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CHARACTERISTICS OF HOT BONED BOVINE MUSCLE

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Summary

SIX Hereford steer carcasses were assigned to each of three holding periods (either 2-, 5- or 8-hr. postmortem). Each carcass was split and one side was "hot" boned into muscles and muscle systems after being held intact for the assigned holding period at 16 C. The corresponding sides were fabricated into the muscles and muscle systems after chilling for 48 hr. at 2 C ("cold" boned).

When the sides to be "hot" boned were held intact for 8 hr. postmortem, then fabricated, the "hot" boned steaks were equal or superior to those "cold" boned when the following parameters were compared: shrink (percent loss), shear force, color value notation, flavor, cooking loss, water-binding capacity, percent moisture and fat.

Introduction

Fabrication of the beef carcass prior to chilling has several potential advantages. These advantages are reflected by the removal of excess fat and bone prior to chilling; thus, the possibility of conserving cooler space and total refrigeration input are apparent. The carcass would be subdivided prior to chilling and this could decrease refrigeration time. By removing excess fat and bone prior to shipping, transportation costs could be reduced and the bone and waste fat would be accumulated in one place for further processing or shipment.

Development of rigor mortis, as defined by the rigorometer, was found by Briskey, Sayre and Cassens (1962) to vary from 2 min. to 8 hr. in porcine muscle. Later work by Sayre and Briskey (1963), using the rigorometer to follow the time course of rigor mortis in porcine muscle, showed that rigor was completed within 5 hr. after exsanguination. Marsh

(1954) reported that all glycolytic processes should be completed 36 hr. postmortem in beef muscle. Smith, Judge, and Stadelman (1969) found that shortening due to rigor mortis was complete within 3 hr. in chicken and 5 hr. in turkey muscle. Complete loss of extensibility in turkey *pectoralis* muscle was accomplished within 25 to 390 min. postmortem (T-1 Ma, Addis and Allen, 1971).

Herring, Cassens and Briskey (1965) demonstrated that bovine muscles excised pre-rigor were more tender when tension was applied during the course of rigor mortis. Lowe and Stewart (1946) noticed that breast muscle of chicken excised soon after death was usually less tender than the intact side. The faster the muscle was removed after death the less tender the product, but if rigor had developed prior to excision no additional toughening was observed. Beef chilled in the carcass was more tender than beef which was boned and chilled at 1.67 C (Ramsbottom and Strandine, 1949). Using the *semitendinosus* muscle, Goll, Henderson and Kline (1964) found that muscles left attached to the skeleton were least tender 6 to 12 hr. postmortem and gradually increased in tenderness during aging. Even after 312 hr. of aging the excised muscles were less tender than the muscles left on the skeleton. Reddy (1962) found no significant differences in shear force for *longissimus* and *gluteus medius* bovine muscles when excised pre- and 48 hr. post rigor. However, the same author observed that the shear force of the *semitendinosus* muscle excised pre-rigor was significantly greater than when excised post-rigor.

Henrickson (1968) evaluated the tenderness of "hot" processed pork using the Warner-Bratzler shear machine, and found no evidence discriminating against "hot" processing of porcine muscle. When shrink, tenderness, juiciness, moisture content and flavor of "hot" processed hams, cured and smoked prior to chilling, were compared to the conventional process (24 hr. chill) the "hot" processed product proved to be of equal or superior quality (Mandigo and Henrickson, 1966).

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The purpose of this study was to evaluate "hot" vs. "cold" boning of beef with respect to product shrink, juiciness, tenderness, flavor and color of lean.

Materials and Methods

Six Hereford steer carcasses (about 450 kg live weight) were randomly assigned to each of three holding periods (2-, 5-, or 8-hr. post-mortem). Therefore, a total of 18 animals were used for this study. Skinning, evisceration and splitting were accomplished within 45 min. of bleeding. Each carcass was split into right and left sides, and one side of each carcass was randomly assigned to either the "hot" or "cold" boned treatment and the corresponding side was assigned to the opposite treatment. The hot side was fabricated into muscles, muscle systems, bone, fat, and lean trim after being held intact for the assigned period at 16 C. The corresponding sides were fabricated identically to the hot boned sides after chilling for 48 hr. at 2 C ("cold" boned).

Shrink. The sides were weighed after splitting and washing and then the parts were weighed after fabrication (muscles, muscle systems, excess fat, bone, and lean trim) of the "cold" boned side. The carcass components from the "hot" boning treatment were held in cryovac bags from the end of holding period until 48 hr. postmortem at which time they were weighed to determine shrinkage (percent loss). Therefore, the shrinkage was based on the initial hot weight and the 48 hr. postmortem weight.

