Between and within mob variation in meat and fat colour of pasture finished steers

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Introduction

Compared to cattle finished on feedlots, pasture-finished cattle are often more variable with respect to meat and fat colour. In addition to the between animal variation present within individual mobs, there can be considerable differences between producers as well as differences between mobs finished at different times of the year. The latter two factors can be especially important when cattle are sourced from a wide base of suppliers in a range of environments to ensure adequate supply over most of the year. This study was conducted to determine the relative importance of variability between suppliers, between mobs from the same supplier and between animals from the same mob on meat and fat colour, using objective colour measurements. The possibility of improving meat and fat colour by identifying and selecting an 'elite' group of suppliers is discussed.

Methods

Measurements were made on 1701 steer carcasses processed at the Richmond Ltd Pacific plant near Hastings, New Zealand between November 1995 and August 1996. Cattle were supplied in a total of 80 mobs by 16 producers. The number of cattle representing each supplier ranged from 43 to 231 with a minimum of two mobs per supplier. The suppliers included in this analysis were selected on the basis of having supplied mainly Angus or Angus-cross cattle in the 1994/95 season. All cattle were finished on pasture.

Carcass weight was measured and subcutaneous fat depth was assessed visually on hot carcasses after splitting into sides. Dentition was used as an indicator of cattle age. Chroma measurements were made on chilled sides, 12 hours or more after slaughter, using a Minolta CR-300 Chromameter (8 mm diameter measuring area). Measurements were recorded as CIE L*a*b* tristimulus values (Rigg, 1987). Meat and intramuscular (IM) fat chroma were measured on ribeye muscle (*M. longissimus dorsi*) cut between rib 12 and 13, 30 minutes or more after cutting. IM fat measurements were not made on 564 of the carcasses because the area of fat was too small for accurate scanning. Subcutaneous (SC) fat chroma was measured over the loin area. Three replicate scans of the chromameter were made for each tissue, with the measuring head moved to a new position for each scan.

Variance components were estimated by maximum likelihood methods. Mixed models, using carcass weight, SC fat depth and dentition as fixed effect predictor variables, were also evaluated to see if these effects could explain some of the between and within supplier variation. These analyses were performed using the SAS procedures VARCOMP and MIXED (SAS Institute, 1989).

Results and Discussion

Estimates of between-supplier variances were significant ($P<0.05$) for all chroma values as well as for carcass weight and fat depth. However, the major source of variation for all chroma variables was within-mob variance, with supplier differences accounting for only a small percentage of the total (Table 1). In contrast, supplier differences in the weight of carcasses were more consistent, with a repeatability of 31%.

Table 1. Means and variance components of meat and fat chromameter measurements, carcass weight and fat cover.

	Meat			Intramuscular fat			Subcutaneous fat			Carcass	GR
	L	a	b	L	a	b	L	a	b	weight	
Mean	34.1	21.0	11.3	76.8	2.27	14.81	63.9	5.11	18.1	323	8.19
Variance											
Total between carcasses	4.40	5.00	2.72	11.03	2.29	5.53	14.06	2.91	8.69	665	14.66
Between suppliers	0.17	0.26	0.11	0.54	0.39	0.58	2.15	0.56	0.89	203	3.19
Between mobs within suppliers	0.66	0.60	0.54	1.93	0.15	0.56	6.06	0.68	1.73	135	2.47
Between carcasses within mobs	3.57	4.14	2.07	8.56	1.75	4.39	5.85	1.67	6.06	327	9.00
Between replicate measurements	2.55	1.86	1.10	0.63	0.06	0.09	9.15	1.60	2.29	N/A	N/A
Repeatability of measurements[1]	63%	73%	71%	95%	97%	98%	61%	64%	79%		
Repeatability of supplier effects[2]	4%	5%	4%	5%	17%	10%	15%	19%	10%	31%	22%

[1] Total between carcasses/(Between replicate measurements +Total between carcasses)
[2] Between suppliers/Total between carcasses

