REAL TIME ULTRASOUND AND CARCASS MEASUREMENT OF FAT DEPTH AND MUSCLE DIMENSIONS AT TWO SITES IN LAMBS

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SUMMARY

In Experiment 1, 102 seven month old cryptorchid lambs were scanned with a real-time ultrasonic scanner over the deepest part of the eye muscle *M. longissimus thoracis et lumborum* (LL) between the 12th and 13th ribs. At this position, fat depth (US FatC) and LL depth and width (US EMD; US EML) were measured. Over the LL at the third lumbar equivalent measurements were taken (USLFatC; USLEMD; USLEML). On the carcass, fat depth over the LL (FatC) and the dimensions of the LL (EMD;EML) were measured on the cut surface between the 12th/13th ribs.

Mean ultrasonic measurements were similar for each characteristic measured at the two sites, with larger differences between *in vivo* and carcass measurements obtained at the 12th/13th rib site; the most notable being for LL depth which was measured as much greater on the carcass. For LL width there was no significant ($P > 0.05$) relationship between measurement *in vivo* and on the carcass.

In Experiment 2, measurements of fat depth and muscle dimensions were taken at the 12th/13th rib and lumbar sites of 46 cryptorchid carcasses. Measurements of fat depth at the 3rd lumbar were greater than those at the 12th/13th rib site and showed that as fat depth at the lumbar site increases, the rate of increase at the rib is half that of the lumbar site. Measurements of LL dimensions showed poor relationships between sites.

It was concluded that the lumbar site may be more difficult for inexperienced operators of real-time ultrasound, but that regardless of the site used, further refinement of measurement techniques is needed to increase accuracy levels.

Keywords: lamb, lumbar, carcass, ultrasound

INTRODUCTION

With the introduction of muscle depth measurement to LAMBPLAN (Fogarty *et al.*1992), field operators are now utilising real-time ultrasound on a routine basis for measurement of meat sheep breeding animals. Previous research has found that measurement of fat depth over the *M. longissimus thoracis et lumborum* (LL), particularly in lean animals, is subject to error (Hopkins *et al.* 1993). It is envisaged measurement accuracy will become more of an issue because there is evidence from across flock analysis of terminal meatsheep sires of a continuing decline in subcutaneous fat levels (Banks 1997). Boundary definition between fat and muscle tissues is always an area of concern when using real-time ultrasound and sites on the animal that provide clear definition are needed. A promising alternative measurement site to the 12th/13th site is the 3rd lumbar which has been used in European studies (Thorsteinsson *et al.* 1994).

Several experiments were made in which the measurement of fat and muscle dimensions at the 3rd lumbar, in live animals using real-time ultrasound and on the carcass were compared with those traditionally taken at the 12th/13th rib.

MATERIALS AND METHODS

Experiment 1

Seven month old cryptorchid lambs (n=102) of six genotypes as described by Hopkins *et al.* (1997) were scanned with a real-time ultrasonic scanner (Aloka SSD-500). Scanning sites were over the deepest part of the eye muscle *M. longissimus thoracis et lumborum* (LL) between the 12th and 13th ribs where fat depth (US FatC) and LL depth and width (US EMD; US EMW) were measured. Also equivalent measurements were taken over the LL at the third lumbar (over deepest LL position) termed (USLFatC; USLEMD; USLEMW).

One week after scanning the lambs were fasted for 15 hours and a pre-slaughter weight was obtained. Hot carcass weight (including kidney and internal fat) and GR (tissue depth over the 12th rib, 110mm from the midline) were recorded following commercial slaughter. Fat depth over the LL (FatC) and the dimensions of the LL (EMD;EMW) were measured on the cut surface between the 12th/13th ribs.

Experiment 2

Carcass measurements of fat depth and muscle dimensions were taken at the 12th/13th rib and lumbar sites of 46 cryptorchid carcasses representing the six genotypes of Experiment 1. Measurements at the 12th/13th site were taken on chilled product, whereas those at the lumbar site were taken on mid loins that had been frozen and then cut at the 3rd lumbar site while frozen. The measurements were taken on the frozen cut surface and repeated after the mid loins were thawed for 24 hrs. The relationships between the *in vivo* and the corresponding carcass measurement, between *in vivo* measurements and between carcass measurements were established using regression analysis. For Experiment 1 the effect of adding fasted pre-slaughter liveweight as an independent variable was examined and for Experiment 2 the effect of adding hot carcass weight (HCW) was examined.