Four muscles were selected for quality determinations. The *biceps femoris*, *semitendinosus*, *semimembranosus* and *longissimus* were selected as the test muscles. Two steaks were cut from each muscle for the measurement of differences in color value notation, pressed fluid, percent moisture and fat, shear force, organoleptic evaluation and percent cooking loss between "hot" and "cold" boning.

Color Reflectance Difference. Sixteen steaks (two steaks from four muscles for both the right and left sides of the carcass), for each carcass, were measured for their color reflectance value. The steaks were permitted to oxygenate under atmospheric conditions at 2 C for 1 hr. before reflections were taken. A Photovolt Reflection Meter (Model 610) with a 610-Y search unit and green filter was used to measure the percent reflectance from the cut surface of the steaks. The unit was adjusted to 100% reflectance using a magnes-

ium oxide surface. A Munsell 5R 5/12 chip was used as a standard. The percent reflectance readings were then converted to Munsell color value (Nickerson, 1958). Thus, the degree of lightness and darkness was determined and used to express color reflectance differences.

Pressed Fluid. Sixteen steaks (two steaks per four muscles for two boning treatments) were used for the determination of pressed fluid for each carcass. Three cores (1.27 cm in diameter) were cut from each steak, and a transverse section with respect to the fibers of approximately 300 mg was extracted from the center of each core. Each sample was placed on humidified filter paper (paper in dessicator over saturated KCl Solution) and pressed between two plexiglass plates for 5 min. at 2,270 kg per sq cm load on the ram of a Carver Laboratory Press. Meat and moisture areas were determined with a compensating polar planimeter. The resulting area covered by the meat was divided into the moisture area to give a ratio expressed as the pressed fluid, or water-binding capacity of the meat, thus, a larger ratio indicates an increase in the "watery" condition of the muscle or a decrease in water-binding capacity.

Percent Moisture and Fat. The steaks used for pressed fluid determinations were trimmed of exterior fat and ground. Duplicate determinations for moisture content (A.O.A.C. method) were made on each blended sample; therefore, 32 moisture determinations were made on each carcass. Only the *longissimus* muscle was used for crude fat, determined by the Goldfish extraction method.

Shear Force. Two steaks from each of the four test muscles were evaluated for shear force as influenced by both "hot" and "cold" boning treatment. The steaks were held at 2 C for 24 hr. and cooked in deep fat at 135 C until an internal temperature of 72 C was reached. The cooked steaks were chilled for 24 hr. at 2 C in order to provide firmness that insured uniform cores. A mechanical coring device was used to extract uniform cores (Kastner and Henrickson, 1969). Each steak provided three 2.54 cm cores and each core was sheared three times with the Warner-Bratzler shear.

Organoleptic Evaluation. Only the *longissimus* muscle was appraised by the panel. The steaks were held 24 hr. at 2 C then oven broiled to an internal temperature of 72 C. Seven untrained panel members consisting of men and women of different ages were used

TABLE 1. PARAMETERS OF "HOT" AND "COLD" BONED STEAKS FOR THREE HOLDING PERIODS

Parameter	Holding period (Hours)					
	2 ^a		5 ^a		8 ^a	
	Hot	Cold ^b	Hot	Cold ^b	Hot	Cold ^b
Shrink (% loss)	1.98	2.20	1.25***	2.51	0.38***	2.76
Shear force (kg)	14.43**	12.06	13.73*	12.85	13.63	13.25
Color value	3.70***	3.86	3.90*	3.85	3.74**	3.67
Pressed fluid ratio	2.70***	2.87	3.12*	2.99	2.67**	2.56
Moisture (%)	73.42	73.38	73.76	73.88	74.40	74.40
Crude fat (%)	4.43	4.32	3.84	3.70	1.86	1.92
Cooking loss (%)	18.15	18.23	15.35	15.64	14.97	13.78

^a Postmortem holding period 2, 5 and 8 hr. for "hot" boned side.

^b "Cold" boned side held 48 hr. postmortem for all holding periods.

* (P<.10), ** (P<.05), *** (P<.01). Significant differences between "hot" and "cold" boning for each holding period.

for each trial. The triangle test was used to determine whether differences in raw meat color and/or cooked meat flavor existed between steaks from "hot" and "cold" boned beef.

Percent Cooking Loss. The steaks used for the taste panel were weighed before and after cooking to determine the percent cooking loss.