Repeatability of supplier effects was greater for fat chroma than for meat chroma. The reason for this appears to be the inflation of within-mob variation in meat colour by the occurrence of 'dark cutters'. As shown in Figure 1, carcasses with very low L* (<30) and a* (<16) values occurred as extreme outliers from the main cluster of normal carcasses. These outliers made up approximately 3% of the total sample set and corresponded to carcasses with high (>5.8) meat pH (Smith et al, 1996). For fat colour, variation in L* and b* was more normal and the two measurements were independent (Figure 2).

Correlations of meat and fat chroma measurements with carcass weight, fat depth, dentition and slaughter date are shown in Table 2. Although many of these correlations were statistically significant, they were weak. The exceptions were the moderate negative associations of SC fat L* values with dentition, weight and fat depth and the positive association with slaughter date. Together, these variables accounted for 34% of the total between-carcass variation in SC fat L* values. Seasonal effects were also evident for IM fat L* values, with a consistent increase in fat brightness over summer and autumn.

Adjustment of meat and fat chroma for the effects of carcass weight, fat depth, dentition and slaughter date had little effect on the estimates of within-mob variance but could account for some of the variation between suppliers and between mobs from the same supplier. For example, adjustment for these effects reduced the between supplier variance component for SC fat b* values from 0.89 to 0.77 (a 14% reduction) and the between mob within supplier variance component from 1.72 to 0.93 (a 47% reduction). However, the estimate of within mob variance was similar (6.08) to the unadjusted value. For SC fat L* values, covariate adjustment reduced estimated between supplier variance by 38% and between mob variance by 73%, but within mob variance by only 9%. A similar pattern was observed for other chroma values, indicating that within mob variability in chroma values would still be relatively large even for mobs that were uniform with respect to age, weight and degree of finish.

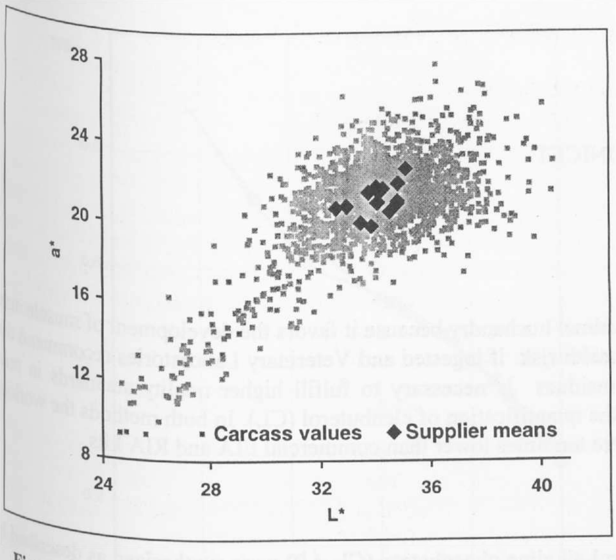

Figure 1 Variation in meat L* and a* measurements.

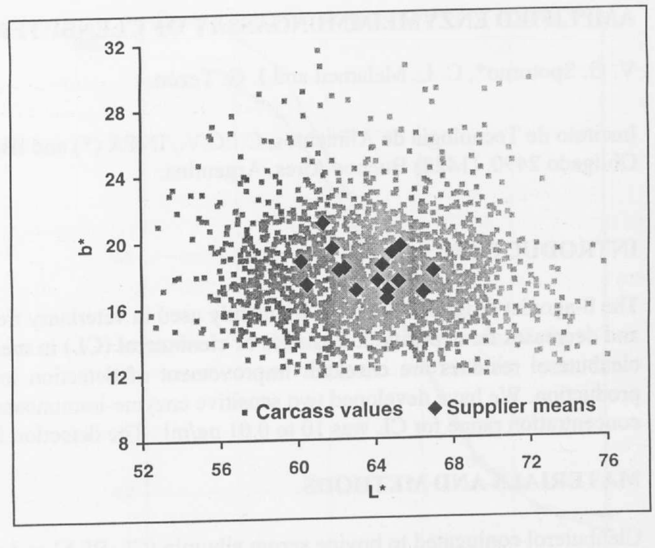

Figure 2 Variation in subcutaneous fat L* and b*

Table 2 Correlations of meat and fat chromameter measurements with other carcass attributes.

