Meat Quality Changes Resulting from Pre-rigor Muscle Boning of the Bovine Carcass

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Story in Brief

Twelve choice and good grade animals were slaughtered, observed, fabricated into individual muscles and muscle systems, for detailed study. Muscle pH was used to follow the level of change in rigor mortis. The conditioning periods studied were 3, 5, and 7 hours. The ultimate pH was reached by the 5 hour period at 16°C. A major advantage in hot processing is the preservation of weight. The hot processing method reflected a loss of only .90 while the conventional chill method lost 2.71 percent.

Introduction

The purpose of this research is to design and evaluate a method of processing and fabricating the beef carcass such that bone and excess fat are removed prior to refrigeration. Thus the elimination of unnecessary cooling of inedible entities will be provided while yielding meat items of comparable, if not improved quality, to conventional processing methods. Therefore the processor would benefit from shorter refrigeration time, increased yields of boneless, fat-free meats, which could be stored in less space thus providing maximization of the refrigerated space. The consumer would benefit by receiving a more sanitary, higher quality product.

Procedure

Forty Angus steers were utilized in the course of the study. The animals were of the choice grade and will be slaughtered after reaching a weight of approximately 1,000 lbs. Each animal was assigned to a 3, 5, or 7 hour holding period for the hot side. The designation of hot or cold sides was randomized. The cold side was moved directly from the slaughter floor into a Chill cooler (1.1°C).

Hot & Cold Treatments

HOT—Immediately after conventional slaughter and Federal Inspection the "hot" side was placed in a 16°C holding room. The side was held suspended from a rail via a pulley and hook placed through the

tendon of Achilles. Thermocouples were then inserted into 4 test muscles, Biceps femoris (BF), Longissimus dorsi (LD), Semimembranosus (SM), Semitendinosus (ST). Each thermocouple was in turn connected to a Honeywell recording potentiometer. At the expiration of a particular holding period the side was weighed and fabricated into a streamlined hindquarter.

This fabrication consisted of the removal of the chuck at the fifth thoracic vertebra and the flank and plate as done in the commercial trade. After the streamlined hindquarter was weighed, dissection of the muscles was initiated, while it hung from the rail in a 16°C holding area. First, excess fat was stripped from the muscle so that only the epimysium remained on the muscle surface. The muscle excision progressed in the following order: Tensor fascia latae, Sartorius, Semimembranosus, Semitendinosus, Biceps femoris, Quadricpes complex, psocis, Gluteus complex, and finally the Longissimus dorsi. The remaining small muscles were placed into lean trim. The long axis of each dissected muscle was measured immediately upon dissection. Then the bone, fat, lean trim and excised muscles were each put into a separate moisture and oxygen impermeable Cry-O-Vac bag. Finally, the components were removed to a 1.1 C cooler for 48 hours (same cooler as the hanging side).

Cold — Immediately after slaughter and Federal inspection, the "cold side" was placed into a 1.1 C cooler for 48 hours. After the expiration of this specified time the "cold" side was fabricated into a streamlined hindquarter, following the procedure as previously described for the "hot" side.

pH: Measurements of pH were taken at 1-5 hours post-mortem and then again at 24 and 48 hours from the Psoas major. The pH was used as a guideline to estimate the end point of glycolysis or rigor mortis in both hot and cold sides. The procedure used was to place 10 g. of finely minced muscle into 50 ml of distilled water. A combination calomol-hydrogen electrode was placed directly into the resulting sample.

Yield: At the expiration of 43 hours and completion of the "cold" side dissection all components were weighed for the determination of yield.

Calculations were made as follows:

$$\text{Cold side} = \frac{\text{cold shrunk side wt} \times 100}{\text{Hot side wt.}} = \%\ \text{loss}$$

$$\text{Hot side} = \frac{\text{sum of streamlined hindquarter comp.} \times 100}{\text{Initial streamlined hindquarter wt.}} = \%\ \text{loss}$$

The sections of Psoas major which were removed for pH determination were weighed and then "figured back into" the yield determination.

Shortening of Muscles: After each muscle was dissected from the "hot" side, the long axis was carefully measured using a flexible rule. At the end of the 48 hours chill period, each muscle was removed from the bag and again re-measured. A comparison of the length (degree of shortening) was made within the initial determination and with the muscles measured for the cold side.

Microbial Determination: The lean trim from both "hot" and "cold" sides was separately ground in a washed and sanitized grinder. Each sample was ground twice, once through a coarse plate and a second time through a fine plate. Then separate 25 g aliquots were weighed and placed into 225 ml of sterile distilled water in a sterile Waring Blender. The sample was then blended for 1 minute at high speed. This constituted a 1:10 dilution. Next 10 mls of the 1:10 dilution were placed in 90 ml of sterile distilled water to constitute a 1:100 dilution. A 1:1,000 and a 1:100,000 dilution were then prepared in a similar manner using 1 ml in 99 ml water. Plates were allowed to incubate at 34°C for 3 days and a second set of plates at 15°C for 7 days.

Chemical, Histological, Color, Organoleptic, Shelf Life, Tenderness Studies: From the muscles of the streamlined hindquarter, four were chosen for the indicated determinations: Biceps femoris (BF), Longissimus dorsi (LD), Semimembranosus (SM), Semitendinosus (ST), The cutting of each muscle into steaks was accomplished in the following order:

Current Results

pH: The pH as shown in Table 1 gives no indication of any drastic variation between sides held at 16°C or those held at 1.1°C for either the 3, 5, or 7 hour holding periods. It should be noted that the ultimate pH was reached at approximately 5 hours, post-mortem. This fact may influence the muscles excised at 3 hours post-mortem since this gives an indication that ATP was not at a low enough level to allow rigor mortis to be complete. Therefore, some shortening of these muscles may occur, resulting in meat that is less tender than muscles excised at 5 or 7 hours PM as compared to the "cold" control. These judgments will be verified upon the completion of the tenderness, taste panel, and histological examinations.

