Relation of Smoking Parameters to the Quality and Consumer Acceptability of Smoked Mackerel Fish (*Scromber scombrus*)

A. O. Oyeniyi¹*, T. A. Akinyemi², A. F. Bankole³, J. O. Olaniyan² and Y. M. Oluroye²

¹Department of Food Technology, Oyo State College of Agriculture and Technology, Igoto-ora, Oyo State, Nigeria.
²Department of Home and Rural Economics, Oyo State College of Agriculture, Igoto-ora, Oyo State, Nigeria.
³Department of Fisheries Technology, Oyo State College of Agriculture, Igoto-ora Oyo State, Nigeria.

Authors’ contributions

This work was carried out in collaboration among all authors. Authors AOO, TAA and YMO designed the study, performed the laboratory analysis, wrote the protocol and wrote the first draft of the manuscript. Author AFB managed the analyses of the study, performed the statistical analysis and participated in writing the first draft of the manuscript. Author JOO managed the literature searches. All authors read and approved the final manuscript.

ABSTRACT

The effects of heat sources (oven, charcoal and stove) on roasted mackerel fish was investigated on proximate composition and sensory evaluation of roasted mackerel fish (*Scromber scombrus*). The fish sample was thawed, cut, eviscerated, washed with brine solution and roasted at a temperature of 75°C for 5 hours using oven, charcoal and stove as heat sources. Minor variations were obtained in crude protein, ash, fat, moisture and crude fibre contents amongst the roasted fish samples, while significant variation (p<0.05) was observed between the raw and roasted samples. The nutritive value of roasted fish improved as a result of the smoking process. In all the treated
samples, the percentage of total protein, lipid and ash contents increased due to water loss during smoking. High value of ash was seen in experimental charcoal and stove heat sourced fish (15.86 & 14.56% respectively). Protein was retained better in oven sourced (49.17%) fish more than other sources used. The result of the sensory evaluation shows clearly that there was no significant difference in the level of acceptability of the three samples. The mean scores showed that all the characteristics of the products were moderately liked. Mean scores for overall acceptability indicates that the products were generally well accepted. Although the oven heated sample was more acceptable than other heat sources.

Keywords: Heat sources; mackerel fish; fish preservation; nutritive value; sensory evaluation.

1. INTRODUCTION

Fish constitutes a very important component of diet for many people, and often provides much needed nutrients for a healthy living [1]. Generally fish contains very little carbohydrate, while the moisture content is very high. In most fish species the moisture content is between 60 – 80%, protein between 15 – 26% and 2 – 13% for fat. The fat content of fishes varies with species, age, size and also season [2].

Since fish is not commonly consumed raw, traditional fish processing, such as salting/brining, drying and smoking, which allows better preservation and storage and increase fish availability to the consumers are employed [3].

In Nigeria, there are various species of fish available for consumption; which is either imported or found locally, most of which are available in fresh, frozen, smoked and fried forms. Some of the species commonly consumed are: Scomber scombrus popularly known as Titus, Trachurus trachurus locally known as Shawa and Ethmalosa fimbriata also known as Bonga fish. These species have been reported as highly commercial [4,5]. [6] reported the following species and forms sold.

Mackerel (Scomber scombrus) of the family scombridae are found in all tropical and temperate seas. Most live off shore in the oceanic environment but a few like the Spanish mackerel (Scomberomorus maculatus) enter bays and can be caught near bridges and piers. The largest species called "Mackerel" is the king Mackerel (Scomberomorus cavalla), which can grow to 66 inches (168 cm). Common features of Mackerel are slim, cylindrical shape (as opposed to the tunas which are deeper bodied) and numerous fillets on the dorsal and ventral sides behind the dorsal and anal fins. The scales are extremely small, if present. They are prized for their meat and fighting ability and are important in recreational and commercial fishery. In the tropics, the meat can spoil quickly, causing scromboid food poisoning. Mackerel fish is of great nutritional value thus essential components of human diet. Fish is a highly quality protein containing about 19% protein similar in amino acid composition that is found in the muscle meat. Fat content varies from 1-20% depending upon the species and the season of the year, which is a substantially lower in fat content than beef. Fish just like meat is universally accepted. It can be processed and consumed in different forms just as boiled, stewed, fried, roasted, smoked and any other ready to eat Nigerian fish snacks which are processed and sold in most market places, club houses, restaurants etc. In most times, they are processed by kutmu, in which over the years have gained expertise in its slicing, sticking, spicing and roasting over opened charcoal heat source. Other heat source not commonly used by this commercial fish producer includes kerosene, stoves and electric/gas cooker [7].

