Original Research Article

Proximate and Mineral Compositions of Different Fish Species from Yamama Lake in Kalgo Local Government Area of Kebbi State, Nigeria

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Abstract

The proximate and mineral compositions of different fish species (Lates niloticus, Gymnarchus niloticus, Hydrocynus forskali, Oreochromis niloticus, Heterotis niloticus, Tilapia zilli, Distichodus brevipinnis, Mormyrus rume, Clarias gariepinus, and Bagrus domac, designated T1 - T10 respectively) caught from Yamama Lake, Kalgo Local Government Area of Kebbi State, Nigeria were evaluated. Thirty pieces of the ten freshly caught fish species were collected from the landing site of Yamama Lake in a plastic container containing ice blocks, and taken to the Agriculture/Chemical Laboratory, Usmanu Danfodio University, Sokoto for analysis. The results indicated that T10 (Bagrus domac) had the highest moisture content (73.52±0.02 %), though it was not significantly different (P>0.05) from T1 (Lates niloticus), while the least value (65.53±0.02 %) was recorded from T6 (Tilapia zilli). T8 (Mormyrus rume) had highest protein content (23.05±0.02 %), while T10 had the least (16.47±0.01 %). For mineral composition, T7 (Distichodus brevipinnis) had the highest sodium content (87.53±0.01 mg/kg), while T9 (Clarias gariepinus) recorded the least value (1503.33±2.03 mg/kg) in potassium content. Oreochromis niloticus (T4) had the highest magnesium content (37.24±0.02 mg/kg), while the least value (3.85±0.01 mg/kg) was recorded in phosphorus content for T4 and T5 (Oreochromis niloticus, Heterotis niloticus respectively). The nutrient profiles of these fish species will provide information to dieticians, nutritionist, livestock farmers, marketing industries and other fisheries stakeholders.

Keywords: Fish species; nutrient profile; proximate; mineral; Yamama Lake

Introduction

Fish is known to be one of the cheapest sources of animal protein and other vital nutrients required in human food (Sadiku and Oladimeji, 1991). It is cherished by many, contains a wide variety of important nutritional components, and so serves as a good source of energy in human and animal diets, and contains easily digestible high-quality protein containing all the essential amino acids,
vitamin and minerals. It is therefore ideal for young and as well as elderly people (Edem, 2009; Sutharshiny and Sivashanthini, 2011). Fish permits for protein improved nutrition in that it has a high biological value in terms of high protein retention in the body (Fagbenro et al., 2005). This is an indication that there is higher assimilation of protein of fish origin as compared to other animal protein sources. The low cholesterol content of its oils makes fish one of the safest animal protein sources (Adebowale et al., 2008). Data on proximate and mineral contents of fish are important in assisting nutritionists, dieticians and consumers to estimate intake required to provide the principal nutrients in human di¿ts, and calculate energy values of di¿ts (Babalola et al., 2011). Therefore, information concerning the mineral and chemical compositions of freshwater fishes, in general, is valuable to nutritionists and dieticians concerned with providing readily available sources of low-fat, high-protein foods to children, patients and the elderly (Sadiku and Oladimeji, 1991; Foran et al., 2005). Determination of the proximate profiles of fishes is often necessary to ensure that they meet the requirement of food regulations and commercial specification (Waterman, 2000; Emmanuel et al., 2011). The nutrient profiles of freshwater fishes are often not available for food regulation and commercial specification requirements, particularly in places where fish contributes signi¿cantly to the protein intake of the people (Waterman, 2000). Mineral elements are also needed in minute quantities for the proper functioning of the human system, healthy growth and development (Angeline and Krishnakumari, 2015). Sutharshiny and Sivashanthini (2011) reported that several studies on proximate composition of fish have been made from di¿erent parts of the world. However, there is paucity of data concerning the proximate and mineral contents of fishes from Yamama Lake. This study was therefore done to provide data on the proximate and mineral contents of ten di¿erent fish species from Yamama Lake.

