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Methods of improving quality of grass-fed beef

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Methods of Improving Quality of Grass-fed Beef

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Summary

Ten steers of known background, approximately 18 months old, and wintered on alfalfa and protein were finished on a brome and bluestem grazing program. Carcass characteristics were measured. The influence of conditioning carcass halves at 55F until eight hours post-mortem was compared with conventional chilling at 36F. Finally, the effects of vacuum storage and display on beef quality were evaluated.

The carcasses, as expected, were light with little external or internal fat. Mean yield grade was 2.2; average carcass quality grade, high standard.

Carcass halves conditioned at 55F until eight hours post-mortem and those conventionally chilled at 36F did not differ in lean color, taste panel flavor, juiciness, tenderness, over-all acceptability, or tenderness as measured by shear force.

Vacuum aging 21 days improved muscle color brightness and gave slightly less yellow fat compared with steaks cut 48 hours post-mortem.

Flavor desirability of fat did not differ between fresh cut steaks and those from muscles held 21 days under vacuum, nor was it affected by five days' display.

Flavor of muscle was scored more desirable for samples held 21 days under vacuum and before display than flavor of meat from any other treatment.

Taste panel tenderness and shear force were generally optimum after 21 days of vacuum storage and display for five days.

Most acceptable were steaks from muscles held in vacuum before display; least acceptable were steaks processed 48 hours post-slaughter.

Display for five days decreased flavor and over-all acceptability if cuts were vacuum aged before displayed, but five days' display generally improved flavor and acceptability when steaks were cut at 48 hours post-slaughter.

Vacuum storage for 21 days pre-display yielded the most acceptable product. Perhaps less vacuum storage time would give the same favorable

changes.

Our preliminary data indicate that steaks from grass-fed beef (even though they graded only high standard) are generally acceptable in several quality attributes. Tenderness and fat color problems encountered may be remedied by using optimum post-mortem conditioning procedures. Channeling grass finished beef into boxed beef sales improved its display color, tenderness, and taste.

Introduction

Recent high feed grain prices have generated considerable interest in marketing forage finished beef when weather, export agreements, or other factors make grain unprofitable to feed.

Some forage finishing procedures produce acceptable beef for all methods of processing and cookery, but some do not.

In 1974, Kropf, Allen, and Thouvenelle reported quality problems, expecially poor tenderness, of broiled rib eye (longissimus) muscle steaks from grass-fed steers taken off Flint Hill pasture in late season.

Conditioning at elevated temperatures after slaughter improves tenderness and may improve grass or forage finished beef.

Experimental Procedure

We evaluated beef finished on only grass, on 80 percent concentrate and 20 percent corn silage for seven or 14 weeks, or on 60 percent corn silage and 40 percent concentrate for 14 weeks; however, only results from grass finished beef are reported here.

Ten grass-fed steers of known background, approximately 18 months old, from the U.S.D.A. Meat Animal Research Center at Clay Center, Neb., were used. In addition to brome and bluestem grass, they had a wintering ration of alfalfa and protein supplement. All were slaughtered in September after fasting overnight (12-15 hours).

To follow post-mortem pH decline, we took samples from carcass halves at hourly intervals beginning one hour post-mortem and continuing to eight hours post-mortem, then another sample at 24 hours post-mortem.

Temperature decline was obtained on five carcasses by inserting thermometers just beneath the subcutaneous fat, in the center of the rib eye muscle, and in the round.

Beginning at approximately 1.5 hours post-mortem, the right side of each carcass was conventionally chilled at 36F until 48 hours post-mortem; the left side was conditioned at 55F until eight hours post-mortem, then chilled at 36F for 40 hours.

At about 48 hours post-mortem, chilled carcasses were weighed and evaluated for U.S.D.A. Quality and Yield Grade and other characteristics.

Four muscles including biceps femoris and semitendinosus from the bottom round, semimembranosus from the top round and longissimus (loin eye) from each half were evaluated. The anterior half of each muscle was immediately fabricated into test steaks; the posterior half was vacuum packaged and stored at 32F for 21 days. After 21 days of vacuum storage, the posterior muscle portion was cut into test steaks. Selected test steaks were evaluated from the muscle halves before and after five days of delux warm white fluorescent light display at 34F under 100-foot candles. All display steaks were oxygenated before being packaged in a styrofoam tray overwrapped with polyvinylchloride film.

