PRELIMINARY STUDY ABOUT REDUCING SODIUM IN DRY SUMMER SAUSAGE

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Abstract – Fermented meat products are an important source of sodium. Brazil has conducted research on how to reduce NaCl in such products. A viable alternative is the use of KCl and $CaCl_2$ as replacements, but there are some difficulties with this alternative in fermented products. In this preliminary study, the following treatments were tested: 2,5% NaCl (T1), 1,0% NaCl + 0,25% KCl + 0,25% $CaCl_2$ (T2), 1,0% NaCl + 0,35% KCl + 0,15% $CaCl_2$ (T3) and 1,0% de NaCl (T4). T1 represents the typical amount of added sodium for this type of product (dry summer sausages), and the other treatments (T2, T3 and T4) represent lower levels of sodium and the use of substitutes. It was found that all treatments showed similar values (between 0.94 and 0.95) after cooking. There was a similar pH decline in all of the treatments, which demonstrates that the low NaCl levels of T4 and the partial substitution of NaCl by different combinations of KCl and $CaCl_2$ did not influence pH declines during fermentation in any of the treatments. The high acidity values observed in all of the treatments indicated that bacteria performed normally in low- NaCl environments. The proposed combinations should be subjected to future study to reduce sodium in these products.

Key Words – Fermented meat products; KCl; NaCl; $CaCl_2$.

I. INTRODUCTION

Currently, there is a worldwide trend towards the development of products with reduced sodium levels because this ingredient, when consumed in excess, damages health [1]. In Brazil, the Italian, Spanish and Portuguese traditions have led to the high consumption of fermented sausages with Mediterranean production characteristics (low acidity). Fermented meat products are a large source of sodium because between 1.5 and 3.0% NaCl is added during their production [2]. In the case of dry summer sausage, sodium chloride encourages microbiological stability; improves the flavor, texture and shelf life of the meat products; and increases the water-binding capacity of the meat. This preliminary study aimed to determine how lowering the level of added NaCl and replacing a portion of that NaCl with other chlorides such KCl and $CaCl_2$ influences the technological properties of dry summer sausage.

II. MATERIALS AND METHODS

Ingredients and treatments of dry summer sausage. The formulation used the following meat ingredients: pork shoulder (60%), bovine chuck (20%) and back fat (20%). The following non-meat ingredients were added, with the percentages based on 100% raw material: sodium nitrate (0.015%), sodium nitrite (0.015%), dextrose, monosodium glutamate, white pepper, ground nutmeg, dried and ground ginger, garlic powder, cinnamon powder, cardamom powder and ground mustard. The dry summer sausages were divided into four different treatments. T1 (addition of 2.5% NaCl), T2 (addition of 1.0% NaCl + 0.25% KCl 0.25% $CaCl_2$), T3 (addition of 1.0 % NaCl + 0.35% KCl 0.15% $CaCl_2$) and T4 (addition of 1.0% NaCl).

Dry summer sausage preparation. The samples were prepared according to the following steps. The meats were ground in Hobart equipment, model 4B22, using discs with 10, 5 and 8mm holes for swine meat, beef and pork back fat, respectively. They were then sent to Beccaro model MB25E mixer, where the additional ingredients were added, and they were mixed for five minutes. The mass obtained was embedded (hydraulic stuffer, model 10 liters Frigomaq) in collagen casings (Viscofan Naturin classic 8.5 cm diameter), and the pieces were fermented in a climatic chamber with a temperature between 23-25°C and relative humidity (RH) ranging from 85 to 90% until they reached a pH of 4.9. When the dry sausage reached a pH of 4.9, the chamber's parameters were modified to 19-17°C and 85-83% (dry) relative humidity (RH) for 72 hours. Then, the sausages were cooked (60ºC for 24 hours, 70°C for one hour and 75°C until an internal temperature of 70°C was reached). The following analyses were performed after cooling.

Sodium Content. The sodium content was determined according to AOAC (2005) [3].

Aw. Water activity was determined using an Aqualab 4T analyzer (Decagon Devices Inc.) at 25.0 ° C ± 0.3.

pH. pH values were determined using a pHmeter (Oakton pH300, USA) with automatic temperature compensation and a glass penetration electrode.

Moisture. Moisture was determined by direct drying at 105°C to constant weight [4].

Lactic acid content. Lactic acid determination to analyze acidity (g lactic acid/100 g fat) was performed according to the methodology proposed by the Agriculture and Food Supply Ministry (1999) [5].

Statistical Analysis. The obtained data was statistically analyzed by analysis of variance ANOVA (p<0.05) using the Tukey Test (p<0.05). The statistical data analysis was performed using SAS Software .

III. RESULTS AND DISCUSSION

Sodium Content. The sodium content of each treatment after processing is presented in Table 1. T1 is the usual formulation for this type of product, while the other treatments (T2, T3 and T4) represent lower level of sodium and the use of substitutes as $CaCl_2$ and KCl. A sodium reduction of 40% in salamis should therefore be of interest to the consumer.

However, some currently available fermented products have higher sodium levels that T1. Desmond (2006) [6] found in his review of the sodium content of Salami products that those from the English market have 1.800 mg.100 g^{-1} and those from the North American market have 1.890 mg.100 g^{-1}

It should also be noted that the daily sodium intake recommended by the World Health Organization is 1.5 g, corresponding to 3.75 g of sodium chloride [7-8].

