

The Effect of Hot Muscle Boning on Lean Yield, Cooler Space Requirements, Cooling Energy Requirements, and Retail Value of the Bovine Carcass

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Story in Brief

The increased pressure for energy conservation has accentuated the need for a more efficient method of processing the bovine carcass. By hot muscle boning the carcass and cooling only the edible portion, savings in the space and energy required for cooling may be realized.

Yield of the boneless edible product resulting from hot muscle boning was determined and expressed as a percent of hot side weight. The mean value for yield was 62.3 percent.

Space occupied by the intact side was measured before muscle boning that side. The space required by only the muscle boned product was determined to be 18.86 percent of that needed by the intact side.

The energy (in BTUs) required for a drop in meat temperature from 102 F to 32 F was calculated for the hot muscle boned product and compared to that of the intact side. The mean value was 68.1 percent.

Retail value was calculated and a difference of \$16.80 per side favoring the hot muscle boned method was obtained.

Introduction

The removal of muscles and muscle systems prior to initial chilling of the carcass has been investigated in recent years to determine the feasibility of this processing method as a future alternative to conventional bovine fabrication. The eating quality of hot boned beef has been demonstrated to be acceptable (Schmidt and Keman, 1974; Dransfield et al, 1976; Will, 1976) by both objective and taste panel methods.

Several potential advantages of hot boning have been alluded to in the literature. Ramsbottom and Strandine (1949) confirmed that boneless cuts resulting from hot boning were chilled faster than the intact beef sides. It was

suggested by Henrickson (1975) that hot boning would eliminate cooling waste fat and bone, and that properly handled hot boned beef would have a lower potential for microbial contamination. Increased yield of boneless meat (Schmidt and Keman, 1974) because of less cooler shrink (Falk, 1974) can be achieved by separating the muscles from the unchilled bovine carcass and vacuum packaging the lean tissue. Even though limited research has been done to specifically evaluate some advantages of hot muscle boning, many areas still need to be investigated. The objectives of this study were to determine the effect of hot muscle boning on the cooling energy and chill space requirements, edible product yield and retail value of the beef carcass.

Materials and Methods

The research was divided into four major phases with a total of 25 cattle being utilized. For all research phases the hot muscles and muscle systems were removed from the side four hours post mortem. The muscles and muscle systems removed were the semimembranosus, semitendinosus, biceps femoris, quadriceps femoris, gluteus medius, longissimus dorsi, psoas major, supraspinatus, flank steak, inside chuck roast, outside chuck roast, brisket roast, and lean trim for ground beef (approximately 20 percent fat). These cuts were selected in an attempt to maximize the use of the meat from the side as boneless steaks and roasts. The muscles were individually wrapped in Avisco cellophane and placed in a 1 C chill cooler. Bone and fat from each side were weighed. After 48 hours the cuts were trimmed to a maximum external fat thickness of 0.65 cm and weighed. Rib eye area, fat thickness, and percent kidney, pelvic, and heart fat were measured on the opposite side.

Yield

Twenty-five steers and heifers of mixed breeding were slaughtered according to normal procedures and each carcass split into right and left sides. One side from each carcass was randomly assigned for hot muscle boning. The percent yield of boneless, edible meat was calculated by dividing the total weight of the hot muscle boned product by hot side weight.

Cooler Space Requirement

One side of each of sixteen carcasses was randomly assigned to the hot muscle boning treatment. Each side was measured using a tape for length, width, and depth at its longest, widest and deepest points to determine the space in cubic centimeters occupied by that side hanging from the rail in the cooler. After obtaining these measurements, the side was hot muscle boned. The resulting product was cooled at 1 C to permit it to condition so more precise measurements could be obtained. Each individual muscle or muscle system was trimmed to 0.65 cm maximum external fat and then measured to determine its space requirements. The combined space occupied by all the cuts from each side was then calculated.

Cooling energy

The amount of heat energy transfer (cooling energy) required to chill the meat was investigated using 25 sides. The energy transfer in kilocalories necessary for 1 C drop in meat temperature was obtained by multiplying the weight of the meat by the specific heat of the meat. Specific heats of 0.75 and 0.82 kilocalorie per kilogram per degree Celsius for the intact side and lean beef respectively (American Society of Heating, Refrigeration, and Air Conditioning Engineers, 1974; Morely, 1972) were used in the calculation.

Retail value

Eight carcasses were used to compare the retail value of the hot muscle boned side to the value of the opposite conventionally cold processed side. After slaughter, one side of each carcass was placed in a 1 C chill cooler while the other side was hot muscle boned. Forty-eight hours after hot boning the muscles and muscle systems were further processed into retail cuts. Following a seven day chill the opposite side was fabricated into bone-in retail cuts according to conventional cutting procedures. Retail value for each side was calculated using retail prices obtained November 23, 1976 from retail outlets in Stillwater, Oklahoma.

