COLOR AND LIPID OXIDATION STABILITY OF LOW SODIUM BOLOGNA SAUSAGE ELABORATED WITH MECHANICALLY DEBONED POULTRY MEAT AND FLAVORS ENHANCERS

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Abstract – The effects of 50% and 75% replacement of NaCl by KCl and addition of the amino acids 5'ribonucleotide disodium inosinate and disodium guanylate on color stability during the shelf life of bologna sausage with mechanically deboned poultry meat were evaluated. This study suggests there was not effect on color during shelf life and that it is possible to reduce sodium chloride by 50% and 75% in bologna sausage using salt substitute and 0,1% of disodium inosinate and 0,1% of disodium guanylate. The levels of NaCl showed stable lipid oxidation during its shelf life.

Key Words – bologna sausage, sodium reduction, disodium inosinate, disodium guanylate

I. INTRODUCTION

Bologna sausage is a product widely consumed worldwide, including Brazil, being a source of protein and sodium for some segments of the population, especially low-income individuals. The high sodium intake, however, has been associated with the development of chronic diseases such as hypertension [1]. Emulsified meat products such as bologna sausage require specific concentrations of NaCl in the original formulations to promote the extraction of myofibrillar proteins, especially complex actomyosin, which are soluble only in solutions of high ionic strength. Myofibrillar proteins extracted in the comminution process in the presence of NaCl are responsible for the water-holding capacity, emulsification and fat binding properties in the batter and the formation of stable gels in the cooking stage [2,3]. Potassium chloride (KCl) has been the most investigated substitute for NaCl and its intake in various studies has reduced blood pressure in humans. From the technological point of view, this salt has been used to ensure the ionic strength necessary to develop stable emulsions. However, its use alone results n a bitter, astringent and metallic taste [4]. Additional challenge is the use of mechanically deboned poultry meat (MDPM), more susceptible to oxidation and sensory deterioration. Currently, several studies have considered the use of flavor enhancers to minimize the effects of metallic and astringent taste provided by the use of potassium chloride at concentrations above 50%. Aminoacids such as 5'-ribonucleotide disodium inosinate (IMP) and disodium guanylate (GMP) can reduce the sensory defects caused by KCl [5]. In this context, the objective of this study was to evaluate the color stability of bologna sausage with low content of sodium with potassium chloride and 0,1% disodium inosinate e 0,1% disodium guanylate).

II. MATERIALS AND METHODS

All bologna sausage formulations were processed in a pilot plant (UNICAMP.) on the same day according to industrial procedures. Batter formulations are shown in Table 1. Lean beef, pork and deboned chicken meat with different previously weighed combinations of salts were placed in a cutter (Mado, model MTK 662, Germany) and comminuted for 3–4 min at low speed to extract myofibrillar proteins. When the temperature reached 7–8 °C, other condiments and additives were slowly added. The temperature of the batters never exceeded 17 °C. Subsequently, the meat emulsion was mechanically embedded (Mainca, model EC12, Spain) in permeable cellulose wrappers (Viskase, 15 cm ø) with approximately 0.5 kg of product per package. The bologna sausage pieces were placed in a steam oven (Eller, Italy) at an initial inside temperature of 60 °C and relative humidity 98–99% where they remained for 15 min. After that, the temperature was raised at 5 °C every 10 min to reach the final core temperature of 72 °C. At this point, the temperature inside the steam oven was around 85 °C. A thermocouple was placed in the center of the samples to monitor and control the internal temperature. After cooking (~2,5 h), the products were immediately cooled in an ice bath, vacuum-packaged (Selovac, Minivac CU18) and stored under refrigeration (5 °C) for analyses. Color was measured after processing and every 15 days during the shelf life established for this study (60 days) using a Hunter Lab colorimeter (Colourquest-II, Hunter Associates Laboratory Inc.,Virginia, USA) with a 20-mm port size, illuminant D65 and a 10° standard observer. CIELAB L*, a*and b* values were determined as indicators of lightness, redness and yellowness. Color variables were measured at four points on the central part of the cut surface of four slices per piece of bologna sausage. Assays were performed in triplicate for each treatment. All samples were at room temperature during the analysis. Lipid oxidation was determined using the thiobarbituric acid reactive substances test (TBARS) which includes the addition of 0.5% sulfanilamide in a 20% HCl (v/v) solution [6]. TBARS values are reported as milligrams of malonaldehyde per kilogram equivalent of sample. For each treatment, values were performed in triplicate.

