

UTILIZATION OF VIDEO IMAGE ANALYSIS IN PREDICTING BEEF CARCASS LEAN PRODUCT YIELDS

T. L. Gardner¹, H. G. Doleza² and D. M. Allen³

Story in Brief

One-hundred-twenty steer carcasses were selected from typical daily production at a commercial beef processing plant. Sides were selected from carcasses weighing 700 to 800 lb to fit a 2 x 4 x 3 matrix of marbling (high Select vs. low Choice), fat thickness (.3, .4, .5, and .6 in), and muscling (thick, average, and thin). A video image of the 12th rib interface was taken approximately 48 hours postmortem. The image included the ribeye, subcutaneous fat thickness, plus an area 3 in ventral to the ribeye muscle. Video variables obtained included: subcutaneous fat thickness, ribeye area, marbling %, fat area (subcutaneous and intermuscular fat), lean area (ribeye and accessory muscles), total area (fat area + lean area), and fat, lean, and ribeye areas expressed as a percentage of the total area. Following Video Image Analysis (VIA) and carcass grade data collection, sides were fabricated into boneless subprimals as dictated by progressive HRI guidelines. VIA determinations were highly correlated with carcass ribeye area ($r = .95$) and fat thickness ($r = .86$), but lowly correlated with marbling score ($r = .37$). Video and weight variables were utilized to develop a multiple regression equation to predict lb of closely-trimmed (1/4") lean product. The equation, side lean (lb) = $-40.5417 + (0.7251 \times \text{side weight, lb}) - (16.4077 \times \text{VIA fat thickness, in}) + (2.6355 \times \text{VIA ribeye area, in}^2)$ accounted for approximately 78% of the variation (RSD = 7.4 lb) in predicting closely-trimmed lean product. These results indicate that VIA is a viable method of predicting closely-trimmed lean product in a commercial processing facility.

(Key Words: Beef, Cutability, Equation, Image, Meat, Prediction.)

Introduction

Currently, commercial beef carcasses are evaluated subjectively by USDA personnel for yield and quality differences. At production speeds of 350 carcasses per hour, accurate assessment of these traits often is difficult. At this rate, a grader has approximately 10 seconds to evaluate maturity and marbling for quality grade, to evaluate fat thickness, ribeye size, hot carcass weight

¹Graduate Student ²Associate Professor ³Vice-President Quality and Training
Excel Corporation

and kidney, pelvic and heart fat percentage for yield grade determination, and to stamp both grades on the carcass. A successful value-based marketing system must be able to accurately assess yield and quality differences rapidly. An objective method of carcass evaluation, Video Image Analysis (VIA), has been evaluated by Cross et al. (1983) and Wassenberg et al. (1986). These researchers found that VIA could be used with reasonable accuracy in evaluating carcass traits and side lean yields. In 1994, the National Beef Instrument Assessment Planning Symposium was held to discuss potential methods of predicting carcass composition and grade data. Video Image Analysis was considered to be one of the most promising methods for objective carcass evaluation.

The objective of this study was to evaluate the ability of VIA to assess carcass grade characteristics and closely-trimmed lean meat yields for beef carcasses that differed in muscling and fat thickness.

Materials and Methods

One-hundred-twenty steer carcasses were selected from typical daily production at a commercial beef processing plant. University personnel selected carcasses based on the following criteria: carcass weight (700-800 lb), marbling score (high Select vs. low Choice), fat thickness (.3, .4, .5, and .6 in), and muscling group (thick, average, and thin). Muscling groups correspond to values given in the USDA ribeye area by their carcass weight schedule. Grade data were obtained by university personnel approximately 48 h postmortem, prior to video analysis.

Video images were obtained by a plant engineer at the 12th rib interface. The images included ribeye area, subcutaneous fat thickness, and an area approximately 3 in ventral to the ribeye. The variables determined by VIA were as follows: subcutaneous fat thickness, ribeye area, marbling %, fat area (subcutaneous and intermuscular fat), lean area (ribeye and accessory muscles), total area (fat area and lean area), and fat, lean, and ribeye areas expressed as a percentage of the total area.

A team of beef fabrication trainers processed each side following grade data collection and VIA. Trainers processed boneless, closely-trimmed (maximum 1/4" fat thickness) subprimals following progressive HRI specifications as set forth by the packer. Weights of the various lean products, fat trim and bone were recorded individually for each side processed.

A 2 x 4 x 3 matrix of marbling (high Select vs. low Choice), fat thickness (.3, .4, .5, and .6 in), and muscling (thick, average, and thin) was utilized. Least squares means for carcass characteristics were determined with the GLM procedure of SAS (1986). Simple correlations were calculated for VIA and actual carcass variables. Additionally, video and weight variables were used in

the STEPWISE procedure of SAS (1986) to generate multiple regression equations to predict lb of closely-trimmed boxed-beef product.

Results and Discussion

Carcass traits. Least squares means characterizing the steer carcasses utilized in this experiment and carcass traits stratified by adjusted fat thickness and muscling are presented in Table 1. Hot carcass weight (CWT) did not differ ($P>.05$) within adjusted fat thickness groups. However, within muscling groups, sides from the thin muscling category were lighter ($P<.05$) than sides from average or thick muscling groups. This is not uncommon; carcasses of this type (thinly muscled) at comparable levels of fat thickness frequently weigh less than from heavier muscled carcasses.

