PROXIMATE COMPOSITION AND MICROBIAL ANALYSIS OF COMMON MARINE FISHES CONSUMED IN MAIDUGURI METROPOLIS, BORNO STATE, NIGERIA

*1BELLO, MUINAT M., 2OYEBOLA, OYEDIRAN O. AND 1LAWAL, TIWUYA H.

1Department of Fisheries, University of Maiduguri, Maiduguri, Borno State, Nigeria
2Department of Aquaculture and Fisheries Management, University of Ibadan, Nigeria.

Abstract
Marine fishes are fish that spend some or all their life in salt water such as ocean. There is need to preserve catch and harvested fish to avoid deterioration in the time gap prior to consumption. The aim of this study was

INTRODUCTION
Fishes are aquatic vertebrate that are typically cold blooded animals which are equipped with two sets of paired and several unpaired fins. A typical fish has a streamlined body that allows it to swim rapidly and obtained oxygen from the water using gills or accessory breathing organs in some species like mud fish which enable them to survive longer even outside water environment (Eyo, 2001). Fishes are greatly perishable but very important foodstuff, especially in third world countries, due to its high protein content and its affordability when compared with beef or pork (Edem, 2009). Nigeria is among the largest consumer of
to determine proximate composition (moisture, protein, ash, lipid, fibre and carbohydrate) and microbial spoilage in four marine fishes. Four marine fishes studied were, Clupea harengus, Trachurus trachurus, Scomber scombrus, and Micropogonias undulates, which were transported from Lagos 1565km away from Maiduguri. The proximate analysis revealed that, moisture content of Clupea harengus was 78.03±0.18%, Trachurus trachurus 71.72±0.49%, Scomber scombrus 68.54±0.29% and Micropogonias undulates 68.74±0.06% in the fresh state. The protein, ash, lipid, fibre and carbohydrate ranged from 19.22±0.02% to 20.82±0.14%, 1.22±0.3% to 1.53±0.12%, 1.22±0.59% to 8.56±0.57%, 0.10±0.54% to 0.50±0.31% and 3.67±0.18% to 0.50±0.31%, respectively.

Microbiological analysis showed that total viable count (TVC) varied between $4.01 \times 10^5$ and $6.37 \times 10^5$ cfu/g. The bacteria isolated on each of the four species include: Staphylococcus aureus, Bacillus aereus, Aeromonas Spp. and Salmonella-shigella, species. However, fungi were not found in these four samples. Conclusively, the proximate composition and microbial load are within the safe levels, which cause no harm to human and fit for consumption.

Fish and it remain one of the main products consumed in term of animal protein. It is cheap and highly acceptable with little or no religious bias, which gives it an advantage over pork or beef (Eyo, 2001). Nigerian is blessed with numerous water bodies, ranging from the marine (Atlantic Ocean), through the brackish water (Estuaries) to inland fresh water (Rivers and streams) (Omorinkoba et al., 2011). Omorinkoba et al. (2011) reported that the inland water bodies in Nigeria are estimated at over 14 million hectares that are being fished predominantly by artisanal fishermen. The Nigeria coastline is about 900 km in length with a total shelf area of about 42,000 km². Only about 50% of the demand of fish is currently being met by suppliers. In 2010, the fishery sectors estimated to
contribute 3.5% of Nigeria gross domestic product (GDP) and provide direct and indirect employment (Trade Investment Nigeria, 2010). However, measurements of some proximate profiles such as protein, lipids and moisture contents are often necessary to ensure that they meet the requirements of food regulations and commercial specifications (Tawfik, 2009; Surtharshiny and Sivashanthini, 2011). This study was therefore carried out to determine the proximate composition (moisture, protein, ash, lipid, fibre and carbohydrate), and microbial load on four marine fish species collected from Maiduguri market, Borno State.

**Materials and Methods**

Borno State, with Maiduguri as capital, which is located at latitude 11˚50'0"N and longitude 11˚85'0"N 13˚50'0"E, is one of the inland states contributing significantly to Nigeria domestic supply of freshwater fisheries products. Its location and accessibility to the Chad Basin, as well as its numerous networks of intra and inter trading in fisheries products. As presented in Table 1, four fish species were studied. These species were the most commonly consumed and available in Maiduguri. A total of 200 g of the fishes each were purchased from the local marine fish wholesaler, in the frozen state from cold store and immediately transported using a cold flask to retain freshness to the National Agency for Food and Drug Administration and Control (NAFDAC) laboratory for analysis on proximate composition and microbial load.

