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THE ASSESSMENT OF SALEABLE MEAT YIELD IN LAMB CARCASSES

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INTRODUCTION

The assessment of meat yield (dissected or saleable) in lamb carcasses has largely been accomplished commercially using visually assessed criteria such as shape and fat cover in many countries. While several British studies (Chadwick *et al.*, 1986; Kempster *et al.*, 1986) have concluded that a 6-point visual score for lamb carcass fatness predicted carcass lean percent with equal or better precision to probe or ruler measures of tissue thickness, there is always the concern that subjective methods have more potential for error when used commercially than objective measurements. Consequently, simple manual techniques for measuring tissue thicknesses in lamb carcasses or semi-automation of these measurements by grading probes require assessment under field conditions. Kirton *et al.* (1984) suggested that measurement of tissue depth over the 12th rib by a ruler (GR) or with a grading probe between the 11th and 12th ribs at a location 11cm from the carcass mid-line as potential sites for grading lamb carcasses for lean content. Jones *et al.* (1992) reported that the total tissue depth measurement between the 12/13th ribs provided an adequate assessment of lamb carcass lean content. The present study was conducted to validate these results under commercial abattoir conditions.

MATERIAL AND METHODS

A total of 281 lamb carcasses were used in the study. The lambs were selected to cover three weight ranges (18-23kg, 23-26kg and 26-30kg warm carcass weight) and three fatness ranges (<3mm, 3-5mm and >5mm based on Hennessy Grading Probe [HGP] values of fat thickness between the 12th and 13th ribs). The total numbers of lambs in each of the weight and fatness sub-classes is shown in Table 1. Ewe and wether lambs were represented in all weight and fat sub-classes.

All carcasses were probed with a Hennessey Grading probe (Lamb model HGP with +80mm shaft) following the slaughter and dressing of the carcass. Grading took place within 30-45 min following stunning. Three main locations on the left carcass side were used to provide carcass measurements. HGP measurements were taken 3 to 4cm from the mid-line (approximate mid-point of the *m.longissimus thoracis*) between the 10th and 11th and 12th and 13th ribs and at the last rib (fat and muscle thickness at all locations) as well as measurements of total tissue depth (TD) between the 10th and 11th ribs and the 12th and 13th ribs. In addition, a sharpened steel ruler was used to measure total tissue thickness over the 12th rib at the GR site 11cm from the carcass mid-line. Carcass muscle thickness was assessed on a 5-point scale (1=long shanks, thinly fleshed throughout; 5=extremely thickly fleshed throughout).

Warm carcass weight was recorded for all lambs as well as cold carcass weight (includes kidney fat). Kidney fat was removed and weighed with the saddle. Loin eye area was traced at the 13th rib and subsequently estimated using an electronic planimeter.

All carcasses were fabricated into the major primal cuts (leg, saddle or back and shoulder) which were trimmed to commercial specifications (maximum of 5mm fat). Each finished cut was weighed to the nearest 10g. Saleable trim from the rough cuts (shank, flank and breast) estimated to contain 80% lean was also weighed. Carcass saleable yield was estimated as the sum of the finished leg, saddle, shoulder and trim expressed as a percentage of warm carcass weight (both kidney fat in and kidney fat excluded).

Analysis of variance was used to analyze the effects of carcass weight, fatness and gender on the carcass measurements recorded. Linear contrasts were used to separate means when significant effects were observed. Multiple regression was used to assess the value of the carcass measurements collected for predicting saleable meat yield.

RESULTS AND DISCUSSION

Effect of weight, fatness and gender on kidney fat, loin eye area and saleable meat yield. Kidney fat proportions increased in all weight groups as carcasses became fatter (Table 2). Kidney fat percentage averaged 2.5% of carcass weight in lean lambs (<3mm fat) and increased to about 4.0% of carcass weight in fat lambs (>5mm fat). Within fat group, carcass weight only had minor effects on kidney fat percentage. Ewe carcasses consistently had a higher percentage of kidney fat than wethers in all weight and fat sub-classes. The difference ranged from a low of 0.26% to a high of 1.79%.

Since kidney fat is included as part of warm carcass weight in Canada, the variation in kidney fat percentage due to gender will contribute as a source of unexplained variation for the prediction of saleable meat yield. Thus the use of measurements of fat thickness to predict saleable meat yield when carcass weight includes kidney fat will tend to result in an overprediction of meat yield in ewe carcasses and an underprediction in wether carcasses, unless separate regression equations are used for meat yield in ewe and wether carcasses. Loin eye area was not significantly influenced by fat group, weight group or gender (Table 2; data for gender not shown). However, loin eye area did show a trend of increasing with carcass weight.

Saleable meat yield consistently decreased as carcasses became fatter, but was not influenced to any extent by weight group within a fat group. These results indicate that fatness is the most important variable influencing saleable meat yield. On average, saleable meat yield was reduced by 4% from the leanest to the fattest group of carcasses. Ewe carcasses generally had lower yields of saleable meat than wether carcasses. A second analysis done to exclude the effect of kidney fat (saleable yield expressed as a % of carcass weight - kidney fat) considerably narrowed the difference in saleable meat yield between ewe and wether carcasses. These results suggest that carcass weight should be re-defined in Canada to exclude kidney fat. Kidney fat is a low value product and its inclusion as part of carcass weight only tends to support the marketing of fatter lambs and masks lambs that have higher than average dressing yields due to good muscling.