Materials and Methods

Description of the study area

Yamama Lake is a eutrophic, perennial, natural standing freshwater body located between latitudes 11°20’ – 12° North and longitudes 04°13’ – 06° East.

![Figure 1: A sketch of Kebbi State Map indicating Yamama Lake.](image-url)
Yamama Lake is an oxbow lake formed by the Shella River, which sometimes floods into the lake. The lake stretches some 900m in length and is 195m wide at its broadest point (Figure 1), giving a surface area of about 18 hectares (Abiodun, 2008).

Sample selection and collection

Thirty (30) pieces of ten (10) of the frequently caught and available fish species at the Yamama Lake landing site were selected for this study. The samples were collected in a plastic container containing ice blocks, and taken to the Agriculture Chemical Laboratory, Usmanu Danfodio University, Sokoto, Nigeria for analysis.

Sample identification and preparation

The collected samples were identified using a field guide by Olaosebikan and Raji (2004), weighed using a sensitive balance (Tanita KD-160: Model), and measured with a plastic ruler. The experiment was conducted using ten different fish species, replicated thrice, and designated as T1 (Lates niloticus), T2 (Gymnarchus niloticus), T3 (Hydrocynus forskali), T4 (Oreochromis niloticus), T5 (Heterotis niloticus), T6 (Tilapia zilli), T7 (Distichodus brevipinus), T8 (Mormyrus rume), T9 (Clarias gariepinus), and T10 (Bagrus domac) as shown in Table 1.

Determination of proximate and mineral compositions

The analyses were conducted in three replicates. The proximate compositions such as moisture, ash, ether extract, crude fibre, crude protein and nitrogen-free extract were analyzed. The total nitrogen was determined by the Kjeldahl method, and a conversion factor of 6.25 was used to obtain the crude protein of the fish samples. The ether extract was determined using the soxhlet extraction method by weighing the filter paper, fish sample and addition of petroleum ether to continuously extract the fat content at 40°C until the ether had siphoned over the barrel. Ash content of each sample was determined by igniting the sample at 550°C in a Gooch crucible inside a Muffle Furnace (Model: M110) for an hour until the sample was completely free from carbon particles. The Nitrogen Free Extract (NFE) was determined by difference thus: NFE (%) = 100 – (%ash + %crude fibre + %ether extract + %crude protein). The mineral (carbon, sodium, potassium, calcium, magnesium and phosphorus) contents were determined according to the methods recommended by the Association of Official Analytical Chemists (AOAC, 2005).

Data analysis

The collected data were subjected to analysis of variance (ANOVA) to test the significant differences among the treatment means. Where a significant difference or differences existed, Duncan’s Multiple Range Test (DMRT) was applied to rank the treatment means at 5% level of significance. All statistical analyses were done using MINITAB (V14) statistical package for Windows.
Table 1: Mean weight and length of the sample fish species

<table>
<thead>
<tr>
<th>Samples</th>
<th>Weight (g)</th>
<th>Standard Length (cm)</th>
<th>Total Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>248.15</td>
<td>22.70</td>
<td>26.50</td>
</tr>
<tr>
<td>T2</td>
<td>121.20</td>
<td>36.90</td>
<td>42.00</td>
</tr>
<tr>
<td>T3</td>
<td>208.33</td>
<td>33.70</td>
<td>35.50</td>
</tr>
<tr>
<td>T4</td>
<td>186.07</td>
<td>18.40</td>
<td>22.30</td>
</tr>
<tr>
<td>T5</td>
<td>154.30</td>
<td>23.90</td>
<td>26.60</td>
</tr>
<tr>
<td>T6</td>
<td>129.50</td>
<td>15.20</td>
<td>18.00</td>
</tr>
<tr>
<td>T7</td>
<td>63.00</td>
<td>13.60</td>
<td>17.10</td>
</tr>
<tr>
<td>T8</td>
<td>48.60</td>
<td>15.80</td>
<td>17.70</td>
</tr>
<tr>
<td>T9</td>
<td>91.30</td>
<td>21.20</td>
<td>25.10</td>
</tr>
<tr>
<td>T10</td>
<td>83.90</td>
<td>19.80</td>
<td>23.30</td>
</tr>
</tbody>
</table>

