Impact of Ham and Brine Temperatures on Processing Characteristics of Cured Ham

J.N. Leach[1] *and F.W. Pohlman*[1]

Story in Brief

The effects of brine temperature and ham temperature during curing on injection and yield characteristics of cured hams were studied. Ham temperature and brine temperature were standardized to yield the following treatments: 1) 29°F ham and 29°F brine (CC), 2) 29°F ham and 34.5°F brine (IC) 3), 29°F ham and 39°F brine (CW) 4) 39°F ham and 29°F brine (WC), 5) 39°F ham and 34.5°F brine (WI) and 6) 39°F ham and 39°F brine (WW). Hams cured with the 29°F brine had less ($P < 0.05$) total weight loss from green weight to chill weight. Hams cured with the cold 29°F brine had less chill loss and cook loss than that of the warm brine. There were no differences in the mean losses and gains of the different ham temperatures in injection uptake, tumble loss, cook loss, chill loss, total gain, or loss from green to chill weight, and moisture. There were no differences in the mean values of the brine temperature for injection uptake, tumble loss, and moisture.

Introduction

Hams are generally cured at the temperature of the individual cooling or processing room. Brine is often mixed at tap water temperatures and ice may or may not be added to lower brine temperatures, thus causing substantial variation in brine temperatures through the curing process. Brine retention is important to meat processors for yield improvement, brine distribution and color development. This is also important since purchasing decisions by consumers are influenced by product color (Dineen, 2000). Curing brine contains sodium nitrite thus making brine uptake an important factor in color and flavor stability in cured meats (Tichivangana et al., 1984). Although some knowledge exists about how brine or marinades affect yield, color, and tenderness characteristics of muscle foods, little is known regarding the impact of brine and ham temperature effects on these attributes. Therefore, the objective of this study was to determine what impact ham and brine temperatures have on injection and yield characteristics of cured hams.

Experimental Procedures

Processing. For this experiment, hams were divided into two temperature groups; 29°F and 39°F. A commercial brine was mixed and brine temperatures were standardized into three groups; 29°F, 34.5°F and 39°F. Each treatment group consisted of ten hams that resulted in the following treatment combinations 1) 29°F ham and 29°F brine (CC); 2) 29°F ham and 34.5°F brine (CI); 3) 29°F ham and 39°F brine (CW); 4) 39°F ham and 29°F brine (WC); 5) 39°F ham and 34.5°F brine (WI); and 6) 39°F ham and 39°F brine (WW). Brine used for each treatment was made from ingredients originating from the same production lot to avoid lot to lot ingredient variation.

Fresh hams were placed on a perforated wire rack in a cooler operating at 29°F or 39°F 1 to 2 days prior to use to temper ham internal temperature. After mixing, the brine was placed in commercial brine chiller (Admix) and chilled to either 29°F, 34.5°F or 39°F. Internal ham temperatures were checked and recorded prior to the curing process. When hams reached either 29°F or 39°F internal temperature, samples of the psoas major and gluteous profundis muscles were removed from each ham and placed in whirl pack bags for moisture determination. Before injection, hams were weighed for fresh (green) weight and recorded. Each ham was then injected with a multiple needle automatic pickle injector (Fomaco FGM 40/20, Denmark). The injector was set for an injection rate of 40%. The injection parameters used were 3 bar pressure and 35 strokes per minute. The head speed was adjusted accordingly to yield a 40% injection rate. During injection, brine was continuously circulated through the brine chiller to maintain target brine temperatures.

After injection, hams were reweighed to determine injection rate, and internal ham temperatures were rechecked. The hams were then placed on a perforated wire screen and drained for 30 minutes. Hams were weighed for dry weight and then tumbled for 8 hours. During the tumbling process, each treatment tumbled for 1 hour, rested for 30 minutes, then tumbled again for a total of 8 hours. The hams were removed from the tumbler, placed in ham stockings, and weighed to determine tumble losses. The hams were next placed in a computer-controlled smokehouse (Alkar Model 1000 Smokehouse, USA) and cooked to an internal temperature of 157°F. The smoke cycle is shown in Table 1. Five thermocouples were placed in hams on top, bottom and center of the smokehouse to record temperatures during cooking and cooling. After 5 hours, hams were reweighed and internal temperatures recorded. Next, hams were placed in a cooler for chilling (34°F) for 24 hours then reweighed again to obtain ultimate chilled ham yield. After curing and chilling, ham center slices were removed from each ham. A portion of the *semimembranousus* muscle was removed from each ham for moisture analysis.

