6:3 # The effect of blade tenderization on the cure and sensory characteristics of dry cured hams

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Introduction

The dry curing process for hams involves application of the cure adjuncts in a granular form. After dry cure application, hams are normally stored at 2-5°C for 30-50 days depending upon product weight and procedure to permit cure penetration. This application procedure, which has been practiced since the early part of civilization, has been widely used throughout Virginia and other states because of the unique cured flavor that is developed.

Two major limitations associated with the dry curing technique are increased production costs and a decrease of product tenderness. Dry curing normally requires 70-180 days, depending on the adopted procedure, for the cure application-penetration, cure equalization, smoking (if incorporated), and aging. Therefore, the extended storage time is responsible for high production costs due to space and capital requirements. The other limitation involves loss of tenderness through moisture loss from the approximate 18% weight reduction during dry curing.

Previous research conducted in our laboratories (Marriott et al., 1983, 1984; Tracy, 1979) and by Cecil and Woodroof (1954), Kemp et al. (1975), and Krause et al. (1978) has been conducted to accelerate the dry curing process. Our recent efforts have revealed that vacuum tumbling of hams with the dry cure adjuncts (Marriott et al., 1984) or with NO gas (Marriott et al., 1983; Tracy, 1979) will accelerate cure penetration. Although the previously mentioned studies suggest viable processes for acceleration of the dry curing process, a solution to the potential reduction of tenderness was not identified. Thus, the objectives of this study were to evaluate blade penetration of hams prior to dry cure application to determine effects on (a) acceleration of the curing process, (b) product tenderness and (c) potential microbial proliferation.

Materials and Methods

Thirty-six hams that weighed from 7.5-10.4 Kg were removed from 18 pork carcasses within 24 hours postmortem, skinned, and trimmed 2/3 of the distance from the collar to shank, and weighed. Hams from the right side of each carcass (T) were run through a Ross Model TC 700 Tenderizer twice. The top side (with bone exposed) was first blade tenderized with subsequent pinning of the bottom side. Hams from the left side (C) were treated the same as the T samples except that they were not tenderized. Cure adjuncts (8% of the product weight of NaCl and 2180 ppm of $NaNO_3$) were applied to all samples for 40 days. After 7 days of storage all hams were overhauled with approximately 50% of the original amount of NaCl. Following 40 days of cure application, the residual cure was removed by washing and those hams not utilized for product evaluation were transferred to a 12°C storage environment with 75% RH for 16 days of cure equilization. Those samples not evaluated after 56 days of curing were aged in a 30°C environment with 65% RH for 14 days. After 70 days of cure application, cure equilization, and aging, the remaining samples were evaluated.

Objective measurements of the whole hams and/or center slice at each evaluation interval included sampling of the Biceps femoris and Semimembranosus muscles for percentage weight loss, percentage moisture (AOAC, 1980), percentage salt (USDA, 1979), ppm NO_2 (USDA, 1979), total plate count (Speck, 1976), psychrotrophic count (Speck, 1976), anaerobic count (Speck, 1976), and Kramer Shear force. Subjective evaluations were determined by a six-member rating panel according to a scaling method described by Larmond (1979). Evaluations included uncured color and overall appearance before curing (8 = very desirable; 1 = very undesirable); cured color before and after cooking (5 = bright cured color development throughout; 1 = no cured color development); percentage of cure penetratrion (5 = 100; 1 = 0); and tenderness, juiciness and flavor (8 = very desirable; 1 = very undesirable).

Data were analyzed by analysis of variance and regression analysis according to Barr et al. (1979) and Snedecor and Cochran (1967). When significant ($P < 0.05$) main effects were observed in the analysis of variance, mean separation analysis was conducted according to Duncan (1955).

Results and Discussion

Color and overall appearance ratings (data not shown) of hams prior to cure application (0 days) revealed that no differences ($P > 0.05$) in these two traits existed between the T and C samples. Subjective evaluation of center slices at 40, 56 and 70 days (Table 1) revealed that blade penetration had no effect ($P > 0.05$) on cure penetration or cured color within each cure period. Although subjective ratings of raw cured color tended to increase with time through the curing, equalization and aging processes, only the C samples after equalization (56 days) were different from their counterparts at 40 days. However, color stability after cooking increased ($P < 0.05$) with increased cure time. Differences ($P < 0.05$) in cured color after cooking among the cure periods suggest that cure times less than 70 days will provide acceptable cured color immediately after slicing, but the transient fixed color will fade during cooking. Therefore, it appears that the total process time should not be less than 70 days if color stability during cooking is desired.