Table 1. Formulations of low sodium bologna sausage and flavor enhancer

Component (%)	FC (control)	F1	F2
Lean beef	28,330	28,130	28,130
Pork	15,000	15,000	15,000
MDPM	30,000	30,000	30,000
Pork fat	10,000	10,000	10,000
Ice	11,000	11,000	11,000
Starch	3,000	3,000	3,000
Condiments	0,305	0,305	0,305
Sodium nitrite	0,015	0,015	0,015
Tripolyphosphate sodium	0,300	0,300	0,300
Sodium erythorbate	0,050	0,050	0,050
NaCl	2,000	0,500	1,000
KCl	-	1,500	1,000
Disodium inosinate	-	0,100	0,100
Disodium guanylate		0,100	0,100

III. RESULTS AND DISCUSSION

The results for color determination on the shelf life are given in Figure 1 and Table 2

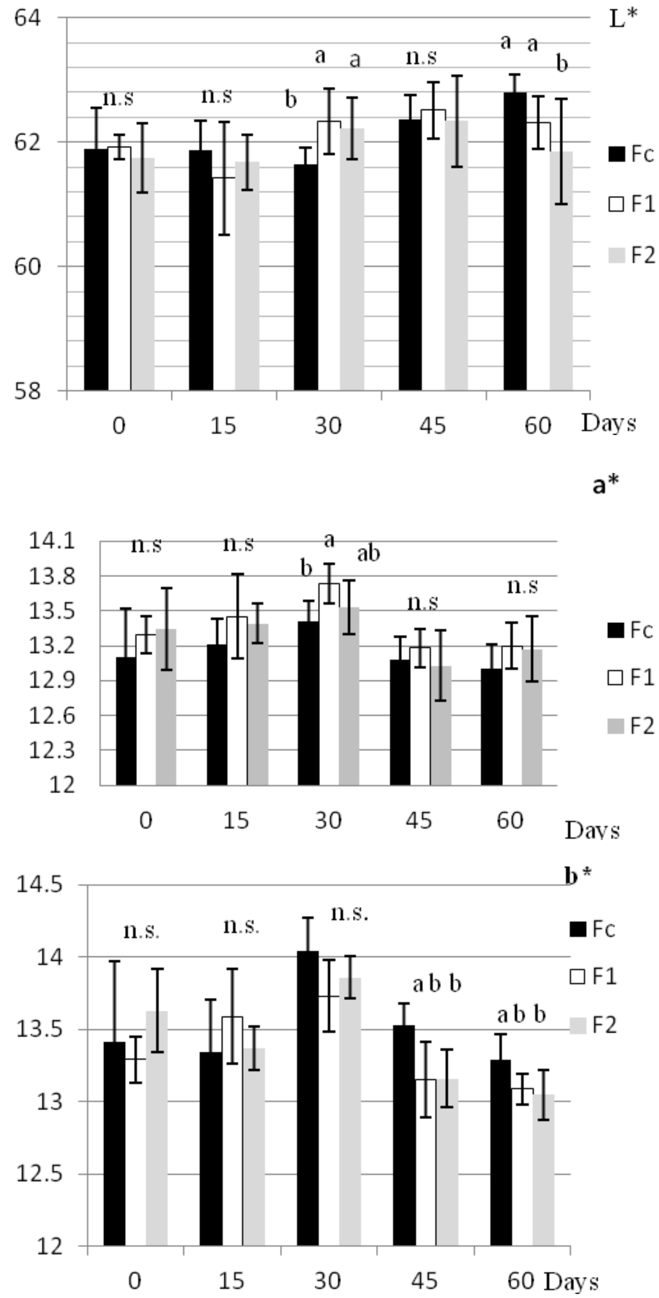

Figure 1. Mean (±S.E.) rated of L*, a*, b*of bologna sausage with sodium reduction

FC – Control (100% NaCl)

F1- 25% NaCl, 75% KCl, 0,1% sodium inosinate and 0,1%sodium guanylate

F2- 50% NaCl, 50% KCl, 0,1% sodium inosinate and 0,1%sodium guanylate n.s.- not significantValues with a different letter (a–b) of the same storage day are significantly different (P < 0.05).