Correlation with:	Meat			Intramuscular fat			Subcutaneous fat		
	L	a	b	L	a	b	L	a	b
Weight	-0.11 ***	0.06 **	-0.01	-0.07 *	-0.01	0.11 ***	-0.13 ***	0.03	0.10 ***
Fat depth	-0.03	0.17 ***	0.18 ***	-0.07 *	-0.23 ***	0.07 *	-0.37 ***	-0.11 ***	-0.12 ***
Dentition	-0.17 ***	0.12 ***	0.02	-0.16 ***	-0.06 *	0.25 ***	-0.35 ***	0.11 ***	0.11 ***
Slaughter date	-0.02	-0.15 ***	-0.17 ***	0.26 ***	0.04	-0.18 ***	0.44 ***	-0.18 ***	-0.04

Conclusions

The low repeatability of supplier effects on meat and fat chroma indicates that discrimination amongst suppliers for consistency of visual meat quality will be difficult. The estimated variance components presented in Table 1 can be used to predict the effect of selecting a group of 'elite' suppliers based on their past performance. For example, even very intense selection of top suppliers will have only small effect on the mean SC fat b* values (Figure 3). The predicted mean fat SC fat b* values of carcasses from suppliers ranking in the top 25% (ie, those with low b* values), is 0.8 units lower than the base population when information on suppliers is based on 40 carcasses. When information on suppliers is based on 160 carcasses (as 8 mobs of 20), the effect of selecting the top 25% is to reduce the mean SC b* value by about 1.1 unit. Similarly, low responses to selection of top suppliers would be expected for meat L* and a* values, with a 25% selection intensity improving L* values by about 0.4 units and a* values by 0.5 units. As shown in Figure 3, the precision of predicting supplier effects on meat and fat colour is enhanced by spreading out measurements over several mobs, rather than by collecting information on large numbers of carcasses from a few mobs.

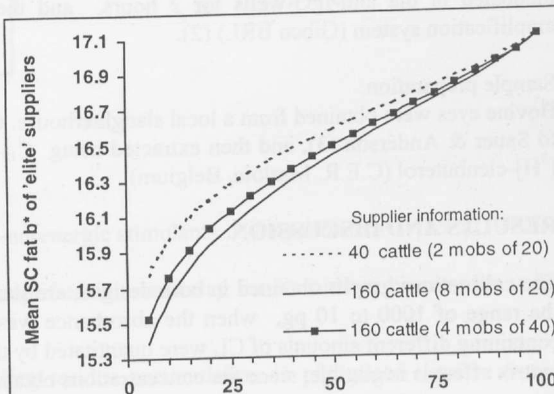

Figure 3 Expected SC fat b* of 'elite' group of suppliers selected on basis of prior chroma measurements

In contrast to the limited between-supplier variability, there was very large within-mob variation. Dark-cutting meat occurred at low frequency for all suppliers and in most mobs. Similarly, carcasses with unusually yellow fat (SC fat b* > 24, see Figure 2) were not unique to specific suppliers but were a general problem. . Improvement in the consistency of supply of pasture-finished beef with good fat and meat colour probably depends more on reducing within-supplier variability then on relying on 'elite' suppliers with good average performance. In this study, carcass weight, fat depth or age could not explain much of the within-mob variation. Genetic variation or differences in growth pathway of individual animals within a mob may be important factors. To study these factors will require better matching of carcass data collected in the processing plant and supplier records of individual animals.

References:

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