Grading Systems for Prerigor Meat

H. Russell Cross*
S. C. Seideman
J. D. Crouse[a]

Introduction

We have had excellent overviews on the pros and cons on the use of prerigor meat this morning. The advantages of such a system far outweigh the potential disadvantages. Scientists throughout the world have conducted research on hot-processing, but industry in the U.S. seems reluctant to move towards such a system. Other countries such as Denmark, Sweden and Great Britain seem to be on the verge of adopting hot-beef processing. What is holding us back? Until the advent of electrical stimulation, tenderness was a problem and hot-boning couldn't safely proceed until five to eight hr postmortem. Shape distortion is often cited as a problem, but research studies prove this not to be the case. Some feel that such a dramatic shift towards a totally boneless product would be resisted by the consumer. This doesn't seem likely since parts of the U.S. retail market are already 70% boneless.

I feel that the lack of a mechanism to quality and yield grade beef carcasses is perhaps the greatest single factor preventing industry from moving to hot-processing. The U.S. livestock and meat industry is unique in the world in that they rely heavily on USDA grades as a marketing tool. Many feel that they cannot market their product effectively without grades.

Dr. Reagan and his committee asked me to update you this morning on what has been done to develop such a system and perhaps look to the future. The answer to the first question is easy—almost no research data is available on prerigor grading of beef. I will report briefly on a pilot study conducted at the Roman L. Hruska U.S. Meat Animal Research Center (MARC), but first I would like to philosophize with you on a few points.

In order to develop a lasting system for grading prerigor meat we must look into the future. How will production practices change and how will this affect our emphasis on marbling? How will processing systems of the future affect the role of grades? Will a retail packaging system at the point of slaughter affect the retail or consumer viewpoint of grades? Recent consumer surveys have indicated that price is the major consideration in the consumer purchase decision. What will the future economic picture hold? Will hot carcass trimming and/or hot-processing make yield grading impractical or unnecessary? Perhaps as we continue to move our processing closer to the point of slaughter the need for beef carcass grades will decrease and the need for live animal grades increase.

I'm posing these questions—to which I have no answers—only to emphasize that we can't direct all of our research to the short-term solution. Neither can hot-processing wait for the long-term answer.

I can see three general approaches to grading prerigor meat:

1. Alternative carcass traits (short-term)
2. Instrumental
3. Carcass certification

The short-term approach would be to seek carcass traits on the unchilled, unribbed carcass that would relate closely to the traits used in the present quality and yield grading systems. Possible factors would include primary and secondary flank streaking, feathering, marbling in the diaphragm muscle, muscle color in the flank, bone maturity, carcass finish, etc. We have recently conducted a pilot study at MARC and I will report on the results later. One could take this approach one step further and relate these carcass traits directly to palatability. It's possible that their relationship may be higher than marbling. This approach may only be a delaying action until more sophisticated methods are developed; or this solution may be adequate to suffice for the long-term.

The instrumental approach is definitely long-term. Our experience with instrument grading has taught us that in order to develop an instrument that can and will be used by industry, three to four generations in its development will be required. Therefore, the instrument that is developed will be designed for the grading system of the future. At the present we feel that such an instrument will perhaps be designed to measure composition rather than quality. Over the next few years we will investigate the following areas: infrared, ultrasound, electrical conductivity, video, and others. I don't feel that the industry should delay hot-processing until this approach is completed.

The certification approach could be considered short- and long-term. This approach will ignore part or all of the present quality grading system in favor of antemortem and postmor-

*H. Russell Cross, Roman L. Hruska U.S. Meat Animal Research Center ARS, USDA, Clay Center, NE.

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tem systems that will reduce the variability in palatability. I feel that the U.S. meat industry must end its love affair with fat. The industry can no longer afford to feed animals until they are palatable. We must begin to rely on present and future meat technology to reduce variability in palatability and produce a uniform quality product. Hot-processing is new technology and we can't afford to let grades stand in the way. Over the months, various certification approaches have been considered such as feeding coupled with electrical stimulation and/or aging. Time-on-feed certification may be difficult, but I can visualize a system using such parameters as electrical stimulation, carcass fat thickness, bone-maturity, hot-processing, vacuum packaging, and in-the-bag aging as means of producing high quality products. Much of the research data is available to develop such a system, but some parts are still missing.

Pilot Study

The Roman L. Hruska U.S. Meat Animal Research Center in cooperation with AMS and Monfort of Colorado conducted a pilot study to look at various carcass traits on the unchilled, unribbed carcass to perhaps estimate the chilled quality and yield grade. The results presented here today are very preliminary since the data hasn't been fully analyzed. The experimental details are as follows:

One hundred and ten heifers from the Roman L. Hruska U.S. Meat Animal Research Center were slaughtered at the Monfort of Colorado Grand Island facility. Carcasses were tagged and partially shrouded leaving the bottom left side unpinned for evaluations. At approximately two hours postmortem, subjective and objective measurements were collected. This time period was needed for the fascia sheath to "set up," changing from an opaque film to a transparent membrane for accurate evaluation to be possible.

