Abstract

At present, considerable interest has been generated in the development of new products with functional properties. Also, it is increasingly evident the need to use the resources of each region to meet the needs of people in the population. That is why a product rich in bonefish fibre, corn oil and grape fibre from the Colombian Caribbean region is developed. The bromatological and microbiological properties of the new product are evaluated in this research. The aim of this study was to assess the physicochemical and microbiological properties of sausages made with bonefish flesh, corn oil and grape fibre (Macabí, Elops saurus). The influence of adding different types of fibre (corn, wheat, grape) on the quality characteristics of sausages was evaluated. The results showed that adding fibre to the product increased its functionality. The sausages were found to be acceptable both in terms of sensory characteristics and microbiological properties.
were measured and the stability during storage time was determined. The results confirm that it is a product with a high content of proteins and low in fat compared to comparable products. It also complies with Colombian regulations for the microbiological control and is stable at 4 °C for 14 days.

**Keywords:** *Elops saurus*, sausages, physicochemical properties, microbiological properties, stability

**Introduction**

Fish has excellent nutritional properties, related to protein content, the quality of its fat and the contribution of certain minerals and vitamins. The fat content can be very variable. This, in turn, influences the caloric value, so it can be double when consuming a fatty fish. The percentage of fat is inversely proportional to the aqueous content, to more fat less content in water. In fish, we find polyunsaturated fatty acids that are involved in the prevention and treatment of cardiovascular diseases, due to the prevention of platelet aggregation, vasodilation, reduction of risk of fractures, regulation of blood pressure, among others [1].

Santos y Arboleda [2] conducted a study on the techniques of obtaining fish pulp from bonefish (*Elops saurus*), to be used in the manufacture of a stable paste that would serve as raw material in the production of commercial products such as sausages and burgers. The results obtained in the use of this species as a raw material for the processing of different food products show that both the pulp and the pulp are stable and have good behaviour concerning the formation of meat emulsions.

On the other hand, the lack of dietary fibre in the diet of humans is a causal factor of numerous diseases called "diseases of civilisation", such as diabetes, obesity, diverticulosis and cardiovascular diseases. Currently, there are several sources of dietary fibre, such as cereals, grains, vegetables, fruits and legumes, which can be consumed directly or transformed into fibre-rich products. The importance lies in the physiological properties in the organism, helping to prevent the presence of silent diseases, as well as the effects of functional properties in food products, improving the organoleptic characteristics. In this context, the objective of the present work was to elaborate a meat product from Macabi (*Elops saurus*) with the incorporation of dietary grape fibres. Some physicochemical and microbiological properties of the products obtained were evaluated and compared with current legislation.

**Materials and Methods**

*Preparation of bonefish sausages*

For the preparation of the sausages, the ingredients were homogenised in a cutter
Physicochemical and microbiological properties ...

for 15-20 min at a temperature of 5-8 °C until an emulsion was obtained. Later the blend was filled into cellulose casings. Then they were cooked with wet steam until reaching 70 °C at the coldest midpoint of the sausage. They were then cooled using an ice bath, packed in high-density polyethene bags and frozen at -18 °C until the corresponding analyses.

Bromatological Analysis

The protein content was determined using the Kjeldahl procedure described by AOAC 920.52 [3]. Fat content was determined by Soxhlet extraction method according AOAC 920.39 [4]. Moisture content was determined by AOAC method 925.45 [5] and total carbohydrates were calculated as the difference between jam total weight and the sum of protein, fat, water and ash.

Microbiological analysis

The microbiological tests performed were total mesophiles (NTC 4519) [6], total coliforms (NTC 4458) [7], Staphylococcus aureus (NTC 4779) [8] and Salmonella (NTC 4574) [9].

Stability during storage time

The stability of the product over time was established by storing it at a temperature of 4 °C. Samples were taken on days 1, 7, 14 and 21 to perform a sensory analysis to determine changes throughout the storage. The results were reported qualitatively for each of the organoleptic characteristics of the product.

Statistical analysis

The analysis of variance was applied through the Software SPSS, version 14 for Windows.