Percentage weight loss (data not shown) from the time of fabrication until cure application was insignificant as evidenced by weight loss for the T hams being only 0.002% more than for the C samples. Furthermore, Table 2 reveals that neither blade penetration nor cure time had any effect ($P>0.05$) on percentage moisture. The only plausible explanation for insignificant weight loss during cure was the humidity conditions alluded to in the materials and methods discussion. These data suggest that blade penetration will not accelerate moisture loss during curing.

Data in Table 2 illustrate that cure time had no effect ($P > 0.05$) on percentage salt of the dry cured T samples. Blade penetration had no effect ($P > 0.05$) on percentage salt of any samples except those cured for 70 days. Since no differences ($P > 0.05$) were found among those samples cured for 40 or 56 days, the larger ($P < 0.05$) percentage of salt among the T samples at 70 days may be an artifact. This table revealed that cure time and blade penetration had no effect ($P > 0.05$) on nitrite content (ppm). Although the numerical differences and standard errors may appear to be large, it should be recognized that these values are minimal since ppm is a small unit of measurement. Results in Table 2 suggest that cure time and blade penetration had little effect on the analytical data (percentage moisture, percentage salt and nitrite content) which relate to measurement of amount of cure and that blade penetration provides no apparent acceleration of the cure process.

Prior to this study, the authors hypothesized that blade penetration for tenderization prior to the dry curing process could increase the microbial load, especially the anaerobic count. Table 3 verifies that this hypothesis should be rejected. Total plate counts (TPC) (except at 0 days) anaerobic counts (AC) or psychrotrophic counts (PC) did not differ ($P>0.05$) between T and C samples cured for the same period of time. Total plate counts of the T samples were higher ($P< 0.05$) than for the C samples at 0 days. However, no differences ($P > 0.05$) were found for any cure period. Cure time was responsible for increased microbial load as evidenced by higher TPC and AC values after 56 and 70 days cure time than for 40 days. The larger ($P < 0.05$) values at 56 days may have been due to the removal of cure with a subsequent increase in storage temperature. However, further increases were not experienced with continued high temperature aging. A decrease in psychrotrophs after 70 days of cure time could be attributable to increased temperature and competition from the balance of the microflora. These data suggest that blade penetration will have no effect on microbial load except an increase in TPC before cure application.

The lack of effect of blade penetration on tenderness of dry cured hams as determined by measurement of Kramer Shear force of the Semimembranosus from the center cut slice of T and C samples was evidenced by no effect of cure time ($P > 0.05$) on Kramer Shear force values (data not shown). Although blade penetration has been shown to increase the tenderness of other meats (Miller, 1975; Bowling, et. al., 1976), our objective measurements did not demonstrate an improvement in this trait. This observation was supported by subjective evaluations of tenderness which are presented in Table 4. The rating panel found no improvement ($P > 0.04$) in tenderness when the T and C samples were compared. Although the tenderness scores for the T samples cured for 56 days were lower ($P < 0.05$) than the tenderized hams cured for 40 days, this difference was not considered to be practical since the variation was only 0.5 of a point on the rating scale. Furthermore, scores were high enough throughout all periods to suggest that both the T and C samples had acceptable tenderness.

Juiciness scores did not differ ($P > 0.05$) between the T and C samples (Table 4) at either sampling time. Control hams were consistently rated higher in flavor at each stage of the process. Yet, flavor scores did not improve after aging as would be expected. The T samples were significantly lower in flavor ($P< 0.05$) after aging (70 days) than the control hams or T samples evaluated after salt equilization (56 days). The T samples cured for 70 days may have yielded lower ($P < 0.05$) flavor scores than the C samples cured for the same time due to an increase in the percentage of salt.

Table 2 revealed that the T samples cured for 70 days were higher ($P< 0.05$) in salt content than the C counterparts. The higher scores ($P<0.05$) for C

Table 1. The effect of blade penetration and cure penetration and color scores[a] of dry cured hams.

	Cure Time					
	40 Days		56 Days		70 Days	
Trait	Blade Penetration	Control	Blade Penetration	Control	Blade Penetration	Control
Cure Penetration[a]	4.6[c]	4.5[c]	4.6[c]	4.7[c]	4.7[c]	4.7[c]
Color Before Cooking[b]	4.5[d]	4.5[d]	4.7[cd]	4.9[c]	4.8[cd]	4.7[cd]
Color After Cooking[c]	2.0[e]	2.3[e]	4.0[d]	3.8[d]	4.7[c]	4.5[c]

[a]Means are based on a 5-point scale (5 = 100; 1 = 0%).
[b]Means are based on a 5-point scale (5 = bright cured color development throughout; 1 = no cured color development).
[cde]Means in the same row followed by a common letter are not different ($P > 0.05$).