<table>
<thead>
<tr>
<th>Common name</th>
<th>Local name</th>
<th>Scientific name</th>
<th>Forms sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sardine</td>
<td>Sardine</td>
<td>Sardinella Spp.</td>
<td>Frozen/Smoked/Fried</td>
</tr>
<tr>
<td>Bonga</td>
<td>Agbodo</td>
<td>Ethmalosa fimbriata</td>
<td>Frozen/Smoked</td>
</tr>
<tr>
<td>Mackerel</td>
<td>Alaran</td>
<td>Scomber scombrus</td>
<td>Frozen/Smoked/Fried</td>
</tr>
<tr>
<td>Stock Fish</td>
<td>Panla</td>
<td>Cod Species</td>
<td>Frozen/Smoked/Fried</td>
</tr>
<tr>
<td>Mormyrus</td>
<td>Ayo</td>
<td>Mormyrus Spp.</td>
<td>Frozen</td>
</tr>
<tr>
<td>Tilapia</td>
<td>Epiya</td>
<td>Tilapia Spp.</td>
<td>Fresh/Smoked</td>
</tr>
<tr>
<td>Clarias</td>
<td>Aro</td>
<td>Clarias spp.</td>
<td>Fresh/Smoked</td>
</tr>
<tr>
<td>Snake head Fish</td>
<td>Owere</td>
<td>Channa obscura</td>
<td>Frozen</td>
</tr>
</tbody>
</table>

Chart 1. [6] reported the following species and forms sold
Fish is an extremely perishable food immediately after catch thus therefore requires immediate and proper handling and good preservation to retain its quality [8]. Fish smoking is one of the traditional processing methods aimed at preventing or reducing post-harvest losses. Heat application removes water and inhibits bacterial and enzymatic actions of fish [9].

Heat is defined as a form of energy transfer due to temperature difference [10]. Artificial sources of heat are oven, stove, and charcoal etc., which is made to pass heat to the food material while natural source of heat such as sun is naturally made in which the temperature or heat of the sun is passed to the food material. Heat can be transferred through conduction (transfer of heat from solid to solid), convection (transfer of liquid medium to food such as steaming) and radiation (transfer of heat through dry air medium to the food such as baking) [10]. In the case of this research “radiation” is seen as an important method of transferring heat to the food.

Due to high amount of water and soft tissues, fishes are highly susceptible to microbial contamination and spoilage [11]. Smoking enhances flavour, texture and shelf life of fish. However in most local settings where it is applied, hygienic standards are not adhered to thus subjecting smoked fishes to spoilage as readily as non-smoked fishes [9].

In preserving fish by smoking, water activity in the fish is lowered to the point where the activity of spoilage microorganisms is inhibited together with the antioxidiant and bacteriostatic effects of the smoke which allows smoked products to have extended shelf-life as the wood smoke add some microbial inhibitory substances like formaldehyde and alcohols [12,13]. The typical smoke flavours result from a number of chemicals found in the smoke, but is mostly attributed to the phenols. Phenolic compounds, which are mainly produced by pyrolysis of lignin, are important for preservation and flavour properties of smoked products.

Fish is one of the most important animal proteins available in the tropics, and it represents about 14% of all animal proteins on a global basis [14]. They are also excellent sources of adequate amounts of lipids, minerals, and vitamins. Fish is also a good source of riboflavin, vitamin A and D. The presence of these nutrients also aids the proliferation of microbes [15].