T1 = Lates niloticus, T2 = Gymnarchus niloticus, T3 = Hydrocynus forskali, T4 = Oreochromis niloticus, T5 = Heterotis niloticus, T6 = Tilapia zilli, T7 = Distichodus brevipinnis, T8 = Mormyrus rume, T9 = Clarias gariepinus, T10 = Bagrus domac

Results

The proximate compositions (moisture content, ash content, ether extract, crude fibre, crude protein and nitrogen-free extract) of the different fish species from Yamama Lake are shown in Table 2.

Table 2: Mean±SE Proximate composition (wet) of different fish species from Yamama Lake

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Moisture content (%)</th>
<th>Ash content (%)</th>
<th>Ether extract (%)</th>
<th>Crude fibre (%)</th>
<th>Crude protein (%)</th>
<th>NFE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>72.49±0.01a</td>
<td>3.02±0.01b</td>
<td>2.52±0.02c</td>
<td>0.57±0.01b</td>
<td>19.62±0.01c</td>
<td>1.78±0.01cd</td>
</tr>
<tr>
<td>T2</td>
<td>71.01±0.01b</td>
<td>2.03±0.01c</td>
<td>1.54±0.02d</td>
<td>0.03±0.01c</td>
<td>21.64±0.02a</td>
<td>3.75±0.03c</td>
</tr>
<tr>
<td>T3</td>
<td>70.02±0.01d</td>
<td>3.02±0.01b</td>
<td>3.04±0.02bc</td>
<td>1.02±0.01a</td>
<td>22.44±0.02a</td>
<td>0.46±0.01e</td>
</tr>
<tr>
<td>T4</td>
<td>69.51±0.01e</td>
<td>3.53±0.02a</td>
<td>3.04±0.01bc</td>
<td>0.55±0.02b</td>
<td>20.25±0.02b</td>
<td>3.12±0.01c</td>
</tr>
<tr>
<td>T5</td>
<td>70.52±0.01c</td>
<td>3.05±0.03b</td>
<td>2.53±0.01c</td>
<td>0.04±0.02c</td>
<td>19.18±0.01c</td>
<td>4.68±0.02c</td>
</tr>
<tr>
<td>T6</td>
<td>65.53±0.02g</td>
<td>3.06±0.02b</td>
<td>2.54±0.02c</td>
<td>0.02±0.01c</td>
<td>19.36±0.01d</td>
<td>9.49±0.76a</td>
</tr>
<tr>
<td>T7</td>
<td>69.52±0.02e</td>
<td>2.06±0.02a</td>
<td>4.19±0.66a</td>
<td>0.04±0.02c</td>
<td>23.28±0.01a</td>
<td>0.91±0.00f</td>
</tr>
<tr>
<td>T8</td>
<td>69.02±0.01f</td>
<td>1.53±0.01d</td>
<td>3.55±0.02b</td>
<td>0.06±0.01c</td>
<td>23.05±0.02a</td>
<td>2.79±0.02d</td>
</tr>
<tr>
<td>T9</td>
<td>70.53±0.01c</td>
<td>1.52±0.01d</td>
<td>1.55±0.01d</td>
<td>0.03±0.01c</td>
<td>15.94±0.01f</td>
<td>10.43±0.38a</td>
</tr>
<tr>
<td>T10</td>
<td>73.52±0.02a</td>
<td>1.55±0.02d</td>
<td>1.04±0.01d</td>
<td>0.04±0.01c</td>
<td>16.47±0.01f</td>
<td>7.38±0.22ab</td>
</tr>
</tbody>
</table>

Means with different superscripts in the same column are significantly different (P<0.05)

Keys: NFE = Nitrogen free extract, T1 = Lates niloticus, T2 = Gymnarchus niloticus, T3 = Hydrocynus forskali, T4 = Oreochromis niloticus, T5 = Heterotis niloticus, T6 = Tilapia zilli, T7 = Distichodus brevipinnis, T8 = Mormyrus rume, T9 = Clarias gariepinus, T10 = Bagrus domac
There was no significant difference (P>0.05) between T1 and T10 in mean moisture content, although both had significantly (P<0.05) more moisture than other species. Values range from 65.53% to 73.52%. T7 (4.19%) had the highest ether extract while T10 (1.04%) had the least, though there are no significant differences between T3 and T4. In protein content, T3 had the highest (22.44%) while T9 (15.94%) had the least. However, there were no significant differences in crude protein between T2, T3, T7 and T8 respectively.

