Feasibility of Hot Boning the Bovine Carcass

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Story in Brief

Thirty choice grade Angus steer carcasses were utilized to evaluate the effects of "hot" boning upon three major muscles of the beef hindquarter versus conventional chilling methods or "cold" boning. The muscles utilized were the Longissimus dorsi (LD), Semimembranosus (SM), and Semitendinosus (ST). Sides from each carcass were randomly designated to be "hot" or "cold" processed. Those sides assigned to the "hot" process were suspended from the rail in a 16°C cooler for 3, 5, or 7 hours post-mortem before boning was initiated. The remaining side was suspended 48 hours post-mortem in a 1.1°C cooler and subsequently boned.

The effect of "hot" versus "cold" boning upon tenderness was evaluated using the Warner-Bratzler shear instrument. The LD muscle showed a significant difference in shear force for the 5 hour treatment, but values were nonsignificant for both the 3 and 7 hour treatments. A significant difference was indicated for the SM muscle at 7 hours as compared to the "cold" boned side, however, this difference was nonsignificant for both the 3 and 5 hour treatments. Shear force values of "hot" (3, 5 or 7 hours) versus "cold" boned ST were not statistically different. The "hot" process consistently yielded greater shear force values indicating a decrease in tenderness as compared to the "cold" processed side. At no time did the difference in shear force between the "hot" versus the "cold" process exceed 2 pounds. Therefore, any evidence of statistical significance should be weighed closely with the ability of an individual to detect small differences in shear force. In conclusion, this study has shown that "hot" boning of the beef carcass as early as three hours post-mortem is feasible without a large decrease in the tenderness of the LD, SM, and ST muscles.

Introduction

The recent development of an energy crisis in the United States as in other countries of the world has resulted in a search by industry for more efficient methods of providing quality products at reasonable prices. Improving the efficiency of processing is one of the major goals of "hot" boning, as well as, providing a product of comparable, if not improved quality to the conventional method of fabricating the beef carcass. Although excellent success has resulted from "hot" processing the pork carcass, limited attention has been given to adapting this method to the beef carcass.

Before "hot" boning of the bovine carcass was feasible, the time of muscle excision and a method of maintaining tension on the musculature needed to be developed. Classic papers by Bate-Smith (1939) and Bate-Smith and Bendall (1949) showed the importance of the time course of rigor mortis upon the shortening and tenderness of muscle. Investigations by Locker (1960) and Herring et al. (1965) provided evidence that bovine muscle excised immediately after death would shorten considerably. In addition, Locker (1960), Herring et al. (1965), Herring et al. (1967), Gillis and Henrickson (1968), and Hostetler et al. (1972) indicated that the amount of stretch upon muscles by various methods of suspension could greatly influence their tenderness. Equally important, Bate-Smith and Bendall (1949), Marsh (1954), de Fremery and Pool (1960), Briskey et al. (1962), and Cassens and Newbold (1967) showed that the time course of rigor mortis was dramatically influenced by temperature and that the shortening of bovine muscle was minimized at 16°C. By using these facts, as well as the studies of Henrickson and Smith (1967) as guidelines, the investigation of "hot" boning of the bovine carcass was initiated.

In 1969, Kastner utilized 18 Hereford steers to study the effects of "hot" processing at 2, 5, and 8 hours post-mortem in an investigation similar to this report. The results indicated that the shear force was statistically greater for "hot" boning than for the control in the 2 and 5 hour holding periods, but conditioning for eight hours produced a non-significant difference in shear force. The author further stated, "that differences for the 2 and 5 hour holding periods, although statistically significant may not be economically important." Schmidt and Gilbert (1970) excised muscles from six carcasses (three steers, two young bulls, and one old bull) at approximately 2 hours post-mortem. These "hot" muscles were then aged for 24 or 48 hours at 15°C in gas impermeable bags and frozen at —14°C. Muscles for the "cold" treatment were excised from the remaining side of the carcass which was suspended for 24 hours at 9°C. The "hot" processed muscles aged for 24 hours were shown to be similar to the controls in tenderness while "hot" muscle aged for 48 hours were significantly more tender than muscle from the control side.