Steaks for visual lean color evaluations were scored the day they were cut and after one, three, and five days' display. Visual color was scored by five panelists. Subcutaneous fat color also was evaluated by the five panelists prior to display.

At the proper sampling time before or after vacuum packaging and before or after display, steaks (1.2 inch) for shear force and taste panel evaluations were taken from corresponding halves of each carcass.

Taste panel (longissimus) and shear force steaks (semimembranosus, semitendinosus, biceps femoris, and longissimus) were vacuum packaged, frozen, and stored at -15F for later analysis. Samples were in frozen storage a maximum of three weeks. Frozen samples were thawed at 36F, modified broiled in a rotary oven at 350F to an internal temperature of 151F, then sampled after cooling at room temperature for approximately ten minutes. Six 0.5 inch diameter cores were taken from each steak and each core was sheared once with the Warner-Bratzler shear apparatus as taken from the conventionally chilled (36F) steaks (longissimus). Six panelists scored lean samples for flavor, juiciness, tenderness, and overall acceptability; fat samples were scored only for flavor.

Results and Discussion

Carcass Characteristics

Carcass characteristics of the grass-fed cattle (table 28.1) were typical of those expected for cattle on relatively low nutrition. The average quality and yield grades were high standard and 2.2, respectively. The carcasses averaged approximately 560 pounds and had minimal external (0.2 inch) and internal finish (1.3% K, P, and H Fat). The average rib eye area was 10.2 square inches.

Conditioning eight hours at 55F instead of chilling at 36F did not affect carcass characteristics other than muscle texture. Muscle texture for halves chilled at 55F was coarser than for halves chilled at 36F.

Visual Color of Fat and Lean

Panelists scored color of fat from cuts vacuum stored for 21 days as slightly less yellow than those cut two days after slaughter (table 28.2). Holding carcass halves at 55F until eight hours post-slaughter did not affect fat color compared to halves chilled at 36F.

Loin eye color was brighter after the meat was held in vacuum 21 days before being cut into steaks than when cut into steaks two days after slaughter. That was true before display and after one or three days' display. Vacuum storage of the cuts, as often done in current boxed beef procedures, apparently improved the color early in display life. All groups were acceptable in color after five days of display, but the color was nearing that that consumers criticize (table 28.2).

Conditioning halves at 55F until eight hours post-slaughter compared to chilling at 36F did not affect muscle color (table 28.2).

Outside round (biceps femoris) muscle also was brighter when held under vacuum 21 days before being cut into steaks than when fabricated at 48 hours after slaughter. If a color score of 3.5 is considered as marginally unacceptable, mean of fresh muscle color scores approached unacceptable after three days of display, and all treatments were unacceptable after five days of display (table 28.2).

Taste Panel Scores

Flavor desirability of grass-fed beef fat did not differ between fresh cut steaks and those held for 21 days under vacuum, nor was flavor affected by five days of display (table 28.3).

Flavor of muscle held 21 days under vacuum before display was more desirable than flavor from any other treatment (table 28.3).

Steaks cut 48 hours post-slaughter and tested before display were the least tender of all, whether held at elevated temperature post-slaughter or not. Apparently, aging steaks either under display conditions in retail package or in vacuum for 21 days improved tenderness (table 28.3).

Poorest over-all acceptability scores were given to steaks not vacuum packed and not displayed; highest acceptability to steaks held in vacuum and cut, and not yet displayed. Acceptability deteriorated during five days of display for cuts that had been held in vacuum bags, primarily from flavor deterioration while displayed (table 28.3).

Conditioning at 55F or chilling at 36F did not significantly affect muscle flavor, juiciness, tenderness, or over-all acceptability (table 28.3).

Nearly all traits evaluated by the taste panel were acceptable.

Tenderness (Shear Force)

We used 55F conditioning to avoid suspected decreased tenderness due to rapid chilling and resultant muscle shortening during conventional chilling. That appears to be a particular problem in carcasses with a small amount of exterior fat cover (i.e., grass-fed beef).

