Ultrasonic scanning of lamb carcasses for non-destructive carcass quality measurements

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ABSTRACT

Eye muscle dimensions of meat and fat together with live or carcass weight are important selection criteria for the improvement of carcass traits in sheep. The use of B-mode ultrasound may offer scope for more efficient progeny testing procedures. Two trials examined the use of ultrasound for estimating eye muscle width (A) and depth (B) between the twelfth and thirteenth ribs on live animals, and their carcasses immediately following slaughter and up to nine hours later. These estimates were then compared with ruler measurements on the eye muscle cut surfaces. Correlations between the various estimates of B were high (r = 0.80 to 0.96). While the correlation between the live scan of A and its ruler measurement was 0.75, the correlations between carcass scans and ruler measurements were 0.40 to 0.61. This was due to difficulty in maintaining acoustic coupling over the length of the probe, which was flat relative to the curved carcass surface. A new curved offset offers excellent prospects for overcoming this problem.

Keywords: eye muscle dimensions; carcass scanning; selection criteria.

INTRODUCTION

Analyses of the Wiremu database (Waldron *et al.*, 1992; Clarke and Binnie, 1994) show that use of carcass eye muscle width and depth, fat over the eye muscle (or GR) and carcass weight are useful as selection criteria for improvement of carcass composition and lean growth. Predicted ten-year changes from selection for high lean and low fat weights (equal and opposite relative economic values) were: + 1.30kg for carcass weight, +1.55kg for lean weight, - 0.50kg for fat weight and + 2.75sq.cm. for eye muscle area. While the likely gains from live animal estimates of these criteria will be less than this, the accuracy obtained from using modern B-mode ultrasound equipment is sufficiently high for the practice to be widely adopted by ram breeders, and is higher than previous reports using early commercial machines (Young *et al.*, 1992; Ward *et al.*, 1992; Young and Deaker, 1994). However, live-animal scanning is time-consuming (the fastest operators perform about fifty scans per hour) and has a significant cost ($3 to $4 per animal) which limits its widespread use for progeny testing. Direct measurement of eye muscle dimensions at a slaughterhouse is disruptive to the normal processing activity and is consequently seldom attempted.

Estimating eye muscle dimensions with a B-mode ultrasound scanner while carcasses are on the cooling floor offers the prospect of a practical, cheaper method of progeny testing sires for meat attributes (Cross *et al.*, 1989; Wood *et al.*, 1991).

MATERIALS AND METHODS

Trial 1

Twelve month old Romney crossbred lambs (n=106) were slaughtered at the Ruakura research abattoir following removal from pasture 24 hours earlier. The lambs were sired by rams from the Massey Southdown Fat (n = 43) or Lean (n = 26) selection flocks(Purchas *et al*, 1982), or by Texels (n=37). All carcasses were ultrasonically scanned on the right side for eye muscle width and depth (Palsson, 1939) immediately following slaughter using an Aloka 500V B-mode machine with a 64mm, 5mHz transducer.

All carcasses were then placed in a chiller and held in fan-circulated air at 4 degrees Centigrade for 24 hours. A random thirty-two of the carcasses were then cut between the 12th and 13th ribs so that eye muscle width (A) and depth (B) could be measured with a ruler on the right side (Palsson, 1939). Sixty-four of the remaining carcasses were halved along the backbone before the right sides were frozen. They were subsequently cut into Devco cuts with a bandsaw before A and B were measured with a ruler.

Trial 2

Thirty ten month old lambs of similar breeding to those used in Trial 1 were ultrasonically scanned on the right side for A, B and the fat depth over the eye muscle (C) two days before slaughter using the same machine as in Trial 1, but also using light parafin oil as an acoustic couplant and a flexible elastic low-attenuation PVC offset (BCF, Scotland). The right sides of the carcasses were scanned at the same site in the chiller for A and B two hours post-slaughter, and again nine hours post-slaughter when the subcutaneous fat had set. Ruler measurements of A, B and C were taken two days later on frozen right sides.

Statistical Analysis

Data were analysed by linear regression using Microsoft Excel V4.0 spreadsheet procedures.

RESULTS

Trial 1

Of the 106 carcasses that were scanned, ten failed to yield a readable image. Characteristics of the 32 fresh and 64 frozen carcasses are given in Table 1. Data are presented separately

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TABLE 1: Average hot carcass weight, GR, ultrasonic and ruler eye muscle widths and depths of fresh and frozen carcasses (standard deviation in brackets).

	Fresh	Frozen
Number	32	64
Hot carcass weight (kg)	18.2 (3.82)	18.2 (2.85)
GR (mm)	6.8 (4.09)	6.2 (3.38)
Scan eye muscle width (mm)	62.4 (5.19)	62.1 (4.57)
Scan eye muscle depth (mm)	26.4 (4.07)	25.3 (2.96)
Ruler eye muscle width (mm)	61.0 (5.08)	55.9 (4.17)
Ruler eye muscle depth (mm)	28.8 (3.52)	32.5 (2.90)

for carcasses on which the ruler measurements were done while they were fresh from those on which the ruler measurements were done when frozen. It has been consistently found in a number of trials that measurements of A on fresh carcasses are 8% larger than those on frozen carcasses, while measurements of B on fresh carcasses are 10% smaller than those on frozen carcasses, i.e. the eye muscles change shape upon freezing to become rounder (Binnie, *unpub.*). This phenomenon has been reported in beef carcasses by Ramsey *et al.* (1965).

Relationships between carcass scans and ruler measurements (dependant variable) derived by linear regression are given in Table 2.

Trial 2.

Characteristics of the carcasses are given in Table 3. Relationships between live scans, carcass scans at two and nine hours post-slaughter and ruler measurements are given in Table 4.