The hypothesis that "hot" boning the beef carcass is economically favorable is supported by the USDA (1971) study which indicated that on-the-rail boning resulted in lower wage rates due to the use of semi-skilled workers during a portion of the operation. In addition, the rail method showed favorable yield tests. The operation was reported to be more flexible as to line arrangement, more sanitary, and less fatiguing to workers. Thus decreased refrigeration time and savings in cooler space, coupled with the advantages of on-the-rail boning, indicate that "hot" boning would significantly decrease processing costs, providing that the process is not detrimental to the quality of the finished product. This report concerns itself with the influence of "hot" boning upon a major attribute of quality, that of bovine muscle tenderness.

Materials and Methods

Thirty Angus steers weighing approximately 454 Kg. were assigned at random to a 3, 5 or 7 hour holding period for the "hot" side. In a similar manner, the designation of "hot" or "cold" sides was also randomized for each animal.

"Hot" and "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. At the expiration of a particular holding period the side was weighed and fabricated into a streamlined hindquarter.

This fabrication consisted of chuck removal at the fifth thoracic vertebra with the flank and plate removed as in the commercial trade. After the streamlined hindquarter was weighed, dissection of the muscles was initiated while it hung from the rail in the 16°C holding area. First, excess fat was stripped from the muscle so that only the epimysium remained on the muscle surface. The muscles were excised in the following order: Tensor fascia latae, Sartorius, Semimembranosus (SM), Semitendinosus (ST), Biceps femoris, Quadriceps complex, Psoas, Gluteus complex, and finally, the Longissimus dorsi (LD). The remaining small muscles were excised and placed into lean trim. Then the bone, fat, lean trim, and excised muscles were put into separate moisture and oxygen impermeable Cry-O-Vac bags. Finally, the components were removed to a 1.1°C cooler for the remaining portion of the 48 hour period (same cooler as the "cold" side).

"Cold" — Immediately after slaughter and Federal Inspection the "cold" side was placed into a 1.1°C chill cooler for 48 hours. The chilled side was then fabricated into a streamlined hindquarter following the procedure previously described for the "hot" side.

Three test muscles (LD, SM, and ST) were selected from the "hot" and similarly from the "cold" boned side. Each muscle was cut into two, 5.08 cm. steaks such that Steak 1 was from the anterior portion of each muscle sampled and Steak 2 from the posterior portion. Extreme care was taken to assure that the steaks from the test muscles were cut as close to the same position as was possible. The steaks were frozen (—10° C) until evaluated for tenderness by the Warner-Bratzler shear instrument. The samples were thawed at 1.1°C for 24 hours at which time they were cooked in Frymax oil at 135°C until an internal temperature of 72°C was reached. The cooked steaks were chilled for 24 hours at 1.1°C in order to provide adequate firmness to insure uniform cores (Kastner and Henrickson, 1969). Each steak yielded three 1.90 cm cores and each core was sheared three times with the Warner-Bratzler shear instrument.

Results and Discussion

The time post-mortem at which muscles are excised from a carcass has a great influence upon their tenderness. This phenomenon is due to tension maintained on the musculature by the weight of the carcass while the tissue is undergoing the chain of events leading to a loss of elasticity i.e., rigor mortis. The end point of rigor is reached when the tissue has used up a sufficient quantity of its available energy stores or when the pH of the muscle is low enough to inhibit glycolytic reactions. Thus, muscles excised from the carcass too early in the development of rigor will dramatically shorten, resulting in a decrease in tenderness, as compared to muscles which were allowed to benefit from this "stretching" for a longer period of time. One of the measures of tenderness estimated was shear force. Generally, the greater the shear force, the less tender the product will be when eaten.

As shown in Table 1, the determination of shear force on the LD muscle indicated no significant differences between "hot" vs. "cold" boning at either of the 3 or 7 hour holding periods. Five hour "hot" boned LD had a significantly higher shear force than muscle from the 48 hour treatment. Differences for "hot" and "cold" boned SM were non-

Table 1. Mean Shear Values of "Hot" and "Cold" Boned Longissimus dorsi

Holding Period(Hrs.)	"Cold" Shear Force (lbs.)	"Hot" Shear Force (lbs.)	Std. Deviation of Treatment Mean (lbs.)
3	15.14	16.44	0.47
5	13.47*	15.25	0.45
7	14.33	14.60	0.47

* ($P < .05$). Significant diffrence between 'Hot" and "Cold" boning.

significant for both the 3 and 5 hour holding period versus the control as shown in Table 2. A significant difference in shear force did occur between the 7 hour treatment and "cold" boned SM. As indicated in Table 3, there were no significant differences between "hot" and "cold" boned ST at any holding period.