Prediction of saleable meat yield

Regression was used to predict saleable meat yield and combinations of measurements were evaluated (Table 3). The lower the RSD the more precise is the prediction of saleable meat yield. The results from Table 3 show that warm carcass weight is not a useful predictor of saleable meat yield. GR measured by ruler over the 12th rib was the most useful single measurement for the prediction of saleable meat yield. This measurement combined with carcass conformation score provided the best practical series of two measurements to predict saleable meat yield (similar to ruler GR + loin eye area). In contrast, HGP measurements (GR or fat + muscle) all had a lower precision for the prediction of saleable meat yield (Table 3).

When carcass weight range is relatively narrow, it contributes little to the prediction of meat yield (Kirton *et al.*, 1984; Garrett *et al.*, 1992). In Canada, the preferred weight for lamb carcasses is within the 20 to 28kg range, so weight is unlikely to assist in improving the precision of predicting saleable lean and GR is likely to be of far greater benefit than in situations where there are wide ranges in carcass weight. While this study confirms the work of Kirton *et al.* (1984) that GR is a useful measure of lamb composition (in this case saleable lean rather than dissected lean), the results suggest that GR measurement is more precise when measured by a ruler over the 12th rib rather than a total measurement of tissue depth between the ribs by the HGP. Kirton *et al.* (1984) found that total tissue depth (measured by a probe), GR (measured by a ruler) and measurements of fat thickness over the *m.longissimus thoracis* all had similar precision and value for predicting carcass meat yield and Chadwick *et al.* (1986) reported that probe measures of fatness and tissue depth were of more value than ruler measurements. This study also found that measurements of muscling (loin eye area or carcass muscle thickness) provided a small but useful increase in the amount of variance explained for the prediction of saleable meat yield. In contrast, the results of other studies (Kempster *et al.*, 1982; Garrett *et al.*, 1992; Jones *et*

al., 1992) have shown conformation score to be of little value. The differences found in the results of this study compared to others is likely to be related to the endpoint chosen (saleable meat yield which contains fat and bone rather than lean yield) and the fairly narrow weight range of carcasses examined in the study.

The results in Table 4 are analogous to those in Table 3 except that saleable meat yield was expressed as a percentage of carcass weight less kidney fat. In all cases the RSD values for saleable meat yield were lower (more precise) than the ones for saleable meat yield expressed as a percentage of carcass weight including kidney fat. This confirms the previous results and provides further justification for not including kidney fat as part of warm carcass weight. A recent study by Garrett *et al.* (1992) also suggested that kidney fat had to be accounted for if left in the carcass following dressing to have a reliable prediction of commercial meat yield. In the same study it was found that kidney fat was either the first or second variable to enter stepwise regressions for the prediction of meat yield and was more important than probe recorded fat, carcass weight and leg conformation for the prediction of meat yield.

The best equations for predicting saleable meat yield were as follows:

Saleable meat yield[1] = 78.92 - 0.51(Ruler GR, 12th rib) + 1.25(carcass conformation score)

Saleable meat yield[2] = 80.33 - 0.35(Ruler GR, 12th rib) + 0.83(carcass conformation score)

where [1] = warm carcass weight and [2] = warm carcass weight excluding kidney fat.

For each carcass assessed in the study, the two above equations were used to predict saleable meat yield. The predicted meat yield was then subtracted from the actual saleable meat yield and the standard deviation of the difference calculated.

For carcasses where saleable meat yield was assessed with kidney fat included, the results are shown in Table 5. Standard deviations were relatively stable across weight and fatness groups averaging about 1.65%. This indicates that 65% of the carcasses would have a predicted saleable meat yield within 1.65% of the actual yield. For carcasses where saleable meat yield was assessed with kidney fat excluded from carcass weight, the standard deviations were lower (data not shown) in all cases than those shown in Table 5. This result again confirms that kidney fat is a source of confounding variation for the prediction of saleable meat yields in lambs. Since lamb processing in Canada is a small industry with only one dedicated plant that slaughters up to 200 lambs per hour, the investment in a grading probe system is probably not worthwhile when the needs of the industry can be met with a manually based ruler system.

CONCLUSIONS

Carcass weight should be redefined in Canada to exclude kidney fat. This will improve the accuracy of assessing carcass value and discourage the feeding of lambs to heavier weights to increase dressed out yield (killing out %).

A ruler measurement of GR at the 12th rib combined with carcass conformation score should be introduced in lamb grading to assess saleable meat yield.

Simple pricing schedules can be developed based on predicted saleable meat yield to reward carcasses with high saleable yields and discount carcasses with less than average meat yields.

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Table 1. Number of lambs by warm carcass weight class and fat group.

