Quality characteristics of reduced-salt sausages using the pre-rigor muscle during frozen storage at different temperatures (#496)

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Introduction

Salt is an important ingredient for processed meats, because it improved flavor, emulsifying capacity, and inhibited the growth of microorganisms in meat products. However, the excessive levels of salt in processed meats can cause cardiovascular disease in the consumers. Thus, Scientific Advisory Committee on Nutrition (SACN) recommended that the daily intake of sodium should be reduced to 6 g or less, and that the additional levels as food should be as low as 2300 mg per day. Pre-rigor processed meat showed higher extractable salt soluble proteins, and it increased water-holding capacity by the addition of salt. Therefore, the objective of this study was to evaluate the quality characteristics of pork sausage (PS) using the pre-rigor muscle to reduce the salt levels for meat products.

Methods

Pork hams were prepared with the state of pre-rigor (< 1 hr after slaughter) and post-rigor (1 day after slaughter). Sausages with post-rigor muscle at the salt levels of 1.5% were manufactured, while those with pre-rigor muscle at salt levels of 1.0% were processed. There were two factors, storage time (0, 4, 8, 12 weeks) and temperature (-30, -70°C) of meat batter. Accordingly, PSs were prepared 4 treatments (HC=PS (1.5% salt) with post-rigor muscle stored at -30°C; LC=PS (1.5% salt) with post-rigor stored at -70°C; HH=PS (1.0%) with pre-rigor muscle stored at -30°C; LH=PS (1.0%) with pre-rigor PS stored at -70°C. The pH, temperature, protein solubility, SDS-PAGE of raw meat batter were measured, while pH and, color values, cooking loss (CL, %), expressible moisture (EM, %), textural properties, lipid oxidation (TBARS), protein oxidation (VBN) of cooked sausages were measured. Data were analyzed by two-way analysis of variance (ANOVA) using IBM SPSS Statistics 23 (SPSS Inc., Chicago, IL, USA).

Results

The pH values and temperature of pre-rigor pork ham (6.07±0.21; 34.4±1.92) were higher than those of post-rigor one (5.68±0.85; 12.3±9.40). Before cooking the PSs, the pH values of LH were higher than those of HC and LC (Table 1). At the initial storage, the lightness (L*) and yellowness (b*) values were highest, and the redness values were lowest. These were partially due to the differences of the frozen and non-frozen. No differences in protein solubility were observed among the treatment.

As shown in Table 2, after cooking the PSs, no differences were observed in pH, color values and cooking loss. However, the expressible moisture of LH and HH were the higher than those HC. This result suggested that the higher the salt level of the PS, the higher the water holding capacity.

As shown in Table 3, the lipid oxidation, protein oxidation and textural properties of sausages were not affected by salt levels and state of pre or post-rigor. These results were supported by Berry et al. (1986) who reported that there were no differences in textural properties of restructured beef steaks, regardless of rigor state and salt levels.

Conclusion

Regardless of storage time and temperature, pre-rigor PSs with additional level of 1.0% salt had the same characteristics as the post-rigor with 1.5% salt. By using the pre-rigor, the salt content could be reduced by one third of original salt level. In addition, the frozen storage of raw meat batter affected the color values, while, it didn't affect the characteristics of cooked sausages.

Table 3. Textural properties, TBARS and VBN of cooked pork sausages with different rigor state and salt levels, and frozen temperatures (-30 vs -70 °C) during frozen storage

	Hardness	Springiness	Gumminess	Chewiness	Cohesiveness	TBARS	VBN
Treatments[1]							
HC	4515±636[a]	6.06±1.07[a]	38.5±6.74[a]	22.8±5.30[a]	0.01±0.00[a]	0.26±0.01[a]	2.03±0.13[a]
LC	5231±729[a]	5.88±0.81[a]	54.3±17.5[a]	310±77.2[a]	0.01±0.00[a]	0.26±0.01[a]	2.04±0.14[a]
HH	5242±1204[a]	5.61±0.79[a]	53.1±18.1[a]	295±111[a]	0.01±0.00[a]	0.26±0.01[a]	2.03±0.12[a]
LH	5271±1075[a]	5.65±0.94[a]	51.1±18.9[a]	293±99.9[a]	0.01±0.00[a]	0.25±0.01[a]	1.98±0.11[a]
Storage time (week)							
0	5009±447[a]	6.25±0.88[a]	44.5±4.65[a]	278±56.0[a]	0.01±0.00[a]	0.25±0.01[a]	2.03±0.20[a]
4	5067±543[a]	5.84±1.01[a]	53.6±13.5[a]	301±71.2[a]	0.01±0.00[a]	0.26±0.01[a]	2.01±0.11[a]
8	4848±1323[a]	5.36±0.46[a]	44.9±18.6[a]	250±113[a]	0.01±0.00[a]	0.26±0.01[a]	2.01±0.07[a]
12	5334±1266[a]	5.75±1.01[a]	54.0±23.9[a]	296±113[a]	0.01±0.00[a]	0.26±0.01[a]	2.03±0.09[a]

[a] Means having same superscripts in a same column are not different (p>0.05).