Maturity score was not different ($P>.05$) for muscling groups, but sides from the .3 in adjusted fat thickness group were more ($P<.05$) youthful than sides from the .4 in group. Although the maturity scores were statistically different, sides from all adjusted fat thickness groups were well within the youthful "A" maturity range. Marbling scores did not differ ($P>.05$) between the fatness and muscling effects tested.

As expected, actual and adjusted fat thickness was different ($P<.05$) between each of the adjusted fat thickness groups (.3, .4, .5, and .6 in). Values increased ($P<.05$) progressively from .25 to .65 in and from .28 to .66 in for actual and adjusted fat thickness, respectively. Within muscling groups, differences were not ($P>.05$) observed for actual fat thickness groups. However, thinly muscled sides had a slightly higher ($P<.05$) adjusted fat thickness than sides from the average muscling group.

Ribeye areas for adjusted fat thickness groups ranged from 12.7 to 12.8 in² with no ($P>.05$) differences noted between categories. However, due to the selection criteria, ribeye area increased ($P<.05$) consistently as muscling increased from thin to thick.

Internal fat thickness (KPH, %) did not differ ($P>.05$) across any of the categories evaluated. However, a numerical increase ($P<.05$) in yield grade was detected as fat thickness group increased. Likewise, a progression from thin to thick muscling resulted in more ($P<.05$) desirable yield grades.

Cutability traits. As indicated in Table 2, side weight and side lean weight (1/4" trim) did not differ ($P>.05$) when compared across adjusted fat thickness groups. Conversely, differences ($P<.05$) were observed for fat trim weight and bone weight. The .3 in group had the least trimmable fat trim weight of 56.2 lb and fat trim increased with each successive fat group. Bone weight was lightest for the .6 in category and weight of bone increased as fat thickness decreased.

As noted for hot carcass weight, sides from the thin muscle group had lighter ($P<.05$) side weights than sides from either the average or thick muscle

groups. Side lean (1/4" trim) increased ($P<.05$) approximately 21 lb as muscling increased from thin to thick. Fat trim weights and bone weights exhibited an inverse relationship with muscling score. With each increase in muscling score, fat and bone trim weights decreased ($P<.05$).

Simple correlations. Actual carcass ribeye area was highly correlated ($P<.01$) with VIA ribeye area ($r = .95$). Actual fat thickness and estimates of adjusted fat thickness also were highly correlated ($P<.01$) with VIA fat thickness, $r = .86$ and $r = .83$, respectively. Pounds of closely-trimmed side lean were highly correlated ($P<.01$) with VIA ribeye area ($r = .61$) and side weight ($r = .79$), but lowly correlated with VIA fat thickness ($r = -.13$). Pounds of closely-trimmed side lean expressed as a percentage of side weight were highly correlated ($P<.01$) with VIA ribeye area ($r = .58$), but lowly correlated with side weight ($r = .21$) and VIA fat thickness ($r = -.36$). These results were not surprising considering the ranges in muscling and fat thickness for the carcasses selected in this study. More importantly, these results reflect the importance of carcass muscularity in predicting boneless, closely-trimmed lean yields among carcasses with fat thicknesses of 0.6 in or less. As the industry progresses in its "War on Fat", inherent muscling differences should become more important as a value determinant.

Actual carcass marbling scores were lowly correlated ($r = .37$) with VIA marbling percentage. Results of this study indicate that VIA is not sufficiently accurate at this time to successfully separate low Choice from high Select carcasses.

Equation. Video image and weight variables utilized in predicting lb of closely-trimmed (1/4") lean product produced the following equation: Side lean (lb) = $-40.5417 + (0.7251 \cdot \text{side weight, lb}) - (16.4077 \cdot \text{VIA fat thickness, in}) + (2.6355 \cdot \text{VIA ribeye area, in}^2)$. This equation accounted for 78% of the variation in the prediction of side lean weight and had a residual standard deviation of 7.4.

Implications

Results from this study indicate that VIA may be utilized as an effective method for predicting boneless, closely-trimmed boxed-beef. Conversely, VIA was not successful in differentiating marbling differences among low Choice and high Select carcasses. The VIA instrument assessed in this study was not evaluated at commercial processing chain speeds that approach 350 carcasses per hour even though the snapshot taken for VIA requires less than 1 second. Proper preparation of the carcass 12th rib interface and camera placement must be addressed before commercial line application. Additional evaluation of VIA should be made from images obtained at commercial operating speeds.

Literature Cited

- Cross, H. R., D. A. Gilliland, P. R. Durland and S. C. Seideman. 1983. Beef carcass evaluation by use of a video image analysis system. *J. Anim. Sci.* 57:908
- SAS. 1986. *SAS User's Guide: Statistics*. SAS Inst. Inc., Cary, NC.
- Wassenberg, R. L., D. M. Allen, and K. E. Kemp. 1986. Video image analysis prediction of total kilograms and percent primal lean and fat yield of beef carcasses. *J. Anim. Sci.* 62:1609.