Physicochemical stability of refrigerated cooked cured smoked "Calabresa" sausage

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I. INTRODUCTION

Cooked sausages are meat products manufactured with butcher's animal meat, fat, water, and food additives. They are stuffed in natural or artificial casings and subjected to cooking. "Calabresa" sausage is a very popular product in Brazil. This type of cured sausage uses coarsely ground pork meat and pork backfat as its raw material, is stuffed in natural or artificial casings, and is subjected to cooking in dry and moisture cycles, with smoking optional. The name of the product comes from its characteristic spicy flavor due to red pepper, called Calabresa pepper in Portuguese [1]. In Brazil, sausage is one of the most consumed meat products.

Depending on the microbiological and chemical quality of the raw material, the ingredients and additives added, and the thermal processing cooking cycle, the cooked "Calabresa" sausage may have a short shelf life, mainly due to changes caused by oxidation. It is known that physicochemical stability affects the shelf life of a product. In this sense, the purpose of this study was to evaluate the physicochemical stability of cooked sausage during 60 days of refrigerated storage.

II. MATERIALS AND METHODS

The samples from the different processing stages of the "Calabresa" sausage used for this study (raw meat batter (RB), raw stuffed sausage (RSS), and cooked cured smoked "Calabresa" sausage (CS)) were obtained from a meat industry located in the state of São Paulo (Brazil).

The proximate composition [2, 3], chloride [4], nitrate [5], water activity, and pH value were determined before and after heat treatment of the sausages. The pH was measured using a Digimed pHmeter with a flow-type combined pH electrode, and the water activity (aw) was determined using an AcquaLab® 4TE model (Decagon, Washington, USA). Lipid oxidation was measured spectrophotometrically with thiobarbituric acid reactive substances (TBARS) [6], and instrumental color (L*, a*, b*) was evaluated on days 1 (48 h after processing), 15, 30, 45, and 60 of refrigerated storage (4°C). The residual content of nitrites and nitrates was determined according to Brazil [5].

To evaluate instrumental color, a portable Konica Minolta Chroma Meter colorimeter (model CR 400) was adjusted to the L*, a*, and b* color spaces of the Commission Internationale de l'Eclairage (CIE; "International Commission on Illumination"), with a D65 illuminant (daylight at 6,500 K), a 10° observation angle, and a 30mm shutter opening. Three different points were chosen on the sausage samples (cut in half lengthwise), totaling six measurements. The results were statistically evaluated using ANOVA and Tukey's test with a significance level of 5% using the Statistica® version 10 program (StatSoft Inc., Tulsa, USA).

III. RESULTS AND DISCUSSION

The raw meat batter (RB) presented an aw of 0.971, pH 5.99, and 13.67 and 39.14 mg/kg of nitrate and nitrite content, respectively. Comparing the raw stuffed sausage (RSS) before cooking with the cooked cured smoked "calabresa" sausage (CS), was observed a water loss of around 30%, a decrease in nitrite content of 90% (3.98 mg/kg), a decrease in aw from 0.97 to 0.95, and a pH of around 6.0. The nitrate content in CS remained constant at 17.32 mg/kg. The residual levels of nitrate and nitrite in the samples evaluated demonstrated that the quantities are in accordance with the levels proposed by legislation, which are 300 mg/kg for nitrate and 150 mg/kg for nitrite [1]. A reduction in water activity (aw) can be observed when evaluating raw meat batter, "Calabresa" sausage, before and after cooking and smoking, indicating that the cooking process achieved the desired result in terms of aw reduction in order to guarantee desirable characteristics and a longer useful life, since with a lower aw, deterioration reactions are delayed [7]. The total protein, lipids, ashes, chorides, and moisture content of CS were 19.59; 19.06; 4.64; 2.71; and 54.54%, respectively. According to Brazilian regulations (RTIQ, MAPA), the moisture content of cooked sausages

should be a maximum of 60%. There was no significant difference in the aw of cooked cured smoked "Calabresa" sausage (CS) during 60 days of storage or in the nitrate content (below 22 mg/kg). However, there was a significant difference in residual nitrite (ranging between 2 and 4 mg/kg), but the values are far below what is permitted by legislation (Figure 1). Regarding pH, there was a significant difference (p < 0.05), mainly between 1 (6.01) and 60 days (5.84). There was a significant difference in the oxidation index (TBArs); however, the values (0.08-0.29 mg MDA/kg, Figure 2) remained below the threshold of 0.5 mg MDA/kg. In this way, the product did not show considerable rancidity during 60 days of refrigerated storage (Figure 1).



There were no significant changes in CS color parameters during the 60 days, whose average values were: luminosity (L*) 51.04, red content (a*) 19.91, and yellow content (b*) 8.45. Considering the values of a*, which are higher than the values of b*, which indicate a greater intensity of the red color component and, consequently, indicate a product with a pinkish to redder tone, corresponding to the color normally presented by cooked smoked cured "Calabresa" sausage.

IV. CONCLUSION

In relation to the product evaluated, the cooked cured smoked "Calabresa" sausage's average physical-chemical composition was 19.6% protein, 19.1% fat, 54.5% moisture, and 4.6% ash content. During 60 days of refrigerated storage, this sausage showed no changes in water activity, a slight decline in pH, nitrite content between 1.92 and 9.98 mg/kg, nitrate content from 13.59 to 21.22, and a low index of lipid oxidation (TBArs), which suggests the high stability of this product.

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