Table 2. The effect of blade penetration and cure time on percentage moisture, percentage salt and nitrite content of dry cured hams.

	Cure Time											
	40 Days				56 Days				70 Days			
	Blade Penetration		Control		Blade Penetration		Control		Blade Penetration		Control	
Trait	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Percentage Moisture	63.3[a]	.28	63.8[a]	.63	63.9[a]	1.20	68.4[a]	1.20	60.7[a]	3.05	61.4[a]	.80
Percentage Salt	6.3[ab]	.24	5.9[abc]	.06	6.1[ab]	.43	5.2[bc]	.19	6.9[a]	.89	4.6[c]	.39
Nitrite Content (PPM)	1.8[a]	.75	4.5[a]	3.23	46.7[a]	27.69	24.7[a]	8.24	46.2[a]	18.60	28.2[a]	11.48

[abc]Means in the same row followed by a common letter are not different ($P > 0.05$).

Table 3. The effect of blade penetration and cure time on $\log_{10}$ microbial counts of dry cured hams.

	Cure Time											
	0 Days		40 Days		56 Days		70 Days					
	Blade Penetration		Control		Blade Penetration		Control		Blade Penetration		Control	
Trait	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Total Plate Count	4.3[d]	.19	3.7[e]	.09	6.4[c]	.09	6.1[c]	.15	7.9[a]	.06	7.5[ab]	.22
Anaerobic Count	2.8[d]	.13	2.8[d]	.03	5.1[c]	.33	4.8[c]	.13	7.2[a]	.11	6.9[a]	.39
Psychrotrophic Count	4.4[d]	.19	4.3[d]	.30	6.1[bc]	.39	5.9[c]	.18	6.7[ab]	.13	7.0[a]	.26

[abcde]Means in the same row followed by a common letter are not different (P > 0.05).

Table 4. The effect of blade penetration and cure time on the sensory attributes of dry cured hams.

	Cure Time											
	40 Days				56 Days				70 Days			
	Blade Penetration		Control		Blade Penetration		Control		Blade Penetration		Control	
Trait	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Tenderness[a]	6.3[b]	.19	6.2[bc]	.06	5.8[c]	.17	6.0[bc]	.10	6.1[bc]	.14	6.3[bc]	.12
Juiciness[a]	5.2[bc]	.17	6.0[b]	.14	5.2[bc]	.14	5.3[bc]	.07	5.5[c]	.09	5.8[bc]	.13
Flavor[a]	5.2[cd]	.11	5.4[b]	.08	5.4[c]	.10	5.4[b]	.06	4.9[d]	.26	5.2[bc]	.14

[a]Means are based on an 8-point scale (8 = very desirable; 1 = very undesirable).
[bcd]Means in the same row followed by a common letter are not different (P > 0.05).

samples at 40 and 56 days may be due to the same reason. These differences, even though significant ($P < 0.05$) deviated by only 0.7 on a rating scale from 1-8. Although the differences of salt among T and C samples at these times were insignificant ($P > 0.05$), the numerical values of the T samples were generally higher. Moreover, the magnitude of the scores indicate that the flavors observed were all intermediate and no doubt influenced primarily by differences in percentage salt among the samples. In this study, neither the control nor the treated hams were evaluated as having a pronounced cured ham flavor. Cure time was responsible for a minimal amount of flavor variation since the only differences in flavor among periods were the T samples cured for 70 days which received lower ($P < 0.05$) scores than the blade tenderized hams cured for 40 and 56 days. Due to the increased percentage of salt, blade tenderized hams achieved the most desirable flavor at 56 days. These data suggest that blade penetration and cure time had minimal effects on taste attributes except the negative relationship of blade penetration on flavor.

Conclusions

Blade penetration had no effect ($P > 0.05$) on visual color, cure penetration rate, percentage weight loss before curing, percentage moisture at various intervals, percentage salt at 40 and 56 days, nitrite level, microbial load (TPC, AC and PC), objective and subjective tenderness measurements, or juiciness scores or flavor scores. Cure time had no effect ($P > 0.05$) on percentage moisture, percentage salt, nitrite level, Kramer Shear force, and juiciness scores. Results from this research revealed that effects of blade penetration on all traits related to accelerated dry curing are minimal and will not enhance product acceptability. Additional observations suggested that cure time should not be less than 70 days if color stability during cooking is desired.

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