Many fishes are spoilt in homes and market due to poor preservation thereby losing some nutrients from the fish. In other to prevent spoilage of fish such as (Mackerel) consumers need to be educated on preservative methods of fishes so that the taste will not be altered and the nutrients will be more retained. This research work will help enlighten fish processors and home makers on other heat sources that could be used to preserve fish with high nutritional value and most acceptable as the commercially consumed smoked fish and at the same time be less strenuous.

The need to look at the effect of processing on the nutrient composition of fish is therefore high. This work is rather a preliminary investigation of the effect of preserving fish using different heat sources on the chemical qualities of one of the commonly consumed marine fishes in Nigeria. Thus, this study therefore examines the effect of heat on proximate composition and consumer acceptability of mackerel fish.

2. MATERIALS AND METHODS

2.1 Materials

The materials used are frozen mackerel fish, salt, oven, charcoal, charcoal pot, kerosene-stove, Kerosene etc. The frozen mackerel fish, charcoal, and salt were purchased from Towobowo Market, Igboora, Oyo state.

2.2 Design for the Study

The experiment was carried out at the food processing unit of Home and Rural Economics department in Oyo State college of Agriculture, Igboora, Oyo State, Nigeria with location of latitude 7°40W and longitude 3°30E in the south western part of the state.

A total of 12 frozen mackerel fishes with average weight of 800 g, was purchased. The fish were allowed to thaw, cut (into 4 pieces each), eviscerated, washed, brined and were randomly selected to 3 groups according to the heat sources intended for the study. Each treatment containing 16 fresh mackerel fishes were prepared for roasting using three (3) different heat sources (oven, charcoal and stove). Roasting was carried out at temperature of 75°C for 5 hours using oven (gas), Kiln (charcoal) and stove (kerosene) sources.
2.3 Determination of Proximate Composition

Proximate analysis of the raw and roasted (oven, charcoal, stove) mackerel fish was determined by standard procedures.

The determination of the crude protein, moisture, ash and fat contents of the fresh and smoked fish were carried out in triplicate in accordance with [16]. The protein content was obtained through the determination of total nitrogen by micro Kjeldahl’s method. The value of nitrogen obtained was then multiplied by 6.25 to get the crude protein value.

Moisture content of the samples was determined by the [16] method in which 2 g of the samples (fish muscles) were oven-dried at 110 ± 1°C for 24 h to a constant weight. Loss in weight is equal to the moisture content of the original sample. The ash content was determined by heating the samples to a temperature of 550°C, the residue is equivalent to the ash content.

The fat content was determined by extraction with hexane by Soxhlet’s method.

2.4 Determination of Consumer Acceptability

A total no of 7 taste panellists consisting of lecturers from the departments of Home and rural Economics and Fisheries Technology in Oyo state College of Agriculture was used to access the consumer acceptability of the roasted fish samples. The roasted fish were served to panellists to evaluate its sensory characteristics using texture, appearance, odour, taste, flavour and overall acceptability based on a 5 – point hedonic scale. Statistical analysis was based on the one-way analysis of variance; homogeneous groups were formed according to the Duncan test for p < 0.05.

3. RESULTS

Table 1 shows the proximate composition of raw and heat sourced fish. The raw sample had the highest moisture (27.01%) as against the heat sourced fish in which moisture content ranges from (3.80-3.10) %, the result of fat content showed no significant difference (p>0.05) among the heat sources. However the treated samples showed higher value in protein, fat, ash and fibre content over the raw sample, although there were no significant difference (p>0.05) among the heat sources except the oven heat source which had a low ash value of 9.41% compared to the other heat sources (15.86%).

The Consumer acceptability result was presented on Fig. 1. The oven heated sample had the highest mean score in all the parameters (texture, appearance, odour, taste, flavour & overall acceptability) considered which was based on a 5 point hedonic scale. The stove heated sample had the least mean score in all tested parameters (21-27).

