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PROXIMATE COMPOSITION OF CULTURED (*Oreochromis niloticus*) AND (*Clarias gariepinus*) BASED ON COMMERCIAL FEED IN BENIN

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ABSTRACT

The aim of this study was to assess and compare the proximate composition of cultured *Oreochromis niloticus* (Linnaeus, 1758) and *Clarias gariepinus* (Burchell, 1822) provided by TONON Foundation in Benin. Thus, thirty (30) samples of fresh fish were categorized into five size intervals each containing six (6) fish such as: [100; 200 g], [300; 500 g] for the Nile tilapia and [300; 500 g], [600; 800 g] and size ≥ 900 g for the African catfish. The biochemical analysis of the moisture, crude protein, ash, dry matter, calcium and iron of the fish fillets were done in the laboratory. The results revealed no significant difference ($p > 0.05$) in crude protein, calcium and ash contents between the two fish species. The percentage of moisture and dry matter were significantly different ($p < 0.05$) in all size intervals and both species, except for the intervals [300; 500 g] and weight ≥ 900 g. This study indicates that the proximate composition in both species varies by size intervals except for crude protein and dry matter. The nutritional values obtained would be useful for the consumers in choosing fish.

Keywords: Clarias, Tilapia, nutritional composition, fillet

1. INTRODUCTION

Fish composite a food of very high nutritional quality, because it is rich in most of vitamins, proteins, minerals, fats and essential amino acids, with high digestibility fillets (about 80 to 98%), and is an important part of human diet (FAO, 1995a; Adam Suieman & Kedji James, 2011). Fish is available at a lower cost than other animal proteins and is recommended in addition to cereal and tuber diets (Fagbenro et al., 2005). Given all this potential, knowledge of its tissue composition is essential to optimize its valorization (Fagbenro et al., 2005), to provide information on its physiological state and nutritional qualities (Azam et al., 2004; Kamal et al., 2007) and comply with international standards (WHO/FAO, 2011). In addition, the nutritional value of the fish is under the considerable influence of the species, production conditions, environment, sexual cycle, stage of maturity, diet, age, organs and muscle localization (Fagbenro et al., 2005; Oladipo & Bankole, 2013) that will need to be considered, as most previous research on freshwater fish species in Africa have focused mainly on the study of their biology and ecology. Limited attention has been given to the nutritional values, flesh yield, and chemical composition of many important freshwater food fish species (Fagbenro et al., 2005). Due to the importance of fish in food (Tobin et al., 2006), the growing interest in the quality and safety of fishery products (Dumas et al., 2010), the influence of quality on demand and prices (Trondsen et al., 2003), this article aims to characterize nutritionally *Clarias gariepinus* (Burchell, 1822) and *Oreochromis niloticus* (Linnaeus, 1758), two main fish species in Benin, for their best valorization.

2. MATERIAL AND METHODS

2.1. Sample preparation

A total of thirty (30) samples of *Oreochromis niloticus* and *Clarias gariepinus* were farmed and provided by the Benin Aquaculture Research and Incubation Centre (CRIAB) and the Toho Aquaculture Incubation Centre (CIAT). The samples were immediately transported to the Soil, Water and Environmental Sciences Laboratory of the National Agriculture Research Institute of Abomey-Calavi (BENIN) where they were weighed and divided into five size intervals each containing six (6) fish such as: [100; 200 g], [300; 500 g] for *O. niloticus*, and [300; 500 g], [600; 800 g] and weight ≥ 900g for *C. gariepinus*. Each group was prepared as described by Olopade et al. (2016): chipped, eviscerated, washed, homogenized, followed by removal of the fillet (portion of flesh) used in human consumption without the head and bowels. All fillets collected by size group were mixed and ground separately for nutritional composition analysis (crude protein, moisture, dry matter, ash, iron and calcium).

