PREDICTING LEAN YIELD OF CANADIAN CULL COWS

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Abstract – Carcass evaluation data from 84 cull cows were used to develop prediction equations for percentage of lean yield (LEAN) utilizing multi linear regression techniques. The majority of the carcass measurements analyzed did not vary more than 20%, while rib eye width (25.4 to 76.2 mm; CV = 43.57%) and muscle score (1 to 4 score; CV = 39.78%) had higher coefficients of variation. However, grade fat, fat class and marbling score variables had negative and significant associations with LEAN (*P* < 0.001), and could be good estimators of LEAN (r ≥ 0.7 and *P* > 0.001). The equation that best estimated LEAN was: LEAN = 59.2 – (Grade Fat × 0.3869) + (REA × 0.0946) – (Marbling × 0.0152) + (Ossification × 0.0515) (R^2 = 0.825; Cp-Mallows = 4.31). The equation developed in the present study could open the opportunity to develop a yield grade for cull cows and improve their carcass value; however, validation is required before its application.

Key Words: carcass, cull cows, lean yield

I. INTRODUCTION

In Canada cull cows are typically sold for consumption as manufacturing beef, relying heavily on the US market [1]. Disruptions to this market arising from a single case of BSE reported in May 2003 highlighted the vulnerability of the mature animal market to US trade [2]. Hence, the beef industry has been looking for opportunities to expand domestic markets and improve the carcass value of cull cows. Current cow grades are based on a broad classification of carcass types [3] and little is known regarding the range in composition within or between grades. Consequently adding value to cull cows may be accomplished by more accurately determining composition. Thus the objective of this study was to characterize the existing cull cow population and determine the potential to develop a predictive equation for carcass lean content.

II. MATERIALS AND METHODS

Eighty four carcasses were selected from a commercial abattoir, which represented four Canadian beef grades (D1, D2, D3, and D4) [3]. Final carcass numbers were 21 for each D grade. Following carcass selection, data were collected including muscling score, bone maturity, fat thickness, rib-eye area, muscle and fat colour and marbling score. Full carcasses (right and left sides) were shipped to the AAFC-Lacombe Meat Research Centre by way of refrigerated truck (2 °C). At 7 d *post-mortem*, the left side of each carcass was separated into nine wholesale primals (round, sirloin butt, short-loin, flank, chuck, rib, plate, brisket, shank), which were further divided into body-cavity, subcutaneous and intermuscular fat depots, lean and bone, as described by Jones *et al.* [4]. The results from the dissection of the primals were transformed to relative content (% of carcass side weight).
Data collected were analyzed using SAS (Cary, NC) version 9.2 [5]. Simple descriptive statistics (PROC MEANS) were computed for carcass traits and composition to characterize the animals. Correlation analysis was performed to determine the relationship of carcass traits (yield factors) to the lean yield proportion. The Snedecor criteria was used to qualify the values of *r* as high, moderate or low (high: ≥ 0.7; moderate: between 0.5 and 0.7; low: ≤ 0.5). Variance inflation factors (VIF) and collinearity diagnostics (COLLINOINT) from the PROC REG procedure of SAS (2003) were used to detect the multicollinearity. Later, STEPWISE regressions were used to determine the precision of carcass traits for predicting carcass composition using the variables which had less multicollinearity. Additionally, in order to evaluate the precision and accuracy of the equation obtained for cows, the actual vs. new predictive lean yield percentages were plotted, and a linear regression was computed. Also, this plot was contrasted against the actual vs.

predictive lean yield percentage plot determined using the existing lean algorithm previously developed for Canadian youthful carcasses [3].