The mineral compositions of the different fish species from Yamama Lake are presented in Table 3. The carbon contents of T1 and T10 were similar (P>0.05), but were each significantly higher than those of the other species. However, T10 (42.65 mg/kg) had the highest value, while T6 (38.65 mg/kg) had the least. In magnesium, T9 (25.26 mg/kg) had the least value while T4 (37.24 mg/kg) had the highest, though there were no significant differences between T2, T4, T7 and T8 respectively.

**Table 3: Mean±SE Mineral composition (wet) of different fish species from Yamama Lake**

<table>
<thead>
<tr>
<th>Treatment/Parameters</th>
<th>Carbon (mg/kg)</th>
<th>Sodium (mg/kg)</th>
<th>Potassium (mg/kg)</th>
<th>Calcium (mg/kg)</th>
<th>Magnesium (mg/kg)</th>
<th>Phosphorus (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>42.07±0.01</td>
<td>77.51±0.01</td>
<td>2101.00±0.58</td>
<td>50.03±0.02</td>
<td>4.06±0.01</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>41.19±0.00</td>
<td>55.04±0.02</td>
<td>1701.00±1.00</td>
<td>40.02±0.01</td>
<td>3.80±0.01</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>40.63±0.01</td>
<td>72.52±0.02</td>
<td>2304.00±2.08</td>
<td>34.06±0.02</td>
<td>3.96±0.02</td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td>40.33±0.01</td>
<td>82.52±0.02</td>
<td>2502.33±1.86</td>
<td>52.02±0.01</td>
<td>3.85±0.01</td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>40.88±0.01</td>
<td>70.02±0.02</td>
<td>1901.66±0.88</td>
<td>42.04±0.02</td>
<td>3.88±0.01</td>
<td></td>
</tr>
<tr>
<td>T6</td>
<td>38.65±0.67</td>
<td>62.55±0.02</td>
<td>1906.33±1.45</td>
<td>46.04±0.03</td>
<td>3.85±0.02</td>
<td></td>
</tr>
<tr>
<td>T7</td>
<td>40.33±0.01</td>
<td>87.53±0.01</td>
<td>2205.00±1.53</td>
<td>38.04±0.01</td>
<td>4.08±0.01</td>
<td></td>
</tr>
<tr>
<td>T8</td>
<td>40.04±0.02</td>
<td>80.04±0.02</td>
<td>1902.33±1.86</td>
<td>42.03±0.02</td>
<td>4.04±0.01</td>
<td></td>
</tr>
<tr>
<td>T9</td>
<td>40.89±0.00</td>
<td>52.55±0.02</td>
<td>1503.33±2.03</td>
<td>20.03±0.01</td>
<td>4.69±1.00</td>
<td></td>
</tr>
<tr>
<td>T10</td>
<td>42.65±0.01</td>
<td>75.02±0.01</td>
<td>1802.33±1.20</td>
<td>30.03±0.02</td>
<td>4.22±0.65</td>
<td></td>
</tr>
</tbody>
</table>

Mean with the same superscript along the same column are not significantly different (P≥0.05)

**Keys:** T1 = Lates niloticus, T2 = Gymnarchus niloticus, T3 = Hydrocynus forskali, T4 = Oreochromis niloticus, T5 = Heterotis niloticus, T6 = Tilapia zilli, T7 = Distichodus brevipinmis, T8 = Mormyrus rume, T9 = Clarias gariepinus, T10 = Bagrus domac

**Discussion**

The moisture content of the sample fish species is an indication of the wetness caused by water, and could also be due to the stable water levels in the environmental location where the fish were collected from (Olagunju et al., 2012). The moisture content values obtained from this study differ from the result earlier reported by Sankar et al. (2013) in their work on the microbial content and proximate composition of six marine fish species in Mudasalodai coastal region. The variation may be attributed to the different water bodies. However, moisture content is one of the limiting factors in deciding the storage life of cured fishery products (Nurullah et al., 2007), and its
quantitative determination is absolutely essential in any quality control programme for such products.