2.2. Determination of nutritional composition

The samples were dried in an oven at 105 ° C for 72 hours until constant weight. The water and dry matter content (AOAC, 1990) were determined by successive weighing of the dried sample. The crude protein content was determined by the Kjeldahl method (Matissek et al., 1989) whereas the ash content by incineration of the samples at 550 ° C (AOAC, 1990), and the Iron and Calcium by the Atomic Absorption Spectrophotometry (AAS) assay method described by Kanninkpo (2013).

2.3. Statistical analysis

The R software (version 3.3.2) was used for statistical analysis. The collected data (crude protein, moisture, dry matter, ash, iron and calcium) were subjected to one-way analysis of variance (ANOVA), while the multiple comparison of means was performed using the Tukey-Kramer HSD test.

3. RESULTS AND DISCUSSION

Table 1 shows the nutritional composition (moisture content, crude protein, dry matter, ash, iron and calcium) of *Clarias gariepinus* and *Oreochromis niloticus* cultured in intensive modern system.

Table 1. Proximate composition of cultured Tilapia (*O. niloticus*) and catfish (*C. gariepinus*) used for the study

Fish species	Size inter-vals (g)	Moisture content (%)	Crude Protein (%)	Ash (%)	Dry matter (%)	Iron, Fe (mg/kg)	Calcium, Ca (mg/kg)
Oreo-chromis niloticus	[100; 200]	76.05±0.19[a]	78.76±3.36[a]	5.42±0.20[a]	23.95±0.19[d]	69.36±1.13[a]	2719.37±309.96[b]
	[300; 500]	74.96±0.51[b]	84.11±1.47[a]	5.22±0.04[a]	25.04±0.51[c]	49.15±5.76[b]	2598.50±200.76[b]
Clarias gariepinus	[300; 500]	74.20±0.09[bc]	81.29±3.69[a]	5.17±0.28[a]	25.79±0.09[bc]	39.64±3.77[b]	3300.36±159.88[a]
	[600; 800]	72.41±0.01[d]	78.5±0.09[a]	4.96±0.80[a]	27.59±0.01[a]	39.90±1.38[b]	853.36±11.38[d]
	≥ 900	73.75±0.32[c]	78.31±2.25[a]	4.72±0.14[a]	26.25±0.32[b]	63.57±4.65[a]	2042.87±35.01[c]

Different letters in the same column means that there was significant difference at $p < 0.05$

3.1. Moisture content

The moisture level in *O. niloticus* of the interval [100; 200 g] was significantly different from that of [300; 500 g] (76.05 ± 0.19% vs 74.96 ± 0.51%; $p < 0.05$). This rate decreases when live weight increases. This observation is similar to that reported by Silva et al. (2015). Nevertheless, the values obtained in both intervals, are lower than those of 80.90 and 80.80% found by Job et al. (2015) respectively for wild and farmed *O. niloticus*. Disparities exist in comparison with the literature: raw cultured *O. niloticus* (71.77% to 80.32 ± 0.39%) (Oladipo et al., 2013; El-Zaeem et al., 2012), dried (8.22%) (Oladipo et al., 2013), males (81.11 ± 2.76%), females (81.67 ± 1.66%) (Olopade et al., 2016); fresh wild *O. niloticus* (70.80 ± 0.57 to 74.28 ± 0.07% or even 78.325%) (El-Zaeem et al., 2012; Ayeloja et al., 2013; fresh *O. niloticus* silage (78.32 ± 0.81%) (Ferraz De Arruda et al., 2006); fresh *Tilapia zilli* (67.33 ± 0.60% to 75.8 ± 0.40%) (Fapohunda et al., 2006; Olagunju et al., 2012), dried (4.11 ± 0.06%), deteriorating (6.13 ± 0.03%) (Fapohunda et al., 2006); fresh cultured red tilapia (males: 80.17 ± 2.82%; females: 80.01 ± 2.50%) (Olopade et al., 2016). These differences might be related to the diet, feeding rate, genetic strain, age of fish (Austreng & Refstie, 1979), the level of feed intake, growth (Svasand et al., 1998; Favalora et al., 2002; Flos et al., 2002), the season, the environment, the sexual cycle, stage of maturity, food, organs and also the location of the muscle, then the species. In *C. gariepinus*, the moisture content was 74.20 ± 0.09; 72.41 ± 0.01 and 73.75 ± 0.32% respectively for the size intervals [300; 500 g], [600; 800 g], and weight ≥ 900 g. The differences are significant ($p < 0.05$), except for the groups [300; 500 g] and weight ≥ 900 g. The values obtained in this study are higher than those reported (56.99 ± 0.80 and 6.52 ± 0.09) by Fapohunda et al. (2006) and also (70.35 and 18.32%) by Oladipo et al. (2013) for fresh and dried *C. gariepinus* respectively; then (4.61 ± 0.03%) for deteriorating African catfish (Fapohunda et al., 2006). However, these values are lower compared to that of 75.085% reported by Ayeloja et al. (2013) for wild *C. gariepinus*. The percentage of moisture of both size intervals in Nile tilapia was higher than that of the three size intervals of *C. gariepinus*. Similar observation was reported by Olagunju et al. (2012) and Ayeloja et al. (2013). Nevertheless, there was no significant difference ($p > 0.05$) in the percentage of moisture for the weight interval [300; 500 g] in both species.