Statistical analysis

The research was designed to be analyzed as a completely randomized block design with each carcass comprising one block. The Analysis of Variance in conjunction with the F-test was used to analyze differences in the space, energy and retail value comparisons.

Results and Discussion

Mean values of various carcass traits of the cattle utilized are presented in Table 1. The mean side weight was 124.96 Kg, and the average USDA Yield Grade was 3.23. These values are reported only as a description of the population of cattle used, since no attempt was made to relate these traits to the results of this study.

Yield

The percent yield of lean, fat, and bone components of the hot muscle boned sides appear in Table 2. An average of 62.4 percent of side weight was recovered in boneless, lean beef. This lean yield value compared very closely to the yield reported by Schmidt and Keman (1974) who found a significantly great yield from hot boning when compared to the opposite side of the carcass which was cold boned after an eight day chill. In the present study the opposite side was not available for cold boning, so no direct comparison could be made.

Space

Mean cooler space requirements for the intact side and the hot muscle boned product are compared in Table 3. Less ($P < .01$) space is occupied by the

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Table 1. Beef carcass trait means

| Trait | Mean Value | S.E. |
|-----------------------------------|------------|------|
| Side Weight (kg) | 124.96 | 4.64 |
| Rib Eye Area (sq. cm) | 64.48 | 1.87 |
| Kidney, Pelvic, and Heart Fat (%) | 3.58 | 0.18 |
| Fat Thickness at 12th Rib (cm) | 1.19 | 0.13 |
| Yield Grade | 3.23 | 0.18 |

Table 2. Composition of hot muscle boned sides

| Component Yield % | Mean Value | S.E. |
|-------------------|------------|------|
| Lean | 62.40 | 0.64 |
| Fat | 19.70 | 0.72 |
| Bone | 15.82 | 0.45 |

Table 3. Space Requirements for Intact Side and Hot Muscle Boned Product

| | Mean Cooler Space Requirement (cu cm) | S.E. |
|--------------------------|---------------------------------------|-----------|
| Intact Side | 648,199.33 | 39,747.48 |
| Hot Muscle Boned Product | 122,818.26 ^a | 6,541.72 |
| Space Saved | 80.78% | |

^aSignificant difference (P<.01)

Table 4. Heat energy transfer requirements for intact side and hot muscle boned product

| | Mean Heat Energy Transfer (Kcal) | S.E. |
|--------------------------|----------------------------------|------|
| Intact Side | 93.72 | 3.48 |
| Hot Muscle Boned Product | 63.70 ^a | 2.43 |
| Heat Energy Saving | 31.77% | |

^aSignificant difference (P<.01)

Table 5. Mean side retail value for hot and cold processing methods

| Method | Side Value (\$) | S.E. |
|------------------------|---------------------|------|
| Hot | 271.98 ^a | 5.61 |
| Cold | 254.85 | 5.00 |
| Increased retail value | \$17.13 | |

^aSignificant difference (P<.01).

hot muscle boned product, and if expressed as a percent of the intact side, only 19.12 percent as much space is needed. This can be explained by the fact that a substantial amount of space is wasted by the intact side due to curves and protrusions such as the foreshank. The hot muscle boned pieces are not as irregularly shaped, and space needed to chill bone and excess fat is eliminated.

Cooling energy

A comparison of heat energy transfer requirements for the intact side and the hot muscle boned lean is shown in Table 4. Less ($P < .01$) heat energy transfer is necessary for the hot muscle boned product, and only 68.23 percent as much as is required for the intact side. The difference is simply because bone and excess fat are not chilled. These values represent only the amount of heat energy transfer within the product, so the actual energy savings will depend on the efficiency of the chilling system. Only a 1C drop in meat temperature is represented, but the energy transfer relationship between the hot muscle boned product and the intact side would be identical regardless of how large a temperature drop (above freezing) was achieved.

Retail value

Mean side retail values for the hot and cold cutting procedures are compared in Table 5. The hot boned side has a greater ($P < .01$) retail value than the conventionally cold, bone-in processed side with a difference of \$17.43 per side. There are three major reasons for the increased value of the hot muscle boned side. First, there is more lean beef recovered because of less weight due to cooler shrink. Second, more of the meat from the hot muscle boned side was more efficiently utilized as higher priced steaks and roasts. Third, the price per unit of weight is greater for the boneless cuts, partially due to the additional labor required to remove the bone from the retail cut.

The beef carcass has a greater retail value as a result of hot muscle boning. Significant savings in the energy and space required for cooling the meat may also be realized. Therefore, hot muscle boning offers the meat industry a more efficient method of processing the beef carcass.

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