Table 1. The sodium content of dry summer sausage after processing (average ± stdev)

Samples	Na g.100g^{-1}	NaCl g.100g^{-1}
T1	1358^{a} (±2.2)	3456^{a} (±5.69)
T2	846^{b} (±19.0)	2153^{b} (±48.43)
T3	832^{bc} (±2.8)	2116^{bc} (±7.19)
T4	809^{c} (±4.2)	2059^{c} (±10.79)

T1 (addition 2,5% of NaCl); T2 (addition of 1,0% NaCl + 0,25% KCl + 0,25% $CaCl_2$); T3 (addition of 1,0% NaCl + 0,35% KCl + 0,15% $CaCl_2$) and T4 (addition of 1,0% of NaCl).

^{ab}Means in a column of subscribed letters differ significantly (p < 0.05).

Aw. All treatments showed similar values after cooking, between 0.94 to 0.95 (Table 2). When T1 (commercial formulation with 2.5% NaCl) is compared to the other treatments (T2, T3 and T4) that used KCl and $CaCl_2$ to partially replace NaCl, it appears that the same ionic strength effectively maintained the system.

Table 2. Aw during drying and after cooking (average ± stdev)

Samples*	1	2	3
T1	0.96 ± 0	0.95 ± 0	0.94 ± 0
T2	0.97 ± 0	0.96 ± 0	0.95 ± 0
T3	0.97 ± 0	0.97 ± 0	0.94 ± 0
T4	0.98 ± 0	0.96 ± 0	0.94 ± 0

* Identical to Table 1.
1.After fermentation, 2. 72 hour after fermentation, 3. After cooking.

This result was similar to those obtained by Ruusunen and Puolanne (2005) [1] in their study of the effects of sodium chloride and pH on the water-binding capacity of meat. When the drying period starts, the water-binding capacity is high, but it begins to decrease as ionic strength increases. This initial phase promotes particle cohesion, and the subsequent decrease in water binding favors the evaporation of water and thus drying [1].

Moisture. The T1 treatment (control) showed the lowest moisture value, and the T2 treatment showed the highest value (Table 3).

Table 3. Moisture content (average ± stdev)

Samples *	Moisture (%)
T1	46.32^{b} (± 0,56)
T2	53.61^{a} (± 0,84)
T3	46.28^{b} (± 4,64)
T4	50.18^{ab} (± 1,45)

* Identical to Table 1
^{ab}Means in a column of subscribed letters differ significantly ($p < 0.05$).

There is probably a direct association between the moisture value and the $CaCl_2$ concentration. Calcium chloride has a greater ability to attract water molecules because it has more loads. This increased retention capacity is reflected as the vapor pressure of water reduction, resulting in a greater amount of water, which determines the total product moisture.

pH. For all of the dry summer sausage treatments, the initial values were between 5.9 and 6.0 (Figure 1). After 72 hours in the fermentation chamber, due to the action of the bacteria that ferment the carbohydrates in the dry summer sausage, the final pH was between 4.9 and 5.1.

There was a similar pH decline in all of the treatments, which demonstrated that the low NaCl level of T4 and the partial replacement of NaCl with different combinations of KCl and $CaCl_2$ did not influence the pH decline during fermentation in any of the treatments. Compagnol et al (2011) [9], in a study of salami with a low NaCl content and salami in which yeast was used as a replacement for NaCl, also did not observe mean differences pH between the control salami (2.5% NaCl) and the treatments with low levels of NaCl.

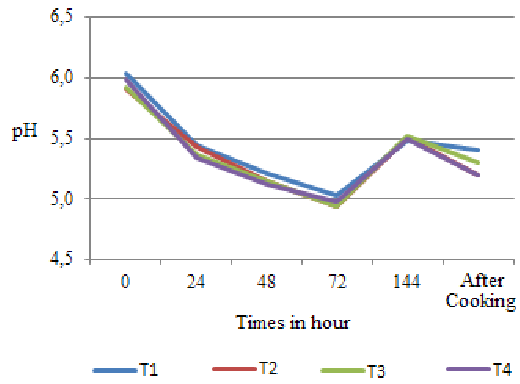

Figure 1. pH values during fermentation and after cooking**.**

The next step in drying process, when the temperature was reduced to 19-17 °C, led to increased pH. This probably occurred due to increased proteolytic activity that release peptide, amino acid and non-protein nitrogen compound formation [10]. However, after cooking, moisture loss led to a slight pH decrease, to values between 5.2 and 5.4.

*Lactic acid content***.** The lactic acid values for all of the treatments were between 1.34 and 1.58 g.100 g^{-1} (Table 4). The high acidity values observed in T1, T2, T3 and T4 demonstrate that the bacteria performed optimally, even in dry summer sausage with reduced sodium content. This is confirmed by the similarity between the acidity values.

Table 4. Lactic acid content (average ± stdev)

Samples *	g.100 g^{-1}
T1	1.34^{c} (± 0,03)
T2	1.58^{a} (± 0,01)
T3	1.43^{b} (± 0,05)
T4	1.48^{b} (± 0,02)

* Identical to Table 1
^{ab}Means in a column of subscribed letters differ significantly ($p < 0.05$).

IV. CONCLUSION

This preliminary study found that treatments with reduced NaCl content did not show greater changes in pH and Aw, whereas there are significantly differences in acidity and moisture compared with the usual 2.5% NaCl formulation (T1). The proposed combinations (NaCl + KCl + $CaCl_2$) are suitable for future studies to reduce sodium in dry summer sausage.

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