3.2. Crude protein content

The crude protein content in *O. niloticus* was 78.76 ± 3.36 for the size interval [100; 200 g] and 84.11 ± 1.47% for [300; 500 g], whereas in *C gariepinus* the percentages obtained were 81.29 ± 3.69; 78.5 ± 0.09 and 78.31 ± 2.25% respectively for the groups [300; 500 g]; [600; 800 g] and for weight ≥ 900 g. There was no significant difference ($p > 0.05$) in the percentage of crude protein composition of the five size intervals in the two fish species. The results also revealed in *O. niloticus* that the crude protein content increases when the body weight increases. Similar to our findings, increased raw fish fillet crude protein content was reported with increased body weight for the same species (Silva et al., 2015). Nevertheless, the opposite effect was observed in *C. gariepinus*. The crude protein content of the five size intervals of the African catfish and Nile tilapia in this study were all higher than the values reported by Oladipo et al. (2013) for fresh and dried catfish and tilapia. However, lower percentages of crude protein content compared to the results of this study were reported for *O. niloticus* by El-Zaeem et al. (2012).

3.3. Ash content

The raw fillet ash content in *O. niloticus* was 5.42 ± 0.20% for the size interval [100; 200 g] and 5.22 ± 0.04 for [300; 500 g], while the values obtained in *C. gariepinus* were 5.17 ± 0.28; 4.96 ± 0.80 and 4.72 ± 0.14 respectively for the groups [300; 500 g]; [600; 800 g] and for weight ≥ 900 g. There was no significant difference ($p>0.05$) in the percentage of ash composition of the five size intervals in the two fish species. Conversely, higher ash content was reported in *C. gariepinus* than in *O. niloticus* by Ayeloja et al. (2013). However, the results also revealed in the two fish species a decrease of the ash content with the increase of body weight. This agrees with an earlier work by Silva et al. (2015) on cage-farmed *O. niloticus*.

3.4. Dry matter content

The mean dry matter content obtained for raw fillets in *O. niloticus* was 23.95 ± 0.19% for the size interval [100; 200 g] and 25.04 ± 0.51% for [300; 500 g], without any significant difference ($p > 0.05$). The results revealed the increase of the dry matter content with the increase of the fish body weight. In *C. gariepinus*, the dry matter content values obtained were 25.79 ± 0.09; 27.59 ± 0.01 and 26.25 ± 0.32% respectively for the size intervals [300; 500], [600; 800 g] and for weight ≥ 900 g, showing significant difference ($p < 0.05$), except for the groups [300; 500 g] and weight ≥ 900 g. An earlier work by Fagbenro et al. (2005) reported a higher dry matter content 26.49 ± 0.04 % compared to this study for the size interval [300; 500 g] in *C. gariepinus*. In addition, the dry matter content obtained in this study for the three size groups in *C. gariepinus* were lower than that reported by Obaroh et al. (2015). However, there is no significant difference (p> 0.05) in that parameter for the two fish species belonging to the group [300; 500 g].

