All measured values are within the FAO standard nutritional ranges, affirming both species as valuable components of human diets. The findings established a nutritional baseline for promoting consumption, value addition, and sustainable utilization of these fish in local diets and aquaculture systems.

## RECOMMENDATIONS

Based on the findings, it is recommended that *Protopterus annectens*, with its significantly higher protein and moisture content, be prioritized for dietary protein supplementation, particularly in nutritionally vulnerable groups, while *Heterotis niloticus*, due to its higher ash and carbohydrate content, should be considered for mineral and energy-rich food formulations. Processing methods should be optimized for each species extended drying or smoking for *P. annectens* to prevent spoilage due to high moisture, and minimal processing for *H. niloticus* to retain its nutritional value. Aquaculture practices should incorporate both species to meet diverse nutritional needs, and extension services should educate local communities on their respective benefits. Additionally, further research is encouraged on seasonal variations and the effects of different smoking techniques to enhance quality and shelf-life, while regulatory bodies should ensure standardized labeling based on nutritional profiles to support informed consumer choices and promote value addition.

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