PHYSICAL-CHEMICAL PARAMETERS AND SENSORY ACCEPTANCE OF BEEF BURGERS WITH REDUCED SODIUM CONTENT

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Abstract – The objective of this study was to reformulate beef burger by reducing or partially replacing sodium chloride with potassium chloride and assaying its physical-chemical characteristics and sensory acceptance, aiming a healthier product with reduced sodium content. Five formulations of beef burgers were processed: Control (2% NaCl); R25% and R50% (reduction of 25 and 50% of NaCl, respectively); S25% and S50% (substitution of 25 and 50% of NaCl by KCl, respectively). Proximate composition, objective color, pH value, loss on cooking and shrinkage (reduction of diameter), instrumental texture and sensory acceptance test were performed. The reformulated beef burgers were in agreement with Brazilian legislation for protein and fat content. The sodium reduction did not affect ($p>0.05$) objective color, texture and shinkage. Differences ($p<0.05$) between the mean values of pH in Control and R50% treatments were observed. The treatments with NaCl replacement (S25% and S50%) displayed lower ($p<0.05$) cooking loss. Although these physical-chemical differences found, the NaCl reduction or its partial substitution with KCl did not impair the sensory acceptance of all evaluated attributes. One can conclude that is possible to obtain healthier beef burgers with lower sodium content by direct sodium chloride reduction, with or without KCl replacement.

Key Words – Hamburger, sodium chloride, potassium chloride, health, sensory evaluation.

I. INTRODUCTION

Salt has been used since ancient times for preservation of meat and today it is the most used ingredients in meat products. Although salt have central role in processing and sensory attributes (*e.g.* intensifying the flavor) of meat products, several processed meat products display high salt content [1]. According to a study carried out by the Brazillian Health Regulatory Agency (Anvisa) [2], salt content in a conventional beef burger ranged between 134 mg to 1120 mg per 100 g in different trademarks which means an average sodium content of 701 mg per 100 g of product.

Due to the high sodium content found in several foods products, the meat industry and consumers have become aware of the relationship between sodium intake and high blood pressure which has increased the demand for a variety of meat products with low sodium content [3]. One of the ways to attend the expectations of consumers regarding sodium reduction is to replace sodium chloride by potassium chloride [4].

The aim of the present study was to reformulate beef burgers to reduce sodium content by reducing sodium chloride or partially replacing sodium chloride (NaCl) by potassium chloride (KCl) and assessing physical-chemical characteristics and sensory acceptance of the products.

II. MATERIALS AND METHODS

The study was performed at the College of Animal Science and Food Engineering of University of São Paulo (FZEA/USP), Brazil. Five formulations of beef burgers with different levels of sodium chloride were processed: Control (beef burger with 2% of NaCl); R25% (beef burger with reduction of 25% of NaCl); R50% (beef burger with 50% reduction of NaCl); S25% (beef burger with 25% of NaCl replacement byKCl) and S50% (beef burger with 50% of NaCl replacement by KCl). The burger formulations are presented in Table 1.

Table 1. Formulations used in the processing of beef burgers with reduced sodium content.

Ingredients (%)	Treatments				
	Control	R25%	R50%	S25%	S50%
Beef meat	79	79	79	79	79
Pork back fat	18.15	18.15	18.15	18.15	18.15
Water	0.35	0.85	0.45	0.35	0.35
NaCl	2.0	1.5	1.0	1.75	1.0
KCl	-	-	-	0.25	1.0
Sodium tripolyphosphate	0.25	0.25	0.25	0.25	0.25
Antioxidant commercial mix	0.25	0.25	0.25	0.25	0.25

For the processing, the animal raw materials were ground in a 4 mm diameter disc and homogenized with the other ingredients for 10 minutes until a homogeneous batter was obtained. Subsequently, the meat batter was divided in portion of 95-100 grams and shaped in a burger machine. Finally,the burgers were frozen at -18 ºC until further analysis.

For the determination of the proximate composition, the official AOAC methodology [5] was used to determine the ash content (920.153) and moisture (950.46). The lipid content was determined by the Bligh & Dyer method [6] and protein content was estimated by the Dumas combustion method [7]. Particularly for proximate composition analysis, the assays were performed using a sample obtained from the homogenization of all treatments, since all formulations were processed with the same raw meat and ingredients. The objective color was evaluated using a portable colorimeter (MiniScan XE model of the HunterLab® brand) using the L* (brightness), a* (redness) and b* (yellowness) parameters of the CIElab system with the illuminant D65, 10 ° viewing angle and 30 mm cell aperture. The pH was measured with a portable pH meter (HANNA® model HI 99163).

The analysis of loss on cooking and shrinkage (reduction of diameter) were performed according to Fontam et al. [8].The texture analysis (hardness) was performed in a texturometer (TA-XT2i Stable Micro System, Godalming, UK.) equipped with an aluminum probe with 30 mm of diameter previously calibrated with a standard weight of 2 kg. The burgers were cooked in a griddle plate and cut into 2x2cm pieces and subjected to analysis with a velocity of 0.3 mm/s and compression of 50% of the height of the burger. The results were expressed in kilograms (kg).

The sensory analysis was performed by the acceptance test with a nine-point hedonic scale which ranged from "9 – liked very much" to "1 – disliked very much". A total of 70 consumers evaluated the texture, juiciness, flavor, saltiness taste and overall quality. The burgers were prepared in griddle plate at 180 °C, turned every 2 minutes for 8 minutes. After cooking, the burgers were served to the panelists. In addition, the acceptance index (AI) was calculated for each burger, using the method described by Dutcosky [9].