Table 1: List of common marine fish species consumed in Maiduguri metropolis Borno state

<table>
<thead>
<tr>
<th>Local name</th>
<th>Common name</th>
<th>Scientific name</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shawa</td>
<td>Atlantic Herring</td>
<td>Clupea harengus</td>
<td>Moronidae</td>
</tr>
<tr>
<td>Titus</td>
<td>Mackerel</td>
<td>Scomber scombrus</td>
<td>Scombridae</td>
</tr>
<tr>
<td>Sabida or Kutai</td>
<td>Horse Mackerel</td>
<td>Trachurus trachurus</td>
<td>Cavangidae</td>
</tr>
</tbody>
</table>
Proximate analysis
The moisture content of the pulp was determined after drying at 103°C for 24 h. while the protein content was determined by estimation of the total Nitrogen by Kjeldahl method and protein content was calculated by multiplying total nitrogen by 6.25 factor (AOAC, 2006). The percentage of ash was determined by ignition in a muffle furnace at 550°C as described by Pearson (1976), while lipid content in pulp was extracted using hexane in a Soxhlet extractor as described by A.O.A.C. (2006). The method of Dubois et al. (1956) was used to determine the carbohydrate content of the dry sample. All the experiments were in triplicate.

Microbiological analysis
The muscles of the fishes were cut aseptically using sterile forceps and scalpels and five grams (5 g) was weighed into the conical flask containing 45 ml of sterile deionised water. The contents were transferred into a sterile mortar and homogenized into a watery paste all within 40 min. Serial dilutions of the samples were used for microbial enumeration with the following media: Standard plate count agar for total viable counts (TVC), Sabouraud Chloramphenicol (for fungi), Chapman (for Staphylococci) and Mac Conkey (for total and faecal coliforms) medium for bacteria. Volume of 1 ml of appropriate dilution was spread on the plate. The standard plate count method described by Coulin et al., (2006) was used to determine the total viable cell count. Pure cultures of the isolates were gram-stained, while the cell morphology was examined by phase contrast microscopy. Fungi were isolated on the sabouraud chloramphenicol (SC) and potates dextrose agar (PDA) media. After incubation at 37°C, the petri dishes were examined for microbial growth.

Statistical analysis
All data were subjected to the analysis of variance and the least significance difference (LSD) was used to separate means at P<0.05 level of significance with aid of statistix 10.0 version software.
RESULTS

The proximate composition of frozen marine fishes consumed in Maiduguri is shown in Table 2. Clupea harengus has the highest moisture content of 78.03±0.18%, followed by Trachurus trachurus 71.72±0.49%, Micropogonias undulates 68.74±0.06%, and Scomber scombrus 68.54±0.29%. The highest protein content was recorded in Clupea harengus (20.82±0.14%) followed by Scomber scombrus, Trachurus trachurus and Micropogonias undulates (20.43±0.27%, 19.32±0.02%, and 19.22±0.02%, respectively). Scomber scombrus has the highest (1.53±0.12%) ash content, while the lowest (1.22±0.03%) was recorded in Clupea harengus. Lipid has the highest value of 8.56±0.57% in Scomber scombrus while the lowest was 1.22±0.59% in Clupea harengus.

Table 2: Proximate composition of frozen marine fish

<table>
<thead>
<tr>
<th>Proximate Parameters (%)</th>
<th>Clupea harengus</th>
<th>Trachurus trachurus</th>
<th>Scomber scombrus</th>
<th>Micropogonias undulates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>78.03±0.18</td>
<td>71.72±0.49</td>
<td>68.54±0.29</td>
<td>68.74±0.06</td>
</tr>
<tr>
<td>Crude protein</td>
<td>20.82±0.14</td>
<td>19.32±0.02</td>
<td>20.43±0.27</td>
<td>19.22±0.02</td>
</tr>
<tr>
<td>Lipid</td>
<td>1.22±0.59</td>
<td>5.95±0.26</td>
<td>8.56±0.57</td>
<td>6.12±0.85</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>0.10±0.54</td>
<td>0.20±0.48</td>
<td>0.10±1.26</td>
<td>0.25±0.21</td>
</tr>
<tr>
<td>Ash</td>
<td>1.22±0.30</td>
<td>1.33±0.30</td>
<td>1.53±0.12</td>
<td>1.35±0.21</td>
</tr>
<tr>
<td>Carbohydrate (NFE)</td>
<td>0.60±0.09</td>
<td>0.91±0.03</td>
<td>0.50±0.31</td>
<td>3.67±0.18</td>
</tr>
</tbody>
</table>

The mean value with different letters superscripts are significantly different (p<0.05).

NFE = Nitrogen Free Extract

Microbiological analysis

The microbiological status of the samples was summarized in Table 3. The total viable count (TVC) of the four fish species varied from 5.0×10^4±0.5 to 6.37×10^5±0.4 cfu/g. The coliform count ranges from 1.9×10^2±0.4 to 3.0×10^3±0.5.

On fungal specific media, no fungal growth was observed for the four samples. Table 4 shows the bacteria isolates obtained from the several fish
species samples analysed. Staphylococcus aureus was found common in all the fish samples.