3.5. Iron content

The iron content of raw fillet in *O. niloticus* was 69.36 ± 1.13 mg/kg for the size interval [100; 200 g] and 49.15 ± 5.76 mg/kg for [300; 500 g]. Therefore indicating that there is significant difference (p <0.05) between the two groups. The results also revealed that the Fe content decreases when fish body weight increases. Compared to this result, a higher Fe content was reported by Job et al. (2015) in wild *O. niloticus*. This suggests the influence of rearing conditions on Fe concentration. The iron level of farmed *C. gariepinus* was found to be 39.64 ± 3.77; 39.90 ± 1.38 and 63.57 ± 4.65 mg/kg respectively for the size intervals [300; 500 g], [600; 800 g] and weight ≥ 900 g. They were all positively correlated with the weight of the fish. There was no significant difference (p>0.05) for Fe content in both fish species for the groups [100; 200 g] and weight ≥ 900 g on the one hand, and for the intervals [300; 500] and [600; 800 g] on the other hand. However, the iron content obtained for the African catfish in this study was higher than the value 25.89 ± 1.85 mg/kg reported for wild *C. gariepinus* by Teame et al.(2016), showing the superiority of farmed catfish.

3.6. Calcium content

Calcium content (mg/kg) decreases with increasing body weight. It varied from 2719.37 ± 309.96 [100; 200 g] to 2598.50 ± 200.76 [300; 500 g] for *O. niloticus* and from 3300.36 ± 159.88 [300; 500 g] to 853, 36 ± 11.38 [600; 800 g] and 2042.87 ± 35.01 for weight ≥ 900 in *C. gariepinus*. The lowest value showed by the catfish group [600; 800 g] might be due to an artifact, and deserves to be investigated deeply in a future study. There was a significant difference (p <0.05) in the calcium content of all size intervals in *C. gariepinus* and between the two fish species. However, there is no significant difference (p> 0.05) for this parameter between the size intervals of *O. niloticus*. Overall, mineral concentrations in fish muscle, as observed in this study, might be influenced by different biological factors (Khitouni et al., 2010; Kozlova, 1997; Gockse et al., 2004; Zlatanos & Laskaridis, 2007; Noel et al., 2011; Roy & Lall, 2006; Younis et al., 2014), all of which could not be evaluated in this study. Nevertheless, the values of calcium content for *C. gariepinus* in this study are higher than 4.318 ± 0.59 to 123.55 ± 4.47 mg/kg reported by Obany et al.(2016) and Teame et al.(2016) for the same species caught in the wild, and 4.015 ± 0.47 mg/kg for farmed *C. gariepinus* (Obany et al., 2016). Very high calcium levels of 30400 mg/kg and 42700 mg/kg have been reported respectively for dark coloured muscle and light coloured muscle of the African sharptooth catfish *C. gariepinus* by Hoffman et al. (1995). In addition, the calcium content values of *O. niloticus* are higher than 297.75 mg/kg reported by Hernandez Sanchez & Aguilera-Morales (2012) and lower than 4761.5 mg/kg indicated by the same authors for whole body of farmed *Tilapia nilotica*.

4. CONCLUSION

This work based on the comparative study of the nutritional value of *C. gariepinus* and *O. niloticus* at different weight intervals revealed that both species are excellent sources of protein, iron and calcium. Although the protein content was equivalent in the two farmed fish species, the results obtained revealed the nutritional superiority of *O. niloticus* compared to *C. gariepinus*, for the moisture and iron content. In addition, this work contributes to develop a database on the nutritional composition of fish fillet, and would help consumers to make their choices based on the nutritional value of fish.

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