A complete randomized design (DIC) 5x2 with five treatments (Control, R25%, R50%, S25% and S50%) and two replicates of processing was used to evaluate the effect of salt content in the burger. The results were evaluated by analysis of variance ANOVA and the means were compared by the Tukey test, at 5% of significance. All statistical analyzes were performed using the SISVAR statistical program [10].

III. RESULTS AND DISCUSSION

The beef burgers showed the following mean composition: 16.01% protein, 16.27% lipids, 64.16% moisture and 2.58% ash.These results are in accordance Brazilian legislation for burger that establishes at least 15% of protein and less than 23% of lipids [11]. Table 2 presents the results of the color analysis (L*, a* and b*), pH value, shrinkage, loss on cooking and hardness of different formulations.

Table 2. Results of the physical analyzes of the beefburgers with reduced sodium content.

Analysis	Treatments					
	Control	R25%	R50%	S25%	S50%	SEM

	L*	49.25[a]	49.07[a]	50.15[a]	49.77[a]	47.62[a]	1.69
Color	a*	9.30[a]	10.95[a]	12.48[a]	10.42[a]	11.60[a]	0.70
	b*	14.21[a]	113.99[a]	14.91[a]	14.24[a]	14.20[a]	0.22
pH		5.86[b]	5.91[ab]	5.93[a]	5.91[ab]	5.91[ab]	0.01
Shrinkage (%)		23.32[a]	21.43[a]	22.52[a]	22.51[a]	23.08[a]	0.48
Loss on cooking (%)		33.39[a]	33.37[a]	32.91[a]	27.41[b]	28.66[b]	0.24
Hardness (kg)		5.17[a]	5.31[a]	3.82[a]	4.73[a]	5.65[a]	0.32

[a,b]Means with different letters with in a row are significantly different ($p<0.05$). SEM – Standard error of the mean.

It was observed that NaCl reduction and/or replacement by KCl did not affect the objective color parameters (L*, a* and b* values), shrinkage and hardness ($p>0.05$). Horita et al. [12], also found no differences in the mean values of L*, a*and b* in mortadella with lower NaCl and fat content with partial replacement of NaCl by a blend of salts (calcium, magnesium and potassium). Oliveria et al. [13] did not find differences in shrinkage between beef burgers containing light salt (66.0% of KCl) and commercial salt (100% of NaCl). Horita et al. [14] studied the reduction of NaCl and replacement by blend of several salts (calcium and potassium) in frankfurter sausage and found that 50% of NaCl replacement by KCl resulted in higher hardness than observed in control formulation. Additionally, authors did not observe significant differences in hardness of 25% substitution of NaCl by KCl and control treatments.

The reduction in NaCl content in R50% induced a significant ($p<0.05$) increase in pH value in comparison to control burger (Table 2). Non-significant differences were observed in cooking loss among control and R25% and R50% treatments. However, cooking loss was reduced ($p<0.05$) by partial substitution of NaCl with KCl (S25% and S50%) in comparison to control, R25% and R50% treatments.

Table 3 presents the results of sensory analysis of beef burgers with reduced sodium content. The acceptance of texture, juiceness and flavor in R25% and S25% were increased ($p<0.05$) in comparison to control treatment. The same result was observed by Carvalho et al. [15] who studied the effect of partial substitution of NaCl by KCl in beef burgers and did not observe differences in the accepatnce of texture in control and 50%NaCl substitution by KCl treatments. On the contrary, Horita et al. [14] observed that sausages with reduced sodium chloride content (by 25% and 50%) had lower scores for the acceptance of flavor.

Table 3. The result of the sensory analysis of beef burgers with reduced sodium content.

Parameters	**Treatments**					
	Control	**R25%**	**R50%**	**S25%**	**S50%**	**SEM**
Texture	6.66[b]	7.26[a]	7.21[ab]	7.24[a]	7.06[ab]	0.15
Juiceness	6.83[b]	7.44[a]	7.24[ab]	7.60[a]	7.31[ab]	0.14
Flavor	6.89[b]	7.60[a]	7.29[ab]	7.67[a]	7.36[ab]	0.14
Saltiness	6.76[b]	7.31[ab]	7.39[a]	7.34[ab]	7.30[ab]	0.15
Overall quality	6.80[b]	7.36[ab]	7.27[ab]	7.67[a]	7.31[ab]	0.14
AI (%)[*]	75	82	81	83	81	-

[a, b]Means with different letters with in a row are significantly different ($p<0.05$). [*]AI – acceptance index. SEM – Standard error of the mean.

Regarding saltiness, it was observed that the burgers with 50% reduction in NaCl (R50%) presented a higher average score than observed for control treatment ($p<0.05$). Furthermore, the overall quality acceptance was significantly increased by reduction of 25% in NaCl treatment in comparison to control treatment ($p<0.05$). Thus, according to the present study, the reduction in NaCl by 50% or replacing 50% of NaCl by KCl (S50% and R50%, respeticvely) did not influence remarkably the evaluated parameters and increased the acceptability. Additionally, Dutcosky [9] stated that a "well accepted" food must achieve AI values higher than 70% in an acceptance test. Therefore all reformulated products in the present study can be considered as "well accepted" by panelists.

IV. CONCLUSION

The reduction of up to 50% of the sodium content by simple reducing of NaCl or by partial replacement with KCl did not negatively affect the physical-chemical characteristics and acceptability of the beef burgers evaluated in the present experiment. Thus, these tested strategies shows potential in the reformulation of hamburgers, in order to obtain healthier meat products with lower sodium content.

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