Table 3: Microbial population (Total viable count) in frozen marine fishes

<table>
<thead>
<tr>
<th>Fish species</th>
<th>TVC</th>
<th>Coliform count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clupea harengus</td>
<td>$5.0 \times 10^4 \pm 0.5$</td>
<td>$3.0 \times 10^3 \pm 0.5$</td>
</tr>
<tr>
<td>Trachurus trachurus</td>
<td>$4.27 \times 10^5 \pm 0.3$</td>
<td>$2.1 \times 10^2 \pm 0.05$</td>
</tr>
<tr>
<td>Micropogonias undulates</td>
<td>$6.37 \times 10^5 \pm 0.4$</td>
<td>$1.9 \times 10^2 \pm 0.4$</td>
</tr>
<tr>
<td>Scomber scombrus</td>
<td>$4.01 \times 10^5 \pm 0.3$</td>
<td>$2.6 \times 10^3 \pm 0.4$</td>
</tr>
</tbody>
</table>

TVC = Total viable count

Micropogonias undulates had four species; Staphylococcus aureus, Aeromanas, Salmonella-shigella, and Bacillus aerius. Scomber scombrus had Salmonella-shigella, Staphylococcus aureus, and Aeromanas spp. while Clupea harengus had Aeromanas spp., Staphylococcus aureus and Bacillus aureus.

Table 4: The mean bacterial isolated in frozen marine fishes in Maiduguri.

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Number of bacteria</th>
<th>Isolates in%</th>
<th>Bacterial Isolated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clupea harengus</td>
<td>3</td>
<td>25</td>
<td>Aeromanas, Staphylococcus aureus, Bacillus aerius.</td>
</tr>
<tr>
<td>Trachurus trachurus</td>
<td>2</td>
<td>17</td>
<td>Staphylococcus aureus, Aeromanas</td>
</tr>
<tr>
<td>Micropogonias undulates</td>
<td>4</td>
<td>33</td>
<td>Staphylococcus aureus, Aeromanas, Salmonella-shigella, Bacillus aerius.</td>
</tr>
<tr>
<td>Scomber scombrus</td>
<td>3</td>
<td>25</td>
<td>Salmonella-shigella, Staphylococcus aureus, Aeromanas spp.</td>
</tr>
<tr>
<td>Total</td>
<td><strong>12</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION
The values obtained on proximate composition (moisture, crude protein, ash, lipid, fibre and carbohydrate contents) were in line with those reported by some researchers (Krzynowek and Murphy, 1987; Castrillion et al., 1996; Chilima, 2006). The moisture content determined in the four species are 78.03%, 71.72%, 68.54% and 68.74% of Clupea harengus, Trachurus trachurus, Scomber scombrus, and Micropogonians undulates, respectively. Krzynowek and Murphy (1987) reported the moisture content of 76.02% and 68.0% for Scomber scombrus (frozen) and Trachurus trachurus (fresh), respectively. It is also reported that loss of moisture in any fish results in increase in the percentage of other nutrients (Castrillion et al., 1996). This confirms the notion that the moisture content in a food had an inverse relation with the fat in fish. According to Chilima (2006) fat contributes to energy supply and assists in the proper absorption of fat soluble vitamins, for example vitamins A, D, E and K in species.

Eyo (2001) reported that lack of sufficient protein is one of the most widespread nutritional deficiencies in many tropical countries. Clupea harengus and Scomber scombrus have significantly higher protein content (20.81% and 20.43%, respectively) than that measured in Trachurus trachurus and Micropogonians undulatus in this study (Table 2). Chilima (2006) reported that, on wet basis, fish generally contain a good quantity of protein within the range of between 18%-20%. Castrillion et al. (1997) reported a protein content of 20.27% and 18.56% for wet and dry samples of Scomber scombrus. In this study, the level of protein is high in Clupea harengus and Scomber scombrus. The low level of protein in Trachurus trachurus and Micropogonians undulatus could probably be related to the length of freezing and storage time. Prolonged freezing of fishes was capable of contributing to the deterioration of the quality of protein and fat in fishes (Omotosho and Olu, 1995; Arannilewa et al., 2005; Saliu, 2008).

Abdullahi (2001) reported higher fat values for Chrysichthys nigrodigitatus, Bagrus filamentosus and Auchenoglanis occidentials in the range of 30.0-30.3%, while 26.77% (fat) was reported for catfish (USDA, 2010). Other values for fat are 2.6% and 6.8% in Tuna and Anchovy respectively (Suhendan et al., 2008) and 9.8% by Krzynowek and Murphy (1987). The 9.8% reported by Krzynowek and Murphy (1987) was similar to 9.4%
obtained in this study for the fat content of Scomber scombrus. Therefore, those values that are reported in other species may be attributed to the quality of those fish species in terms of handling and the status of their quality as at the time of analysis (Londahl, 1981). Ash is a measure of the mineral content of a food item (Omotosho and Olu, 1995). The ash contents of the fish species used in this study agree with the values reported by USDA (2010); Scomber scombrus (1.530%), Micropogonians undulatus (1.35%), Clupea harengus (1.22%) and Trachurus trachurus (1.33%).