No differences in shear force (tenderness) were observed between halves conditioned at 55F or chilled at 36F, whether evaluated before or after vacuum storage or before or after display (table 28.4). Therefore, the high conditioning temperature (55F for eight hours) did not improve tenderness (table 28.4). Our taste panel agreed regarding tenderness (tables 28.3 and 28.4).

Lowest pH was achieved eight hours port-mortem; therefore, most post-mortem metabolic activity must have been complete by eight hours and occurred at different room and product temperatures (tables 28.5 and 28.6).

No differences between post-mortem temperature treatments may have resulted from carcasses having enough exterior fat to retard cold shortening. Perhaps 36F was not cold enough to initiate cold shock; 55F was not high enough to retard cold shortening, or eight hours at 55F was not long enough to alleviate cold shortening.

Vacuum storage generally improved the tenderness of all muscles except the inside round (semimembranosus) as did display before and after vacuum packaging. The over-all best treatment from a shear force (tenderness) standpoint was vacuum storage 21 days and display five days.

Table 28.1 Mean Carcass Characteristics of Grass-fed Beef Halfs held at 55F until Eight Hours Post-slaughter versus Conventional Chilling at 36F.

Characteristic	36F	55F
Chilled Half, lbs.	282.5	282.0
Adjusted Fat Thickness, in.	0.21	0.21
Rib Eye Area, in.^{2}	10.22	10.41
Kidney-Pelvic-Heart, Fat, %	1.41	1.22
Yield Grade	2.24	2.19
Conformation Score	Good +	Good +
Muscle Texture Score[a]	5.0	6.5*
Marbling[b]	9.1	9.0
Quality Grade[c]	6.7	7.0

[a]Muscle Texture Score: 1=finest, 5=average, 10=coarsest tenderness.
[b]Marbling: 8=traces, 11=slight.
[c]Quality Grade: 5=average standard, 8=average good.
*$P<.05$: All other differences not statistically significant.

Table 28.2 Mean Visual Color Scores for Lean and Fat Samples Derived from 55F Conditioned and 36F Chilled Carcass Halves, Fabricated before and after Vacuum Storage, and Displayed for Five Days.

	Pre-Vacuum		Post-Vacuum		Variance Ratio	Least Significant Difference (P<.05)
	36F	55F	36F	55F		
Fat Color[a]	1.97[d]	2.06[d]	1.67[c]	1.71[c]	14.87**	0.14
Longissimus (Loin Eye) Muscle Color[b]						
Day 0	2.60[d]	2.56[d]	1.84[c]	1.85[c]	67.96**	0.14
Day 1	2.66[d]	2.63[d]	2.00[c]	1.99[c]	56.13**	0.14
Day 3	3.30[d]	3.15[d]	2.47[c]	2.47[c]	48.01**	0.18
Day 5	3.38	3.27	3.22	3.19	0.70 N.S.	
Biceps Femoris (Outside Round) Muscle Color[b]						
Day 0	2.86[e]	2.59[d]	1.91[c]	1.85[c]	220.74**	0.09
Day 1	3.00[e]	2.87[d]	2.21[c]	2.14[c]	91.92**	0.13
Day 3	3.53[d]	3.44[d]	2.92[c]	2.97[c]	16.77**	0.21
Day 5	3.74	3.67	3.54	3.60	1.67 N.S.	

**(P<.01): N.S.=Non Significant.
[a]Fat Color: 1=white, 2=slightly yellow, 3=moderately yellow; evaluated at Day 0.
[b]Muscle Color: 1=very bright red, 2=bright red, 3=slightly dark red or brown, 4=dark red or brown, 5=extremely dark red or brown.
cde[Means within same row with same or no superscript letter are not different (P>.05).

Table 28.3 Mean Taste Panel Scores[z] for Longissimus (Loin Eye) Muscle and Fat Samples Derived from 55F Conditioned and 36F Chilled Carcass Halves Fabricated before and after Vacuum Storage and Display.