The lipid (ether extract) values recorded in this study corroborate with the lipid content of *C. senegalensis* and *P. quadrifillis* reported by Daniel (2015) while investigating the proximate composition of three commercial fishes commonly consumed in Akwa Ibom State, Nigeria. Alasalvar *et al.* (2002) reported that lipids from fish are well known as a rich source of some long-chain n-3 polyunsaturated fatty acids which cannot be synthesized by humans from their diets. Usually, moisture and lipid contents in fish are co-related inversely (Anthony *et al.*, 2000), and the lipid content directly related to the nutritional quality of the fish (Begum *et al.*, 2012).

The protein content recorded in this study is an indication of the protein-rich nature of the sampled fishes. The result obtained is similar to the report of Heliene *et al.* (2016) where they reported 19.7 – 23.00 % protein while evaluating the chemical composition of fish species captured in the lower stretch of Itapecuru River. Fishes are well known to be vital sources of good quality digestible protein (Abdul and Sarojnalini, 2012), as they contain all the naturally-occurring amino acids (Louka *et al.*, 2004). Wu *et al.* (2014) reported that proteins contribute to a wide variety of functions within each cell, ranging from being structural materials to performing mechanical functions in muscular tissues. However, the protein content in fish may vary with species due to factors as differences in genotype, seasons of the year, the effect of spawning, migration and food availability (Abdullahi, 2001).

The ash contents from this study varied from the result reported by Kasozi *et al.* (2014). These researchers reported a considerably higher value than those obtained in the present study. The variations may be attributed to the inherent differences in the fish species. The nutritional components of the freshwater fishes tend to differ among species, sexes, sizes, season and geographical localities (Zenebe *et al.*, 1998). Waterman (2000) reported that the measurement of proximate profiles are often necessary to ensure that they meet the requirements of food regulations, and commercial specification.

The calcium and phosphorus values recorded in this study were lower than those reported by Palani *et al.* (2014). The variation may be attributed to different fish species and method of analysis. Calcium and phosphorus are the main constituents of the bone skeletons, and are important for regulating many vital cellular activities such as nerve and muscle function, hormonal actions, blood clotting and cellular mortality (Sakina *et al.*, 2013). Calcium is essential for healthy bones, teeth and blood (Charles, 1992). Phosphorus maintain blood sugar level, normal heart concentration, and also important for normal cell growth and repairs (Linder, 1991). Indrayan *et al.* (2005) reported that phosphorus helps in the process of ossification of bones by getting deposited in the form of calcium phosphate.

The sodium, potassium and magnesium values recorded corroborate with the result reported by Egbal *et al.* (2017) while investigating the proximate and mineral composition of some commercially important fishes in Jebl Awlia Reservoir. These may be attributed to the same fish
species sampled. Shefat (2018) reported that mineral deficiencies in fish resulted in skeletal deformities, reduced resistance to diseases and anaemia. However, Ndungi (1985) reported that in human, deficiency in sodium can result in restlessness, cramp, and can also cause poor appetite and loss of weight.

Conclusion

In conclusion, the proximate and mineral contents of these fishes indicate their great potential to fish farming and possible inclusion in human and livestock diets, and use in the pharmaceutical and marketing industries. Since fish from the Yamama Lake contain high quality proteins and other nutrients which can promote overall health as well as control specific nutritional diseases, it is recommended that the government and other fisheries stakeholders should afford the Lake the necessary attention it deserves, as it is currently underutilized despite its valued fish products.

References