Subjective measurements, were evaluated by a panel of three trained professional evaluators; two of whom were from the academic ranks and one member being from the Meat Grading and Certification Branch, Meat Quality Division, AMS, USDA. Unchilled (two hours post slaughter) and chilled (24 hours post slaughter) carcasses were graded on the characteristics compiled in Table 1.

Flank color was evaluated on the primary or *rectus abdominus* muscle. An 8-point scale was used with 8 corresponding to a very bleached red and 1 corresponding to very dark red. The brisket and diaphragm color was also evaluated on an equivalent scale of eight.

As in lamb grading, flank streaking is a useful indicator of the quality grade. Therefore, by the use of the USDA photographic guidelines, flank streaking values of the unchilled and chilled carcasses were determined. This is mainly a subjective measurement of the amount of adipose tissue dispersed in the *rectus abdominus*. A useful indicator in the evaluation of the quality grades of the unchilled and chilled carcasses is thought to be the degree of marbling in the diaphragm muscle. This was evaluated by slicing the diaphragm muscle perpendicular to the muscle fibers. Evaluations were determined using a 9-point scale, ranging from practically devoid to abundant. Maturity of the lean, bone and vertebra (including sacral, lumbar and thoracic) were determined utilizing the guidelines provided by the USDA.

Table 1. Evaluations of carcass traits

Carcass Traits	*Unchilled*	*Chilled*
FDI Hot Fat Evaluations	X	
Rib Feathering[a]	X	
Primary Flank Streaking[a]	X	
Secondary Flank Streaking[a]	X	
Diaphragm Color[b]	X	
Diaphragm Marbling[c]	X	
Brisket Color[b]	X	
Overall Conformation[f]	X	X
Muscle Score[e]		X
Marbling[c]		X
Bone Maturity[d]	X	X
Sacral Maturity[d]	X	X
Lumbar Maturity[d]	X	X
Thoracic Maturity[d]	X	X
Lean Maturity[d]	X	X
Overall Maturity[d]	X	X
Final Quality Grade[f]		X
Hot Carcass Weight	X	
Actual Fat Thickness, cm. 12/13 Rib		X
Adjusted Fat Thickness, cm		X
Ribeye Area, sq. cm.		X
Percent Kidney, Pelvic and Heart Fat		X

[a] = Scored on a 9-point scale (1 = low amount, 9 = high amount).
[b] = Scored on an 8-point scale (1 = dark, 8 = light).
[c] = Scored on a 9-point scale (1 = practically devoid, 9 = abundant).
[d] = Scored on a 15-point scale (A → E).
[e] = Scored on a 9-point scale (1 = very thin, 9 = thick).
[f] = Prime+ = 12, prime = 11, etc.

Fat depth on the unchilled carcasses was determined by the fat depth indicator (Hennessy and Chong, LTD). Six specific areas were examined: a) brisket, b) clod, c) 5th rib and d) between the 11th and 12th ribs at 4", 5" and 6" from the midline. A fat color score evaluating the color of the subcutaneous fat was also collected. This was rated on a 5-point scale (5 = white, 1 = yellow).

The chilled carcasses were measured only for 12th rib fat thickness. The ribeye area was determined by the tracing method in which a compensating polar planimeter was used to assess the area.

Discussion

Simple correlation coefficients of carcass traits evaluated on the unchilled carcass with marbling and final USDA quality grade are presented in Table 2. The simple correlations were relatively low, especially with final quality grade. Fat streaking in the primary and secondary flanks was highly correlated with marbling but not with quality grade. Correlations derived from this data should be evaluated very carefully since the marbling score and quality grade did not vary greatly. The majority of the marbling scores were in the slight plus to typical small range.

Table 3 outlines the mean ratings of marbling indicators on the unchilled and chilled carcass. The ratings were relatively close, but the chilled rating tended to be somewhat higher than the unchilled.

Time did not allow a complete analysis of this data set. A

Table 2. Simple correlation coefficients between unchilled carcass traits, marbling and final quality grade

	Correlation Coefficient	
Unchilled Carcass Trait	*Marbling*	*Final USDA Quality Grade*
Feathering, Rib Cage	0.06	0.01
Streaking, Primary Flank	0.30**	−0.15
Streaking, Secondary Flank	0.30**	−0.09
Color, Diaphragm	0.05	0.09
Marbling, Diaphragm	0.18	0.11
Color, Brisket	−0.09	0.08

**P < .01
n = 110

Table 3. Comparison of chilled *vs* unchilled evaluations

Carcass Traits	*Unchilled*	*Chilled*
Feathering, Rib Cage	SL^+	SM
Streaking, Primary Flank	SM^+	MT
Streaking, Secondary Flank	SM^+	SM^-
Color, Diaphragm	SM^-	SM^+
Marbling, Diaphragm	SM^+	SL^+
Color, Brisket	SM^-	SM^+

more thorough analysis with various regression techniques will evaluate the contribution of combinations of various carcass traits. For purposes of establishing trends and making preliminary judgements, Tables 4-7 present frequency data for individual carcass traits. The data for each factor is broken down by each degree or level. Within each level the percentage of those carcasses that had minimum small or greater, minimum slight or greater, and minimum slight or greater coupled with at least 0.3" fat thickness over the 12th rib is presented. Since this sample population contained no carcasses with less than minimum slight marbling, the data presented here should be considered as preliminary.