Statistical Analysis. The Analysis of Variance and the F-test were used to analyze differences in shrinkage, color reflectance, percent moisture, fat, pressed fluid, shear force, and percent cooking loss between "hot" and "cold" boned beef. The method for determining statistical significance for subjective flavor and color differences may be found in Fundamentals of Quality Control for the Food Industry (Kramer and Twigg, 1966).

Results and Discussion

Shrink. The difference in weight loss between "hot" and "cold" boned beef for the two hr. holding period was statistically nonsignificant (P>.10); however, for both the 5- and 8-hr. holding periods significant differences (P<.01) existed between percent weight loss for "hot" and "cold" boned beef (table 1). For all holding periods the "hot" boned treatment had a smaller average percent loss than the cold boned beef. Even though more extensive yield studies should be initiated it appeared that "hot" boning did not adversely affect yield when the product was treated as outlined in this study.

Shear Force. The "hot" boned and the "cold" boned steaks were statistically different in shear force (table 1) for the 2 hr. (P<.05) and 5 hr. (P<.10) holding periods, but the difference at the 8-hr. holding period was nonsignificant (P>.10). The conditioning time at the 8-hr. holding period appeared to allevi-

ate the shear force difference between "hot" and "cold" boned steaks. Even though the shear force differences for the 2- and 5-hr. holding periods were statistically different these may not be economically important.

Color. The differences in reflected color value between "hot" and "cold" boned steaks were statistically significant (table 1) for each holding period: 2 hr. (P<.01), 5 hr. (P<.10) and 8 hr. (P<.05). A relatively dark colored product was produced by "hot" boning when compared to that boned cold for the 2 hr. holding period (table 1). However, the "cold" boned steaks were darker colored than the "hot" boned steaks for the 5- and 8-hr. holding periods. Even though the reflected color value for steaks from the 5- and 8-hr. holding periods were statistically different between "hot" and "cold" boning, these differences were not noted by the panelists subjective evaluation (table 3).

Pressed Fluid Ratio. The pressed fluid ratios for "hot" vs. "cold" boned steaks were statistically different for all holding periods: 2 hr. (P<.01), 5 hr. (P<.10) and 8 hr. (P<.05). Even though pressed fluid ratios were statistically different for "hot" and "cold" boned steaks, these differences were not evident in the flavor panel data (table 2).

TABLE 2. HOLDING PERIOD, COMPARISONS AND PANELIST RESULTS FOR FLAVOR OF STEAKS HOT AND COLD BONED

Holding period hours	Total no. of of triangular comparisons	Total no. identifying odd sample
2 ^a	42	11 ^{NS}
5 ^a	42	13 ^{NS}
8 ^a	42	16 ^{NS}

^{NS} Nonsignificant.

^a Postmortem holding period 2.5 and 8 hr. for "hot" boned side.

TABLE 3. HOLDING PERIOD, COMPARISONS AND PANELIST RESULTS FOR THE COLOR OF STEAKS HOT AND COLD BONED

Holding period hours	Total no. of of triangular comparisons	Total no. identifying odd sample
2 ^a	42	23 ^{***}
5 ^a	42	15 ^{NS}
8 ^a	42	12 ^{NS}

*** (P<.01).

NS Nonsignificant.

^a Postmortem holding period 2.5 and 8 hr. for "hot" boned side.

Percent Moisture and Crude Fat. The differences in percent moisture and crude fat between steaks from "hot" and "cold" boning treatments were statistically nonsignificant (P>.10) for all holding periods (table 1).

Percent Cooking Loss. "Hot" boning did not appear to influence the percent cooking loss of steaks since the differences between steaks "hot" vs. "cold" boned were nonsignificant (P>.10) for each holding period (table 1).

Flavor and Color Panel. When each holding period was considered separately, the differences in meat flavor (table 2) between the "hot" and "cold" boned samples were statistically nonsignificant (P>.05).

The panel observed a significant difference (P<.01) in color for "hot" vs. "cold" boning in the 2-hr. hold period (table 3). This observed difference in color of steaks corresponded to the large reflected color value difference for "hot" vs. "cold" boning for the 2-hr. holding period (table 1).

Even though the reflected color value for the 5- and 8-hr. holding periods were statistically different (table 1), the panel was not able to visually detect a color difference (table 3). It was concluded that flavor and color differences between "hot" and "cold" boned steaks are not likely to be apparent and would not influence the acceptability of the "hot" boned product, if the sides to be "hot" boned

were held intact 5- to 8-hr. postmortem before fabrication.

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