Carcass weight group	Fat Group (HGP fat) <3mm	3-5mm	>5mm
18-23 kg			
Ewe	16	34	11
Wether	31	20	6
Total	47	54	17
23-26 kg			
Ewe	7	16	18
Wether	17	24	15
Total	24	40	33
26-30 kg			
Ewe	1	12	15
Wether	5	18	15
Total	6	30	30

Overall Number = 281

Table 2. Effect of carcass weight, fatness and gender on kidney fat, loin eye area and saleable meat yield.

Carcass Measurement; wt group	Gender	Fat Group <3mm	3-5mm	>5mm
Kidney fat (% carcass wt)				
1	Overall	2.46[a]	2.85[a]	3.78[b]
	Ewe	2.94[a]	3.41[a]	4.35[a]
	Wether	1.99[b]	2.30[b]	3.21[b]
2	Overall	2.58[a]	2.76[a]	4.16[b]
	Ewe	3.01	3.26[a]	4.29
	Wether	2.15	2.26[b]	4.03
3	Overall	2.59[a]	3.30[a]	4.27[b]
	Ewe		4.20[a]	4.96[a]
	Wether		2.41[b]	3.58[b]
Loin eye area cm²)				
1				
2	Overall	13.0	13.6	12.9
3	Overall	14.3	14.6	14.2
	Overall	16.5	15.3	14.7
Saleable meat yield (% hot carcass)				
1				
	Overall	77.5[a]	76.6[b]	73.4[c]
	Ewe	77.2	75.8[a]	73.1
	Wether	77.7	77.4[b]	73.8
2				
	Overall	76.6[a]	74.8[a]	73.0[b]
	Ewe	75.4[a]	75.3[a]	73.2
	Wether	77.9[b]	76.8[b]	72.9
3				
	Overall	76.8[a]	74.8[a]	72.8[b]
	Ewe		73.3[a]	71.5[a]
	Wether		76.3[b]	74.0[b]
Saleable meat yield (-kidney fat)				
1				
	Overall	79.4[a]	78.8[b]	76.3[c]
	Ewe	79.6	78.4	76.4
2	Wether	79.3	79.2	76.2
	Overall	78.7[a]	78.2[a]	76.1[b]
	Ewe	77.7[a]	77.8	76.4
	Wether	79.6[b]	78.5	75.9

Weight groups 1, 2 and 3 = 18-23, 23-26 and 26-30 kg warm carcass weight.abc Overall means are compared across fat group, gender means are compared within fat group.

Table 3. Prediction of saleable meat yield (%) in lamb carcasses with saleable yield as a percentage of carcass weight .

Carcass measurements	Without carcass weight Residual SD	R^2	Including carcass weight Residual SD	R^2
Warm carcass wt	2.54	0.13	-	-
Ruler (12th rib GR)	1.84	0.55	1.84	0.55
Ruler (12th rib GR) + loin eye area	1.69	0.61	-	-
Ruler (12th rib GR) + leg conform. sc.	1.71	0.61	1.71	0.61
HGP[1] (GR 12th/13th)	2.11	0.40	2.11	0.40
HGP (10th/11th)	2.07	0.43	2.07	0.43
HGP (fat & muscle depth, 10th/11th)	1.96	0.49	1.95	0.49
HGP (fat & muscle depth, 12th/13th)	2.09	0.42	2.07	0.43
HGP (fat & muscle depth, last rib)	2.08	0.42	2.05	0.44
HGP (fat & muscle depth, 10th/11th) + conform. score	1.93	0.50	1.91	0.51

Table 4. Prediction of saleable meat yield (%) in lamb carcasses with saleable yield as a percentage of carcass weight without kidney fat.

Carcass measurements	Without carcass weight		Including carcass weight	
	Residual SD	R^2	Residual SD	R^2
Warm carcass wt	1.85	0.10	-	-
Ruler (12th rib GR)	1.37	0.50	1.37	0.51
Ruler (12th rib GR) + loin eye area	1.32	0.54	1.32	0.54
Ruler (12th rib GR) + leg conform. sc.	1.30	0.56	1.30	0.56
HGP[1] (GR 12th/13th)	1.55	0.37	1.55	0.37
HGP (10th/11th)	1.51	0.40	1.51	0.40
HGP (fat & muscle depth, 10th/11th)	1.44	0.46	1.43	0.47
HGP (fat & muscle depth, 12th/13th)	1.50	0.41	1.49	0.42
HGP (fat & muscle depth, last rib)	1.51	0.40	1.50	0.41
HGP (fat & muscle depth, 10th/11th) + conform. score	1.42	0.47	1.41	0.48

[1]HGP = Hennessey Grading Probe.

Table 5. Standard deviation of the difference (actual - predicted) for saleable meat yield (kidney fat included).

Weight Group	Gender	Fat Group <3mm	3-5mm	>5mm
18 -23 kg	Overall	1.57	1.62	1.76
	Ewe	2.03	1.66	2.14
	Wether	1.31	1.58	0.85
23 - 26 kg	Overall	1.69	1.86	1.68
	Ewe	1.76	2.44	1.47
	Wether	1.36	1.41	1.73
26 - 30 kg	Overall	1.33	1.59	1.81
	Ewe	--	1.45	1.55
	Wether	1.36	1.43	1.92