Table 1. Carcass characteristics[1] and total of yield[2] of lean, bone and fat from mature cattle

Carcass traits	N	Means	STD	CV	Min	Max
Cold carcass weight, kg	84	345.94	25.15	7.27	307.25	390.65
Grade fat, mm[v]	84	9.59	2.05	21.35	6.25	14.00
Fat class[w]	76	4.58	0.83	18.10	3.00	6.00
Rib eye area, cm^2	84	83.62	10.21	12.21	66.25	106.25
Rib eye width, mm	76	45.12	19.66	43.57	25.4	76.2
Rib eye length, mm	76	67.51	12.97	19.21	38.1	76.2
Muscle score[x]	76	2.45	0.97	39.78	1.00	4.00
Marbling[y]	84	455.92	95.46	20.94	310.00	670.75
Ossification, %[z]	84	92.69	13.15	14.19	54.00	100.00
Lean, %	84	61.35	2.65	4.32	55.44	66.66
Bone, %	84	18.00	1.32	7.36	15.14	20.40
Fat, %	84	20.07	2.78	13.84	15.56	27.47

[1]Canada beef grading system (Canada Gazette, 1992).
[2]Yield calculated based on carcass side weight
STD: standard deviation ; CV: coefficient variation
[v]Back fat thickness between the 12th and 13th ribs.
[w]Determined on the basis of back fat thickness: 3 = 6 or 7 mm; 6 = 14 or 15 mm.
[x]Determined on the basis of rib eye length and width measurements: 1 = < 141 mm length and < 64 mm width; 4 = > 150 length and > 71 mm width.
[y]USDA marbling standards: 200 – 299 = Traces; 300-399 = Slight; 400-499 = Small; 500-599 = Modest; 600-699 = Moderate; 700-799 = Slightly Abundant; 800 – 899 = Moderately Abundant; 900 – 999 = Abundant and 1000 – 1099 = Very Abundant.
[z]Percentage of ossification of spinal process at 11th and 12th thoracic vertebrae

III. RESULTS AND DISCUSSION

Means, standard deviations (SD), coefficient of variation (CV) and minimum/maximum values for carcass characteristics are presented in Table 1. For carcass traits, a wide range of variation was observed on rib-eye width and muscle score, while grade fat, fat class, rib-eye area (REA), rib eye length, marbling and ossification presented moderate to low ranges of variation. Cold carcass weight showed lower variation.

The small variation in body measurements (lengths and areas) and the wide variation in the indicators of body fat have been reported by other authors [6, 7] for cattle. The findings of the current study agree with Johnson and Rogers [8] who, working with mature cows, found moderate to low range of variation in most of carcasses traits, with the exception of marbling (CV of 56%).

The correlation coefficients for carcass traits and lean yield percentage are presented in table 2. According to Snedecor criteria, grade fat, fat class and marbling score variables could be good estimators of lean yield percentage (LEAN) ($r \geq -0.7$ and $P < 0.001$). These variables had negative associations, indicating that increases in fat deposition would result in lower LEAN. On the other hand, cold carcass weight had moderate negative association ($r = -0.452$ and $P < 0.001$); while REA (cm^2) and rib eye length presented low positive association with LEAN (r = 0.23 and 0.24, respectively and $P < 0.05$). A positive trend ($r = 0.200$ and $P = 0.067$) was observed for ossification scores. Rib eye width (mm) and muscle score were not associated with LEAN ($P > 0.05$).

Some researchers [6, 8, 9] have reported that carcass traits from mature or young animals evaluating fatness (back fat thickness and marbling) had the highest simple correlation to LEAN. Johnson and Rogers [8] also indicated that bone maturity from mature cow was not associated with LEAN, while REA and carcass weight had low association. These findings agree with the results of current study. Different researchers [6, 7, 10] have indicated that carcass weight has little predictive power for LEAN.

Table 2. Correlation analysis between carcass characteristics and total boneless lean yield percentage from cull cow cattle.

	Lean yield percentage		
Independent variables	N	r	*P*-value
Cold weight, kg	84	-0.452	< 0.001
Grade fat, mm	84	-0.842	< 0.001
Fat class	76	-0.822	< 0.001
Rib-eye area	84	0.226	0.038
Rib-eye width	76	0.047	0.686
Rib-eye length	76	0.239	0.038
Muscle score	76	0.129	0.267
Marbling	84	-0.725	< 0.001
Ossification	84	0.200	0.067