Fish is generally reported to show low levels of carbohydrate (USDA, 2010). High values of this nutrient were recorded for Micropogonians undulatus (3.67%), but other species such as Clupea harengus recorded 0.60%, Trachurus trachurus, 0.91% and Scomber scombrus, 0.50%. The result of carbohydrate in Micropogonians undulatus was unusual; 0% in marine fishes as reported for most species (USDA, 2010). Although earlier reports for New Zealand marine fish show high carbohydrate values (Vlieg, 1988), this seeming contradiction can probably be accounted for by several factors such as the food and feeding habit, habitat and geographical location, age, methods of handling/processing, seasons and some other environmental factors (Nadcisa et al., 2001; Suhenden et al., 2008).

According to Adams and Moss (2008), the normal bacterial load of the marine fishes can range from $10^2$ – $10^7$ cfu/cm$^2$ and the Gills and Intestines can range up to $10^3$ and $10^7$cfu/g, respectively. In this study, the total viable counts of the marine fishes consumed in Maiduguri ranged from $3.4 \times 10^3$ to $6.37 \times 10^5$cfu/g. The bacterial load of marine fishes consumed has maximum limit of $(10^5$ cfu/g) as recommended by the International Commission for Microbiological Standards of Foods (ICMSF, 1978; Okoro et al., 2010; Adebayo-Tayo et al., 2012). Assessment of food safety knowledge and practices of abattoir and butchery shops in the Mekelle city, Ethiopia by Mekonnen et al., (2011) and Haileselassie et al., (2012) showed that marine fish samples collected from marine market cold store had viable bacterial load in the range of $1.1 \times 10^5$to 4.3x10$^6$cfu/g. It was recorded that both Clupea harengus and Micropogonians undulatus fish incur heavy growth of coliforms with values of $3.0 \times 10^3$ cfu/g and $2.6 \times 10^3$ cfu/g, respectively. Arannilewa et al., (2005) also found that the
total coliform count in fish was between $3.0 \times 10^3 - 7.5 \times 10^6$ with increasing values, as the duration of storage increases. The presence of total coliforms suggested the presence of other harmful and pathogenic microorganisms such as Salmonella spp. (Rabbi et al., 2011). Generally, the presence of coliform and faecal coliform is an indication of contamination since coliform is not the normal flora of bacteria in fish (Mandal et al., 2009). This is reflecting the contamination of fish habitat with the human and animal faeces.

Staphylococcus spp. was most predominant bacterial isolates in this study. Coagulase positive Staphylococci were found in all the examined samples. This deviated from the findings of previous studies (Alyaaqoubi et al., 2009). In the study by Alyaaqoubi et al., (2009), coagulase-positive Staphylococci were not found in all the examined samples. Similarly, Hanashiro et al., (2005) stated that Staphylococci were not detected in home- and street-prepared marine fish samples in Sao Paulo, Brazil. Food poisoning by Staphylococcus affects hundreds of thousands of people each year (Rabbi et al., 2011). Staphylococcus spp. produces toxins that withstand high temperatures and are spore-forming which germinate and release enterotoxins. Ingestion of toxin-containing food causes nausea, vomiting, abdominal cramps and diarrhoea.

However, in this study, Salmonella spp count was 16% and in most studies, S. aureus are amongst the most common pathogens found (Shojoei et al., 2006). It is also revealed that marine fish handlers were carriers of S. aureus. It does indicate that the prevalence of Salmonella in marine fishes is very low (Rabbi et al., 2011). Other studies have also identified pathogens including Salmonella spp. on other marine fishes in South Africa (Adu-Gyamfi and Nketsia-Tabiri, 2007). This study was in agreement with the studies reported by Soriano et al., (2001) who found no Salmonella in raw and ice samples from 20 University restaurants in Valencia, Spain and Alyaaqoubi et al., (2009) who also found no Salmonella in some selected ready-to-eat food at Hulu Langat district, Malaysia. The scanty presences of Salmonella in these studies indicated that good handling practices on board and good storage facilities were available.

Conclusively, marine fish species consumed in Maiduguri had good proximate composition. The desirable moisture content and high protein
content confirms that these species are good for consumption. Based on the acceptable level of the microbiological guidelines/standards, the total viable count was within the approved rate for fish consumption. Therefore, marine fishes can be recommended for consumption in Maiduguri, Borno State.

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References


Fish, Mullet (Liza falcipinnis) under different Storage Conditions. New York Science Journal. 3(8): 21-28. ISSN: 1554-0200