Although significant differences did occur in both the LD and SM muscles, it should be noted that the difference in shear force was less than two pounds, a value which is generally regarded as the minimum amount of difference that can be detected by taste panels. In addition, Sharrah (1965) indicated that sensory discrimination may be more acute within a lower range of shear force values (2 vs. 4 lbs.) than in a higher (6 vs. 8 lbs.) range. Thus, weighing the evidence of statistical significance against the ability of an individual to detect small differences, it is feasible to "hot" bone beef carcasses as early as three hours post-mortem without a large dcrease in tenderness.

Literature Cited

Bate-Smith, E.C. 1939. Changes in elasticity of mammalian muscle undergoing rigor mortis. J. Physiol. 96:176.

Bate-Smith, E.C., and J.R. Bendall. 1949. Factors determining the time course of rigor mortis. J. Physiol. 110:47.

Table 2. Mean Shear Values of "Hot" and "Cold" Boned Semimembranosus

Holding Period(Hrs.)	"Cold" Shear Force (lbs.)	"Hot" Shear Force (lbs.)	Std. Deviation of Treatment Mean (lbs.)
3	19.65	20.74	0.44
5	19.29	20.02	0.34
7	19.75*	21.43	0.47

* ($P < .05$). Significant diffrence between 'Hot" and "Cold" boning.

Table 3. Mean Shear Values of "Hot" and "Cold" Boned Semitendinosus

Holding Period(Hrs.)	"Cold" Shear Force (lbs.)	"Hot" Shear Force (lbs.)	Std. Deviation of Treatment Mean (lbs.)
3	20.90	21.68	0.34
5	21.20	21.23	0.27
7	21.76	22.44	0.32

Briskey, E.J., R.N. Sayre, and R.G. Cassens. 1962. Development and application of an apparatus for continuous measurements of muscle extensibility and elasticity before and during rigor mortis. J. Food Sci. 27:560.

Cassens, R.G. and R.P. Newbold. 1967. Effect of temperature on the time course of rigor mortis in ox muscle. J. Food Sci. 32:269.

de Fremery, D., and M.F. Pool. 1960. Biochemistry of chicken muscle as related to rigor mortis and tenderization. Food Res. 25:73.

Gillis, W.A. and R.L. Henrickson. 1969. The influence of tension prerigor excised bovine muscle. J. Food Sci. 34:375.

Henrickson, R.L. and R.E. Smith. 1967. Effect of rapid processing on the properties of freshly slaughtered pork. Transactions of the Am. Soc. Agr. Engineers, St. Joseph, Michigan.

Herring, H.K., R.G. Cassens, and E.J. Briskey. 1965. Further studies on bovine muscle tenderness as influenced by carcass position, sarcomere length, and fiber diameter. J. Food Sci. 30:1049.

Herring, H.K., R.G. Cassens, G.G. Suess, V.H. Brungardt, and E. J. Briskey. 1967. Tenderness and associated characteristics of stretched and contracted bovine muscle. J. Food Sci. 32:317.

Hostetler, R.L., B.A. Link, W.A. Landmann, H.A. Fitzhugh, Jr. 1972. Effect of carcass suspension, sarcomere length, and shear force of some major bovine muscles. J. Food Sci. 37:132.

Kastner, C.L. 1969. Influence of "hot" boning on bovine muscle. Ph.D. Thesis, Oklahoma State University, Stillwater, Oklahoma.

Kastner, C.L. and R.L. Henrickson. 1969. Providing uniform meat cores for mechanical shear force measurement. J. Food Sci. 32:603.

Locker, R.H. 1960. Degree of muscular contraction as a factor in tenderness of beef. J. Food Sci. (Food Res.) 25:304.

Schmidt, G.R., and K.V. Gilbert. 1970. The effect of muscle excision before the onset of rigor mortis on the palatability of beef. J. Food Technol. 5:331.

Sharrah, N., M.S. Kunze, and R.M. Pangborn. 1965. Beef Tenderness: Comparison of sensory methods with the Warner-Bratzler and L.E.E. Kramer Shear Presses. Food Technol. Vol. 19:238-45.

USDA, ARS 52-63. 1971. Boning carcass beef on the rail; a feasibility study.