Moisture analysis. Moisture content was determined by freeze vacuum drying on fresh gluteous profundis muscles and on cured semimembranousus muscles obtained from hams. For this, duplicate samples of approximately 3 grams were weighed and placed in 30-mL beakers then weighed again. The beakers were placed in a vacuum-flask and frozen completely. Next, the vacuum-flasks were placed on a Labconco freeze dryer (model 4.5, Labconco Corp., Kansas City, MO) and dehydrated at a vacuum of < 10 um mercury

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[1] Department of Animal Science, Fayetteville

(Hg). Samples remained on the freeze dryer for a minimum of 48 hours. The samples were re-weighed and the difference between the initial and dried beaker weights was divided by the sample weight and multiplied by 100 to calculate the percentage moisture.

Statistical analysis. The experiment was analyzed as a completely randomized factorial design. Data were analyzed by using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC). For analysis, the main effects of ham and brine temperature as well as their interaction were placed in the model. Since there were no ham x brine temperature interactions for processing characteristics, least-squares means were generated for all dependent variables for each main effect and separated using the PDIFF option of SAS.

Results and Discussion

The impact of ham temperature during curing on injection uptake, processing yields and moisture content are shown in Table 2. Since injection rate was calibrated, and therefore expected, ham temperature had no effect ($P > 0.05$) on injection uptake. Likewise, ham temperature did not affect ($P > 0.05$) ham tumble losses, cook losses, chill losses or final ham yield (total gain/loss %). Since ham temperature did not affect processing yields, cured moisture content did not differ ($P > 0.05$) between ham temperature treatments.

The impact of brine temperature on injection uptake, processing yields and moisture content are shown in Table 3. There were no differences ($P > 0.05$) between mean values for injection uptake percentage, tumble loss percentage and moisture content between brine temperature treatments. However, brine temperature did have an effect on mean cook losses where hams injected with 34.5°F brine had less ($P < 0.05$) cooking losses than those injected with 29°F brine. Futhermore, hams cured with 39°F brine had less cooking losses than those cured with either 29°F or 34.5°F brine. Ham chill losses were lowest ($P < 0.05$) for 34.5°F treatment, intermediate for the 39°F, and highest for the 29°F treatment. Therefore, total losses were affected ($P < 0.05$) by curing brine temperature, and losses declined with the use of progressively warmer brines. Advantages in ham cook yields when cured with warmer brines, therefore, also translated into greater final product ham yields and would lead to greater quantities of finished product to be sold. While Gillet et al. (1982) found that in boneless fresh hams that pump level had no effect on yield of intermittently massaged hams when the pump level exceed 30%, results from our study indicate that cook losses can be reduced and, therefore, yield increased by curing hams with warmer brines.

Implications

Discovering a way to increase brine retention is important for producing higher quality hams with greater yields. The use of warmer brine curing temperatures can improve both cooked as well as chilled finished product yields and have an economic advantage by allowing increased quantities of product sold and therefore greater profitability.

Literature Cited

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Gillet, T. A., et al. 1982. J. of Food Sci. 47:1.
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Table 1. Ham cook and smoke cycle.

Step	Time, Min	Cycle	Dry Bulb	Wet Bulb	Relative Humidity, %
1	10	cook	120	0	0
2	120	cook	150	90	12
3	180	smoke, cook	160	120	30
4	60	cook	170	130	32
5[a]	60	cook	190	175	71

Table 2. Least-squares means for injection uptake, tumble loss, cook loss, chill loss, total gain or loss, and moisture content as influenced by ham curing temperature.

	Ham temperature	
Trait	Cold (29°F)	Warm (39°F)
Processing		
Injection uptake, %	41.03 ± 1.25	41.92 ± 1.30
Tumble loss, %	3.54 ± 0.57	3.45 ± 0.53
Cook loss, %	22.39 ± 0.62	23.24 ± 0.59
Chill loss, %	8.01 ± 0.51	7.61 ± 0.51
Total gain/loss, %	9.70 ± 1.13	10.08 ± 1.13
Moisture, %	72.31 ± 0.80	71.28 ± 0.97

Means within a row do not differ ($P > 0.05$).

Table 3. Least-squares means for injection uptake, tumble loss, cook loss, chill loss, total gain or loss, and moisture content as influenced by brine curing temperature.

	Brine temperature		
	Cold	Intermediate	Warm
Trait	(29°F)	(34.5°F)	(39°F)
Processing			
Injection uptake, %	42.66 ± 1.58	38.57 ± 1.58	43.19 ± 1.54
Tumble loss, %	3.66 ± 0.65	3.30 ± 0.63	3.38 ± 0.73
Cook loss, %	25.96 ± 0.71^{x}	21.82 ± 0.71^{y}	20.67 ± 0.80^{z}
Chill loss, %	15.84 ± 3.66^{x}	7.52 ± 3.66 ^{z}	9.11 ± 3.78^{y}
Total gain/loss, %	14.59 ± 1.37^{x}	9.27 ± 1.37^{y}	5.80 ± 34.51^{z}
Moisture, %	73.09 ± 1.21	71.51 ± 1.05	70.79 ± 1.00

^{xyz}Least-squares means within a row with no letters in common differ ($P < 0.05$).