Table 2- Mean (±S.E.) rated of L*, a*, b*of bologna sausage with sodium reduction

	0day	15days	30 days	45 days	60 days
L*					
FC	61,89±0,65^{bc}	61,87±0,48^{bc}	61,64±0,28^{b}	62,37±0,38^{a}	62,8±0,28^{b}
F1	61,92±0,20^{ab}	61,42±0,91^{b}	62,32±0,53^{a}	62,51±0,45^{a}	62,31±0,42^{a}
F2	61,75±0,55^{a}	61,68±0,45^{a}	62,22±0,50^{a}	62,33±0,73^{a}	61,85±0,85^{a}
a*					
FC	13,1±0,42^{ab}	13,2±0,22^{ab}	13,41±0,18^{a}	13,08±0,20^{ab}	13,00±0,21^{b}
F1	13,28±0,16^{ab}	13,44±0,36^{ab}	13,73±0,17^{a}	13,18±0,17^{b}	13,2±0,20^{b}
F2	13,34±0,55^{abc}	13,38±0,17^{ab}	13,53±0,23^{a}	13,03±0,30^{c}	13,17±0,28^{bc}
b*					
FC	13,41±0,56^{a}	13,34±0,36^{a}	14,04±0,63^{a}	13,52±0,15^{a}	13,29±0,18^{a}
F1	13,29±0,16^{bc}	13,59±0,32^{ab}	13,73±0,25^{a}	13,14±0,26^{c}	13,09±0,11^{c}
F2	13,63±0,29^{ab}	13,37±0,15^{bc}	13,86±0,14^{a}	13,16±0,20^{cd}	13,04±0,17^{d}

Values with a different letter within a column of the same batch are significantly different ($P < 0.05$).
FC – Control (100% NaCl)
F1- 25% NaCl, 75% KCl, 0,1% sodium inosinate and 0,1%sodium guanylate
F2- 50% NaCl, 50% KCl, 0,1% sodium inosinate and 0,1%sodium guanylate

Table 3- Mean (±S.E.) rated TBARS values (milligrams of malonaldehyde per kilogram) during storage (days) of bologna sausage with sodium reduction

Formulations	0 day	15 days	30 days	45 days	60 days
FC	0,11^{aA} (0,02)	0,04^{aAB} (0,02)	0,02^{aB} (0,01)	0,08^{aAB} (0,01)	0,08^{aAB} (0,03)
F1	0,98^{aA} (0,02)	0,04^{aA} (0,00)	0,02^{aA} (0,02)	0,09^{aA} (0,02)	0,06^{aA} (0,04)
F2	0,10^{aA} (0,01)	0,03^{aD} (0,00)	0,02^{aE} (0,01)	0,07^{aB} (0,00)	0,06^{aC} (0,00)

Values with a different letter within a column of the same batch are significantly different ($P < 0.05$).
a, b, c Means in the same column with the same letter did not differ significantly at pb0.05 and A,B,C the same row with the same letter did not differ significantly (Tukey's test).

For all treatments, the effects of salt reduction during refrigerated storage was not important for L* (luminosity), a*(redness) and b* (yellowness), despite the differences ($p <0.05$) between samples . In the same day of storage, the effect was not considered. Color degradation reactions is not completely elucidated but some studies suggested that color deterioration during refrigerated storage of cured and cooked meats is explained by the oxidative degradation of certain nitroso pigments, mainly if mechanically deboned poultry meat is used in the formulation due to its susceptibility to oxidation mainly because its own process for obtaining: extreme mechanical stress, extraction of considerable quantities of lipids and heme components from bone marrow and aeration during the machine-deboning process [8, 9]. However, in this study, there were no differences ($p<0,05$) in color (L*, a*,b*) for all batches (FC, F1 e F2) during storage (Table 2). These results are in agreement with several authors [6,7]. The difference may be explained by the different ingredients in the formulation, in this case used sodium erytorbate, that have properties antioxidants, unlike in sausages formulated only with sodium nitrite [9]. Lipid oxidation was evaluated by the levels of TBARS that developed during refrigerated storage (Table 3). There were no significant differences between the treatments in TBARS values on the same day of storage ($p<0,05$). The results suggest a good stability in lipid oxidation for all treatments during the shelf life because the values in the end of storage (60 days) was lower than zero time. A similar pattern of results was obtained in low salt bologna sausage with sodium reduction [6].

IV. CONCLUSION

Reductions in sodium content substituting NaCl by KCl at the level of 75% did not result in lower color stability and oxidation.

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