Treatment	Fat Flavor	Muscle Flavor	Juiciness	Tenderness	Over-all Acceptance
36F Pre-Vacuum, Pre-Display	5.84	5.92^{a}	6.01	4.96^{a}	5.14^{a}
36F Pre-Vacuum, Post-Display	5.98	5.63^{a}	6.51	6.35^{b}	5.84^{bcd}
36F Vacuum, Pre-Display	6.28	6.61^{b}	6.56	6.66^{b}	6.31^{de}
36F Vacuum, Post-Display	5.73	5.73^{a}	6.24	6.38^{b}	5.72^{bc}
55F Pre-Vacuum, Pre-Display		5.78^{a}	6.46	5.38^{a}	5.47^{ab}
55F Pre-Vacuum, Post-Display		6.05^{ab}	6.44	6.72^{b}	6.10^{cde}
55F Vacuum, Pre-Display		6.58^{b}	6.49	6.74^{b}	6.48^{e}
55F Vacuum, Post-Display		5.77^{a}	6.45	6.51^{b}	5.87^{bcd}
Variance ratio (treatments)	1.57 N.S.	3.52**	1.13 N.S.	8.90**	4.70**
Least significant difference (P<.05)		0.57		0.62	0.56

**(P<.01); N.S.=Non Significant.

abcde Means within same column with same or no letter superscript are not different (P>.05).

[z] Flavor, juiciness, tenderness, and over-all acceptability evaluated using 9-point scale (9=most desirable, 6=slightly desirable, juicy, tender, flavorful, or acceptable).

Table 28.4 Mean Shear Force Values for Selected Test Muscles Derived from 55F Conditioned and 36F Chilled Carcass Halves Fabricated before and after Vacuum Storage and Display.

Treatment	Muscles			
	Semimembranosus	Semitendinosus	Biceps Femoris	Longissimus
36F Pre-Vacuum, Pre-Display	10.40^{b}	9.82^{bc}	13.56^{bc}	6.13^{de}
36F Pre-Vacuum, Post-Display	8.60^{a}	10.62^{c}	13.04^{bc}	4.97^{bc}
36F Vacuum, Pre-Display	12.08^{c}	8.68^{a}	12.11^{b}	4.49^{ab}
36F Vacuum, Post-Display	11.24^{bc}	8.69^{a}	9.47^{a}	4.03^{a}
55F Pre-Vacuum, Pre-Display	10.80^{b}	10.14^{c}	14.46^{c}	6.54^{e}
55F Pre-Vacuum, Post-Display	8.59^{a}	10.59^{c}	14.25^{c}	5.64^{cd}
55F Vacuum, Pre-Display	12.06^{c}	8.93^{ab}	12.19^{b}	4.67^{ab}
55F Vacuum, Post-Display	11.28^{bc}	8.78^{a}	9.07^{a}	4.12^{a}
Variance Ratio (treatments)	9.67**	5.61**	10.45**	14.42**
Least Significant Difference (P .05)	1.23	1.00	1.15	0.68

** ($P<.01$).

^{abcde}Means within same column with same superscript are not different ($P>.05$).

Table 28.5 Post-mortem pH for Carcass Halves Conditioned at 55F or Chilled at 36F.

Hours Post-mortem	36F	55F
1	6.38	6.36
2	6.07	5.96
3	5.84	5.70
4	5.74	5.61
5	5.72	5.61
6	5.65	5.60
7	5.66	5.59
8	5.65	5.58
24	5.54	5.54

Table 28.6 Post-mortem Temperature Declines and Differences for Corresponding Halves Conditioned at 55F or Chilled at 36F.

Hours Post-mortem	55F			36F			Temperature Difference		
	Round	Loin	Fat	Round	Loin	Fat	Round	Loin	Fat
2	103.5	91.0	86.0	102.9	90.5	83.0	0.6	0.5	3.0
3	102.5	87.0	78.5	101.5	85.0	72.0	1.6	2.0	6.5
4	100.0	80.0	73.0	98.0	75.0	64.0	2.0	5.0	9.0
5	97.0	75.0	69.2	94.5	68.0	59.0	2.5	7.0	10.2
6	94.0	71.0	66.5	91.5	63.0	56.0	2.5	8.0	10.5
7	91.3	68.0	64.5	88.0	59.0	53.2	3.3	9.0	11.3
8	89.0	65.0	61.5	84.5	55.2	51.0	4.5	9.8	10.5