Table 4 presents the data for primary flank streaking. The percentage of carcasses with minimum small or greater decreased with decreasing levels of flank streaking. The trend for slight and fat thickness was difficult to establish. More numbers in the upper and lower flank streaking levels are needed before conclusions can be reached. Data for secondary flank streaking (Table 5), diaphragm marbling (Table 6), and feathering (Table 7) shows similar trends.

To summarize the portion of this study relating to quality, there appears to be a positive relationship between certain traits evaluated on the unchilled carcass and marbling. Further analysis of this data will use regression analysis to look at combinations of traits. We will also conduct studies to relate these and other unchilled carcass traits directly to palatability. It's possible that such combinations as fat thickness, streaking, feathering, and bone maturity can relate to palatability as well or better than the current USDA quality grades.

Table 4. A Comparison of unchilled primary flank streaking with marbling in the ribeye

		Percentage of Total with the Following Marbling Levels		
Primary Flank Streaking	*N*	*≥SL⁻*	*0.3" Fat and ≥SL⁻*	*≥SM⁻*
Moderate	2	100	50	100
Modest	4	100	100	50
Small	34	100	82	47
Slight	46	100	70	28
Practically Devoid	1	100	100	0

Table 5. A comparison of unchilled secondary flank streaking with marbling in the ribeye

		Percentage of Total with the Following Marbling Levels		
Secondary Flank Streaking	*N*	*≥SL⁻*	*0.3" Fat and ≥SL⁻*	*≥SM⁻*
Moderate	5	100	60	40
Modest	30	100	87	53
Small	37	100	76	30
Slight	15	100	60	27

Table 6. A comparison of unchilled carcass diaphragm with marbling in the ribeye

		Percentage of Total with the Following Marbling Levels		
Diaphragm Marbling	*N*	*≥SL⁻*	*0.3" Fat and ≥SL⁻*	*≥SM⁻*
Moderate	6	100	83	67
Modest	16	100	81	31
Small	20	100	90	45
Slight	32	100	75	41
Traces	13	100	46	15

Table 7. A comparison of unchilled carcass feathering with marbling in the ribeye

		Percentage of Total with the Following Marbling Levels		
Feathering	*N*	*≥SL⁻*	*0.3" Fat and ≥SL⁻*	*≥SM⁻*
Slightly Abundant	1	100	100	0
Moderate	1	100	100	100
Modest	6	100	67	50
Small	26	100	69	31
Slight	53	100	79	40

Grading of unchilled carcasses would also require systems for yield grading. In this study we used the Fat Depth Indicator (FDI) in cooperation with Bettcher Industries to measure fat on the unchilled carcass. Fat depth was measured at six locations. In addition, a subjective fat cover score was recorded for each carcass. Table 8 presents simple correlations of the unchilled fat measurements with actual and adjusted fat thickness. Most correlations were significant but rather low. Again, the lack of variability in fatness was the major cause for the low magnitude. Since the adjusted fat thickness is used as an estimator of the percent fat trim, further work using the FDI on the unchilled carcass will evaluate various fat depths as tools in assisting the grader in arriving at an adjusted fat thickness. We will also attempt to develop new prediction equations using criteria such as muscle score, fat depth (new locations), weight, etc. from the unribbed carcass.

In order to evaluate the relative usefulness of FDI hot fat probes as compared to the USDA adjusted fat thickness, each of the individual fat probes was substituted in the yield grade formula in place of adjusted fat thickness (Table 9). The mean actual yield grade was 2.27 while the yield grade using the average of three fat probes at the 11/12th rib was also 2.27. Other fat probes that gave similar yield grades were clod and overall average. Further research will evaluate hot fat probes in prediction equations with other independent variables from the unribbed carcass.

To summarize, it appears that the use of various carcass traits from the unchilled carcass may have some usefulness as an alternative system for quality and yield grading. Much additional research on greater numbers will be needed to validate this trend.

Table 8. The relationship between unchilled FDI fat probes and chilled fat measurements

Unchilled Fat Probes	*Adjusted Fat Thickness*	*Actual Fat Thickness*
11/12th Rib		
4″	0.22*	0.21*
5″	0.37**	0.33**
6″	0.52***	0.52***
5th Rib	0.01	−0.06
Clod	0.33**	0.29*
Brisket	0.36**	0.32*
Fat Cover Rating	0.48***	0.44***

*P < .05
**P < .01
***P < .001

Table 9. A comparison of computed yield grade using various fat measurements

Fat Measurement Used in Computing Yield Grade	*Computed Yield Grade*
Actual USDA Yield Grade	2.27
11/12 4″	2.69
11/12 5″	2.70
11/12 6″	1.40
Average 11/12 Probes	2.27
5th Rib	1.87
Clod	2.25
Brisket	1.57
Overall Average	2.08