TABLE 2: Relationships between carcass scans and ruler measurements (dependent variable) for the model y=a+bx (parameters after adjusting for hot carcass weight in brackets)

	Ruler Measurements	
	Fresh	Frozen
Eye muscle width (A)		
Slope (b)	0.40 (0.05)	0.36 (-0.09)
Standard error of slope	0.16 (0.19)	0.11 (0.11)
Intercept (a)	36.0 (57.7)	33.4 (61.2)
Correlation coefficient (r)	0.41 (0.05)	0.40 (0.10)
Standard deviation of ruler A	5.08 (4.15)	4.17 (3.06)
RSD	4.64 (4.15)	3.82 (3.04)
Eye muscle depth (B)		
Slope (b)	0.71 (0.50)	0.78 (0.52)
Standard error of slope	0.09 (0.14)	0.08 (0.09)
Intercept (a)	9.95 (15.5)	12.8 (19.4)
Correlation coefficient (r)	0.83 (0.55)	0.80 (0.59)
Standard deviation of ruler B	3.52 (2.25)	2.90 (1.90)
RSD	1.981 (1.87)	1.75 (1.54)

TABLE 3: Average hot carcass weight, GR, ultrasonic dimensions prior to slaughter and at two and nine hours post-slaughter, and ruler dimensions when frozen (standard deviations in brackets).

	HCW	GR	A	B	C
Live			56.7(7.46)	25.5(4.65)	2.90(1.65)
Carcass					
(2 hours)	17.0(4.69)	7.33(5.04)	57.8(7.14)	24.7(4.87)	
(9 hours)				25.1(4.91)	
Ruler			54.3(5.32)	29.7(5.16)	2.60(1.85)

Numbers varied because some carcasses did not yield readable images at some carcass scans.

Two operators (one scanning, and one holding the carcass and recording) were able to scan fifty carcasses per hour.

DISCUSSION

The fact that some fresh carcasses failed to yield readable images was almost certainly due to air becoming trapped in the subcutaneous fat layer during pelt removal, thereby causing loss of acoustic continuity. An attempt was made to remove this air by puncturing the fat with a pad of pins and firmly stroking the fat. This was successful on five out of the fifteen affected carcasses.

As carcass fat cooled, it became increasingly difficult to obtain good images of eye muscle width. This was through inability to maintain acoustic coupling along the entire length of the flat-surfaced offset as the subcutaneous fat became hard, and thereby being able to view both ends of the eye muscle at once. No such difficulties were experienced with eye muscle depth where it is necessary to maintain coupling over a relatively narrow part of the surface. Since these two trials were conducted, a different curved offset has been obtained, which shows excellent prospects of overcoming this problem. Once the data were corrected for live weight, neither live scanning nor carcass scanning significantly reduced the residual standard deviations for eye muscle width. By contrast, eye muscle depth and eye muscle fat variations were reduced by incorporating scanning measurements after live weight. These results are in agreement with those of McEwan *et al.* (1989).

Under the conditions of these two trials, it was possible to estimate eye muscle depth with sufficient accuracy to offer the prospect of using carcass scanning for progeny testing sires for meat trait improvement. However, the accuracy of estimating eye muscle width was much lower, and will need improving for the technique to be adopted. The use of a curved offset has excellent prospects of giving this improvement.

ACKNOWLEDGEMENTS

This work was funded by the New Zealand Animal Breeding Trust through an A.L.Rae scholarship.

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TABLE 4: Relationships between ultrasonic measurements and carcass ruler measurements of eye muscle width (A), eye muscle depth (B) and fat over the eye muscle (C) in live animals and carcasses for the model y=a+bx.(parameters after adjusting for hot carass weight in italics)

Independent	Dependent	n	b	SE_b	a	r	SD	RSD
Live scan A	Carcass scan A_2*	25	0.912	0.089	4.75	0.91	7.14	3.03
			0.682	*0.195*	*17.9*	*0.59*	*3.63*	*2.93*
Live scan B	Carcass scan B_2	26	1.01	0.064	-1.63	0.96	4.87	1.45
			0.927	*0.139*	*0.430*	*0.81*	*2.42*	*1.43*
Live scan B	Carcass scan B_9*	29	0.997	0.062	-0.349	0.95	4.91	1.50
			0.897	*0.143*	*2.23*	*0.77*	*2.33*	*1.48*
Carcass scan B_2	Carcass scan B_9	26	0.940	0.068	2.55	0.94	4.91	1.64
			0.772	*0.131*	*6.60*	*0.77*	*2.33*	*1.49*
Live scan A	Ruler A	30	0.537	0.089	23.9	0.75	5.32	3.51
			0.051	*0.188*	*51.6*	*0.05*	*3.09*	*3.09*
Carcass scan A_2	Ruler A	25	0.428	0.117	30.6	0.61	5.32	4.23
			-0.145	*0.185*	*62.9*	*0.16*	*3.09*	*3.05*
Live scan B	Ruler B	30	1.04	0.071	3.06	0.94	5.16	1.74
			1.01	*0.166*	*3.87*	*0.75*	*2.65*	*1.74*
Carcass scan B_2	Ruler B	26	0.950	0.096	6.92	0.90	5.16	2.30
			0.733	*0.187*	*12.1*	*0.62*	*2.65*	*2.07*
Carcass scan B_9	Ruler B	29	0.933	0.094	6.33	0.89	5.16	2.40
			0.628	*0.187*	*14.0*	*0.54*	*2.65*	*2.22*
Live scan C	Ruler C	30	1.04	0.080	-0.414	0.93	1.85	0.699
			0.823	*0.106*	*0.231*	*0.83*	*1.10*	*0.620*

* Subscript denotes hours between slaughter and scanning.

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