Yield Data (% Loss): The yield data this far collected is most promising as shown in Table II. Average percent loss for the hot sides was 1.18, 0.76, and 0.76 percent for the 3, 5, and 7 hour holding periods. On the other hand the loss of moisture for the control on conventionally processed sides was considerably more averaging 2.71 percent for the 12 sides. Therefore, the commercial advantage of "hot" processing becomes most important when one considers the monitary gain a 1-2 percent in-

Table 1. The Change in pH of Beef Muscle as Influenced by the Method of Processing

Animal No.	Hours PM 1		2		3		4		5		24		48	
	pH Hot	pH Cold	pH Hot	pH Cold	pH Hot	pH Cold	pH Hot	pH Cold	pH Hot	pH Cold	pH Hot	pH Cold	pH Hot	pH Cold
1112-3	5.73	6.07	5.57	6.12	---	---	5.46	5.68	5.46	5.82	5.47	5.50	5.51	5.47
1113-3	5.92	5.72	5.83	5.61	5.71	5.51	5.46	5.48	5.46	5.49	5.48	5.49	5.55	5.52
1120-3	5.60	5.47	5.35	5.46	5.35	5.44	---	---	5.35	5.38	5.38	5.44	5.38	5.44
0-3	5.98	6.05	5.93	6.05	5.78	5.94	5.56	5.94	5.41	5.93	5.46	5.48	5.32	5.21
X-3	5.81	5.83	5.67	5.81	5.61	5.63	5.49	5.70	5.42	5.66	5.45	5.48	5.44	5.41
55-5	6.20	5.85	6.07	5.61	6.08	5.86	6.12	5.93	5.86	5.84	5.53	5.47	5.42	5.41
100-5	5.75	6.02	5.49	5.67	5.42	5.50	5.45	5.57	5.47	5.44	5.47	5.45	5.43	5.45
1129-5	5.79	5.69	5.82	5.57	5.61	5.33	5.33	5.29	5.28	5.27	5.29	5.35	5.34	5.41
1144-5	6.07	6.13	5.93	6.01	5.96	5.86	5.88	5.90	5.71	5.63	5.30	5.36	5.26	5.25
X-5	5.95	5.92	5.83	5.72	5.77	5.64	5.70	5.67	5.58	5.54	5.40	5.41	5.36	5.38
1143-7	S	S	5.59	5.57	5.45	5.44	5.43	5.44	5.41	5.42	5.38	5.40	5.48	5.39
1116-7	5.98	5.57	5.70	5.53	5.57	5.47	5.39	5.39	5.39	5.39	5.50	5.50	5.50	5.51
1140-7	6.24	6.29	6.01	6.17	5.84	6.04	5.54	5.78	5.48	5.96	5.52	5.54	5.54	5.50
1126-7	6.02	6.03	5.85	5.99	5.67	5.88	5.42	5.62	5.43	5.43	5.49	5.45	5.49	5.50
X-7	6.08	5.96	5.79	5.82	5.63	5.71	5.44	5.56	5.43	5.55	5.47	5.47	5.50	5.48

X = Mean

Table 2. The Weight Loss in Beef as Influenced by the Method of Processing

	An. #	Live Wt. (lbs)	Hot Side Wt. (lbs)	Cold Side Wt. (lbs)	Dr. %	Loss Hot (%)	Loss Cold (%)
3 hrs.							
	1112-3	1080	334.5	334	62	1.92	2.69
	1113-3	1036	338	325	64	0.70	3.80
	1120-3	1090	343	334	62.1	1.05	2.10
	0-3	1126	342.5	343	60.8	1.07	2.04
5 hrs.							
	Mean	1083	339.5	334	62.2	1.18	2.66
	55-5	1040	317	315	60.7	0.41	2.86
	100-5	890	280.5	280.5	63	1.00	2.92
	1129-5	1210	387	394	64.5	0.66	3.05
	1144-5	1068	327	328	61.3	0.93	2.96
7 hrs.							
	Mean	1052	327.8	329.4	62.4	0.76	2.95
	1143-7	960	281	293	59.8	0.24	2.32
	1116-7	1035	312.5	323.5	61.5	0.81	2.23
	1140-7	1095	344.5	346.5	63	1.22	2.74
	1126-7	1184	357	360	60.5	0.78	2.78
	Mean	1068	323.7	330.7	61.2	0.76	2.53

crease in yield will offer the processor. As an operator became increasingly efficient, the loss would be further reduced. Theoretically a loss of less than 0.5 percent should be afforded by proper and efficient hot boning operations.

Grades and Grading: The twelve animals utilized to-date graded Choice and Good. General appearance of the hot muscle would indicate a similar grade as was placed on the cold carcass. Emphasis is now being given to the epimysial connective tissue layer as a feasible aid to visual grading. Fat streaking on the muscle surface along with general muscle appearance are also being considered. New mechanical tools (Rotating Dull Knife Tenderometer, Nip Tenderometer and Rapid Fat Testers) are being studied. Techniques for rapid color Measurement are also being investigated.