Results and Discussion

After the capture of the fish, the pH decreases (due to the accumulation of lactic acid), reaching levels of 5.8 - 6.2 and rigour mortis appears. The terminal pH will depend on several factors like the fish species, the amount of muscle glycogen, the buffer capacity of the fish components. The measurement was done considering the pH in three of the samples of Macabi (Elops saurus) pulp, to establish the quality of the raw material. For this, the pH was evaluated by taking 20 g of Macabi (Elops saurus) pulp to which the reading is taken. Then these are macerated, and distilled water (5-10 mL) is added. Afterwards, the reading is retaken after one hour. These values are reported in the Table 1 that gave an average value in three readings.
Table 1. Mean values and standard deviation of pH of Macabi (*Elops saurus*) samples before and after rigour mortis

<table>
<thead>
<tr>
<th>Sample</th>
<th>pH before rigour mortis</th>
<th>pH after rigour mortis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonefish samples</td>
<td>6.6 ± 0.2(^a)</td>
<td>6.5 ± 0.2(^a)</td>
</tr>
</tbody>
</table>

Different superscript letter in the same file indicates significant differences (p < 0.05)

These pH values are within normal ranges, and the raw material is in optimum quality conditions for processing.

*Bromatological Analysis*

The primary purpose of a proximal analysis is to determine, in food, the moisture content, fat, protein and ash. These chemical procedures also reveal the nutritional value of a product and how it can be combined in the best way with other raw materials to achieve the desired level of the different components of a diet. It is also an excellent procedure to perform quality control and determine if the finished products reach the standards established by the producers and consumers. Table 2 shows the results of the analysis performed on the final product.

Table 2. Mean values and standard deviation of bromatological analysis for studied formulations

<table>
<thead>
<tr>
<th>Sample</th>
<th>Protein</th>
<th>Fat</th>
<th>Moisture</th>
<th>Ash</th>
<th>Fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15.97 ± 1.1(^a)</td>
<td>5.64 ± 0.5(^a)</td>
<td>67.62 ± 0.7(^a)</td>
<td>1.95 ± 0.2(^a)</td>
<td>2.07 ± 0.2(^a)</td>
</tr>
<tr>
<td>F1 (1.5 g fibre /Kg product)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2 (2.5 g fibre /Kg product)</td>
<td>15.93 ± 0.8(^a)</td>
<td>5.68 ± 0.6(^a)</td>
<td>67.60 ± 0.8(^a)</td>
<td>1.97 ± 0.3(^a)</td>
<td>2.62 ± 0.3(^b)</td>
</tr>
<tr>
<td>F3 (3.5 g fibre /Kg product)</td>
<td>15.98 ± 0.7(^a)</td>
<td>5.63 ± 0.8(^a)</td>
<td>67.59 ± 0.5(^a)</td>
<td>1.94 ± 0.3(^a)</td>
<td>3.29 ± 0.2(^c)</td>
</tr>
</tbody>
</table>

Different superscript letter in the same column indicates significant differences (p < 0.05)

The different formulations, designed with constant amounts of Macabi (*Elops saurus*) pulp, turned out to be isoproteic, as evidenced by the absence of variation in protein content (p > 0.05). The range of protein values found in this study was around 16%. It is remarkable that these values are higher than those established by NTC 1325 [10] (10%, 12% and 14% respectively) and those reported in the literature for fish sausages of 12.2% and 12.35-12.71% [11].

In recent years there has been a trend towards the formulation of low-fat foods, due to the association between high intake and the development of cardiovascular diseases.
In the determination of fat in the three treatments it is observed that the data obtained are within the parameters established for the meat products scalded in the NTC-1325 [10] standard. It is evident that the level of fat found in sausages is much lower than the contents reported for comparable products made with beef, chicken and pork, for which values are reported in the fat content ranging between 24 and 45%. However, it reports similar values by Granados et al. [11] for sausages made with tuna meat (5.15%).

It should be mentioned that the moisture content of the Macabí (Elops saurus) based-product did not show significant differences (p > 0.05) among the different treatments.