[1] Treatments: HC=PS (1.5% salt) with post-rigor muscle stored at -30°C; LC=PS (1.5% salt) with post-rigor stored at -70°C; HH=PS (1.0%) with pre-rigor muscle stored at -30°C; LH=PS (1.0%) with pre-rigor PS stored at -70°C

Table 3

Table 2. pH and color values, expressible moisture and cooking loss of cooked pork sausages with different rigor state and salt levels, and frozen temperatures (-30 vs -70 ℃) during frozen storage

	pH	L*	a*	b*	EM	CL
Treatments[1]						
HC	6.22±0.05[a]	72.2±1.28[a]	10.7±0.52[a]	4.22±0.37[a]	29.1±1.90[b]	5.88±1.70[a]
LC	6.22±0.05[a]	72.4±1.34[a]	10.6±0.49 [a]	3.99±0.34[a]	30.6±2.55[ab]	6.36±1.38[a]
HH	6.28±0.23[a]	71.8±1.57[a]	11.5±0.84[a]	5.30±0.86[a]	31.2±1.87[a]	10.8±7.64[a]
LH	6.35±0.17[a]	72.3±0.96[a]	11.2±0.67[a]	5.33±0.85[a]	31.7±2.87[a]	9.47±6.22[a]
Storage time (weeks)						
0	6.27±0.15[a]	72.9±1.04[a]	10.8±0.62[a]	4.40±0.71[a]	30.7±2.91[a]	6.45±1.21[a]
4	6.29±0.13[a]	72.5±1.27[a]	10.9±0.85[a]	4.91±1.01[a]	31.7±2.88[a]	8.98±6.15[a]
8	6.23±0.22[a]	71.5±1.33[a]	11.1±0.75[a]	4.71±0.96[a]	31.4±3.24[a]	9.22±7.68[a]
12	6.28±0.16[a]	71.9±1.17[a]	11.2±0.68 [a]	4.83±0.87[a]	31.8±3.41[a]	7.85±4.13[a]

[a, b] Means having same superscripts in a same column are not different ($p>0.05$).
[1] Treatments: HC=PS (1.5% salt) with post-rigor muscle stored at -30°C; LC=PS (1.5% salt) with post-rigor stored at -70°C; HH=PS (1.0%) with pre-rigor muscle stored at -30°C; LH=PS (1.0%) with pre-rigor PS stored at -70°C

Table 2

Table 1. pH and color values and protein solubility of pork meat batter with different combination of rigor state and salt levels, and frozen temperatures (-30 vs -70 ℃) during frozen storage

	pH	L*	a*	b*	Protein solubility (%)
Treatments[1]					
HC*	6.01±0.09[bc]	56.8±2.60[b]	6.14±1.63[ab]	5.14±1.57[b]	54.9±12.4[a]
LC	5.97±0.07[c]	57.0±2.47[ab]	5.25±1.54[b]	5.51±1.28[b]	58.8±8.75[a]
HH	6.15±0.20[ab]	58.4±1.84[ab]	6.98±1.95[a]	6.14±1.28[ab]	50.5±7.64[a]
LH	6.16±0.22[a]	58.5±2.15[a]	6.78±1.90[a]	6.72±1.44[a]	54.0±5.63[a]
Storage time (weeks)					
0	6.02±0.17[a]	60.2±2.41[a]	4.34±1.64[b]	6.99±1.73[a]	58.8±12.4[a]
4	6.09±0.18[a]	56.3±1.48[b]	7.17±1.71[a]	5.48±1.52[b]	54.2±6.26[a]
8	6.09±0.18[a]	57.1±1.41 [b]	6.97±1.61[a]	5.59±1.09[b]	54.2±5.28[a]
12	6.09±0.18[a]	56.9±1.85[b]	6.67±0.73 [a]	5.45±1.05[b]	50.9±4.47[a]

[a-c] Means having same superscripts in a same column are not different ($p>0.05$).
[1] Treatments: HC=PS (1.5% salt) with post-rigor muscle stored at -30°C; LC=PS (1.5% salt) with post-rigor stored at -70°C; HH=PS (1.0%) with pre-rigor muscle stored at -30°C; LH=PS (1.0%) with pre-rigor PS stored at -70°C

Table 1