r: Pearson correlation coefficient

Due to a lack of association and multicollinearity, some variables were discarded and few traits were considered as predictors of LEAN. The better predictive equation was selected based on the highest determination coefficient (R^2) and the lowest Mallow's coefficient (Cp). The stepwise regression indicated that grade fat alone contributed the most to prediction of LEAN (R^2 = 0.69; P < 0.001). Further stepwise inclusion of marbling score improved the model (R^2 = 0.78), whereas inclusion of REA (cm^2) and ossification slightly improved the model (R^2 = 0.81 and 0.83; respectively). However, when ossification was included as a forth variable, it reduced Mallow's coefficient (Cp 4.31 vs. 7.44), thus improving the model accuracy. In consequence, the best equation to predict LEAN was: LEAN = 59.2131 - (Grade Fat×0.3869) + (REA×0.0946) - (Marbling×0.0152) + (Ossification×0.0515).

The Canada lean youthful lean yield algorithm was not designed to accommodate mature carcasses, just youthful carcasses in Canada Prime and A grades. However, in this study a new equations for mature cow carcasses was developed and was compared to the results obtained using the yield algorithm for youthful carcasses [(Lean % = 63.65 + 1.05 (muscle score) - 0.76 (grade fat)]. Thus, both equations the new predictive LEAN equation for cows and the currently used predictive LEAN equation for youthful animals were contrasted (Figure 1). As expected, the results indicate that the new lean yield equation for cows was more precise to predict the actual lean yield percentage (83%) than the equation used for youthful animals (70%).

Johnson and Rogers [8] found the best equation for predicting the yield of whole muscle cuts from mature cow carcasses had three variables (hot carcass weight, rib eye area and marbling) but percentage of total variation explained was relatively low (R^2 = 0.58). O'Mara *et al.* [11] used USDA yield grade standards in cows to predict LEAN content. The best carcass traits for the LEAN prediction model included adjusted preliminary yield grade, kidney, pelvic and heart fat adjustment, marbling score and lean maturity, resulting in a high R^2 (0.91). Given the differences in cattle populations, comparison with other foreign prediction equations could give wrong and underestimated predictions [12]. Furthermore, for illustration purposes only, the new equation was tested on the same population used to develop the model. Thus, the next steps would require validation of the new prediction equation for Canadian cow carcasses using a separate commercial population.

IV. CONCLUSION

The equation developed in the present study for cull cows could explain over 83% of the variation of LEAN with high accuracy, indicating that there may be opportunity to develop a yield grade for cull cows and more precisely define their carcass value. Further validation of the regression equations for LEAN will be required before implementing.

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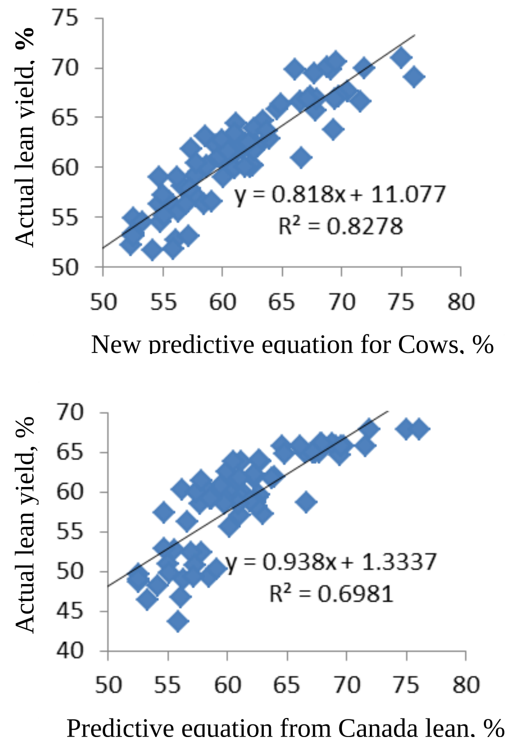

Figure 1. Contrasting the new predictive lean yield equation for cull cows vs. predictive equation from Canada lean yield grade. New predictive equation for cull cows is: LEAN = 59.2131 - (Grade Fat * 0.3869) + (REA * 0.0946) - (Marbling * 0.0152) + (Ossification * 0.0515). Predictive equation for youthful animals: LEAN = 63.65 + 1.05(Muscle Score) – 0.76(Grade Fat).