**Microbiological analysis**

Three samples of each formulation were analysed 48 hours after elaboration, performing controls in duplicate of mesophilic aerobes, total coliforms, *Salmonella* and *S. aureus*. The methodology established by the Colombian norms (Ministry of Health of Colombia) was followed. From the above, it was evident that in the elaboration of the different formulations of sausages, good manufacturing practices were applied where all the values are below the limits established in the Colombian norms NTC-1325 [10]. Table 3 show results for microbiological analysis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mesophilic aerobes</th>
<th>Total coliforms</th>
<th><em>Salmonella</em></th>
<th><em>S. aureus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 (1.5 g fibre /Kg product)</td>
<td>20</td>
<td>&lt;10</td>
<td>&lt; 10</td>
<td>Absent</td>
</tr>
<tr>
<td>F2 (2.5 g fibre /Kg product)</td>
<td>40</td>
<td>&lt;10</td>
<td>&lt; 10</td>
<td>Absent</td>
</tr>
<tr>
<td>F3 (3.5 g fibre /Kg product)</td>
<td>20</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>Absent</td>
</tr>
</tbody>
</table>

**Stability during storage time**

An essential aspect of the food industry is the shelf life of the food. The useful life of a food product is defined as the period that corresponds, under defined circumstances, to a tolerable decrease in its quality. Quality is defined by the degree of concordance of the food with the established norms and by the satisfaction of the consuming public. Studies of useful life allow establishing the weak points of a product when subjecting it to specific conditions of storage, indispensable information for the improvement of the product through its reformulation or modification of its packaging.

The stability of the product over time was established by storing it at a temperature of 4 °C. Samples were taken at 1, 7, 14 and 21 days of production. Sensory analyses
were carried out to determine changes during storage. The results obtained are a qualitative response for each of the organoleptic characteristics of the food. This test shows that the organoleptic characteristics of the product, such as colour, taste and texture, show a noticeable change in this period, but it was shown that the changes are minimal and do not significantly alter the organoleptic quality of the food as time passes. However, after 21 days of storage, the product begins an evident deterioration process with significant changes in the level of texture, colour and odour, as shown in Table 4.

Table 4. Values of sensorial analysis of sausages based- Macabi (*Elops saurus*) during storage time

<table>
<thead>
<tr>
<th>Time</th>
<th>Odour</th>
<th>Colour</th>
<th>Texture</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Normal</td>
<td>Reddish tones</td>
<td>Firm consistency</td>
<td>There is no decomposition</td>
</tr>
<tr>
<td>Day 7</td>
<td>Normal</td>
<td>Reddish tones</td>
<td>Firm consistency</td>
<td>There is no decomposition</td>
</tr>
<tr>
<td>Day 14</td>
<td>Normal</td>
<td>Reddish tones</td>
<td>Firm consistency</td>
<td>There is no decomposition</td>
</tr>
<tr>
<td>Day 21</td>
<td>Slightly acid</td>
<td>Greenish tones</td>
<td>Soft consistency</td>
<td>It presents a leached liquid</td>
</tr>
</tbody>
</table>

Conclusions

Fish-based sausages Macabi (*Elops saurus*) were prepared with the addition of corn oil and different percentages of fibre from grapes. The fibre was added up to 3.5%. The results of the bromatological tests indicate that the products have a high content of protein and a low percentage of fat in comparison with the simulated products of other species. On the other hand, the microbiological analysis showed that the products comply with Colombian standards on the permissible content of mesophilic aerobes, total coliforms, Salmonella and Staphylococcus aureus. Finally, the study of the stability during storage time showed how the products could be stored at 4 °C while maintaining good sensory properties for up to 14 days, between day 14 and day 21 a leaching process begins and the consequent loss of sensorial quality.

Acknowledgements. The authors thank the University of Cartagena for their support in the development of this work. Karen Paola Maria gives the thanks to Ornella Annicharico for their support and friendship during the development of this work.

References


https://doi.org/10.4067/s0718-07642013000600005

Received: June 10, 2018; Published: September 6, 2018