4. DISCUSSION

This result agrees with earlier works of [17] that the removal of moisture content increased the shelf life of fish products.

### Table 1. Proximate composition of raw fish, charcoal, stove and oven heated sample

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Raw</th>
<th>Charcoal</th>
<th>Stove</th>
<th>Oven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>38.81</td>
<td>47.64</td>
<td>46.64</td>
<td>49.17</td>
</tr>
<tr>
<td>Fat</td>
<td>16.09</td>
<td>71.98</td>
<td>70.46</td>
<td>70.80</td>
</tr>
<tr>
<td>Fibre</td>
<td>1.05</td>
<td>2.40</td>
<td>2.40</td>
<td>2.41</td>
</tr>
<tr>
<td>Ash</td>
<td>5.78</td>
<td>15.86</td>
<td>14.56</td>
<td>9.41</td>
</tr>
<tr>
<td>Moisture</td>
<td>27.01</td>
<td>3.10</td>
<td>3.51</td>
<td>3.51</td>
</tr>
</tbody>
</table>

Values in the same row with the same superscript are not significantly different from each other.

### Table 2. Sensory evaluation of charcoal, stove and oven heated samples

<table>
<thead>
<tr>
<th></th>
<th>Texture</th>
<th>Appearance</th>
<th>Odour</th>
<th>Taste</th>
<th>Flavour</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>26 a</td>
<td>21 a</td>
<td>27 a</td>
<td>28 a</td>
<td>29 a</td>
<td>27 a</td>
</tr>
<tr>
<td>Stove</td>
<td>22 a</td>
<td>25 a</td>
<td>19 b</td>
<td>20 a</td>
<td>21 a</td>
<td>26 a</td>
</tr>
<tr>
<td>Oven</td>
<td>29 a</td>
<td>30 a</td>
<td>32 a</td>
<td>31 a</td>
<td>30 a</td>
<td>32 a</td>
</tr>
</tbody>
</table>

Values in the same row with the same superscript are not significantly different from each other.
In all the samples, the percentage of total protein, lipid and ash contents increased due to water loss during smoking. Similar findings were reported by [18,19] in European eel, pike perch and rainbow trout. High moisture content in raw sample over the treated samples was also similar to [3] who recorded high moisture content in fresh Clarias gariepinus as to its smoked counterpart. The reduced moisture content in the treated samples is indicative of the effect of heat on fishes which had causes water loss from the fish muscle. A high value of ash that was seen in all the treatments, was also recorded by [3], who observed that Ash content of O. niloticus and C. lazera was 2.1% and 1.0% (on wet basis), respectively before processing, while after smoking, it increased to average of 7.91% and 11.18% respectively. Although the value of ash in charcoal roasted fish (15.86%) and stove heat source (14.86%) from Table 1 is higher than that of oven heat source (9.14%). This perhaps is due to mineral contribution from the heat source used (charcoal and kerosene).

The sensory evaluation results of the samples are presented in Fig. 1. The mean scores showed that all the characteristics of the products were moderately liked. Mean scores overall acceptability indicate that the products were generally well accepted. Although the oven heated sample was more acceptable than other heat source. This is in agreement with [3], who reported similar results for Clarias lazera and Oreochromis niloticus.

5. CONCLUSION

The result of the sensory evaluation test revealed that the sources of heat (oven, stove and charcoal) showed no significant difference in terms of taste, texture, appearance, flavour and odour, although the oven treated sample had a better acceptability above its other two counterparts. Also the proximate analysis shows that nutritional qualities of the fishes improved with processing, the chemical composition of the treated fish samples were not also significantly different from one another.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

   DOI: 10.4172/2155-9600.1000199
2. Omolara O. Oluwaniyi, Omotayo O. Dosumu. Preliminary studies on the effect of processing methods on the quality of...


© 2020 Oyeniyi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here: http://www.sdiarticle4.com/review-history/60692