RESULTS

Experiment 1

Mean ultrasonic measurements were similar for each characteristic measured at the two sites (Table 1) with larger differences between *in vivo* and carcass measurements obtained at the 12th/13th rib site; the most notable being for LL depth which was measured as much greater on the carcass. The variation for the ultrasonic measurements was also much less as indicated by the standard errors than the corresponding carcass measurement. Models relating *in vivo* and carcass measures are shown in Table 2. All coefficients were significant at the $P = 0.05$ level unless indicated. For Model 1 the addition of liveweight was significant ($P < 0.05$) improving the accuracy of estimation, with a reduction in the r.s.d. to 1.14mm.

Measurements of fat depth at the two sites were strongly correlated (Model 2, Table 2), and this was the case also for measurement of LL depth (Model 4, Table 2), with liveweight having no significant ($P > 0.05$) effect on the relationships. However the relationship between LL depth measured *in vivo* and on the carcass was weak (Model 3, Table 2) and indicates that the ultrasound measurement significantly ($P < 0.05$) under-estimated the carcass equivalent. For LL width (Model 5, Table 2) there was no significant ($P < 0.05$) relationship between measurement *in vivo* and on the carcass. Liveweight did alter this and significantly ($P < 0.001$) influenced the relationship of the 2 measurements. A difference was noted between measurement of LL width at the 12th/13th and 3rd lumbar sites using ultrasound with the latter underestimating LL width at the 12th/13th rib (Model 6, Table 2).

Table 1. Mean (± s.e.) pre-slaughter liveweight, ultrasonic and carcass fat depth and muscle dimensions for lambs in experiments 1 and 2

	Experiment 1		Experiment 2
	Carcass	Ultrasound	Carcass
Liveweight (kg)	50.1 ± 0.38		
HCW (kg)	26.4 ± 0.23		25.3 ± 0.43
GR (mm)	13.8 ± 0.23		14.6 ± 0.43
Fat C (mm)	4.2 ± 0.15	3.7 ± 0.07	3.9 ± 0.22
LFat (mm)		3.9 ± 0.07	
LFat C (mm) - Frozen			5.8 ± 0.29
LFat C (mm) - Thawed			5.6 ± 0.27
EMD (mm)	32.2 ± 0.29	23.4 ± 0.23	30.8 ± 0.45
LEMD (mm)		24.0 ± 0.21	
LEMD (mm) - Frozen			34.5 ± 0.51
LEMD (mm) - Thawed			30.8 ± 0.53
LEMW (mm)		63.7 ± 0.36	
EMW (mm)	62.6 ± 0.40	65.2 ± 0.35	60.4 ± 0.67
LEMW (mm) - Frozen			67.2 ± 0.94
LEMW (mm) - Thawed			64.5 ± 0.98

Table 2. Models and regression coefficients for estimating carcass measurements of fat depth and muscle dimensions at the 12th/13th rib from corresponding ultrasonic measurements, for relating ultrasonic measurements at the 12th/13th site to those at the 3rd lumbar site and for relating carcass measurements at the 2 sites

Variable	Intercept	Independent variable	R^2	r.s.d.	Model number
Fat C	-0.69^{ns}	1.32 US FatC	0.41	1.17	1
US FatC	-0.39^{ns}	0.85 USLFatC	0.65	0.44	2
EMD	16.05	0.67 US EMD	0.29	2.52	3
US EMD	1.43^{ns}	0.92 USLEMD	0.69	1.31	4
EMW	60.50	0.03 US EMW^{ns}	0.00	4.08	5
US EMW	13.88	0.81 USLEMW	0.70	1.94	6
Fat C	0.82^{ns}	0.55 LfatC (Thawed)	0.46	1.11	7
Fat C	1.00^{ns}	0.51 LfatC (Frozen)	0.45	1.12	8
EMD	22.84	0.26 LEMD (Thawed)	0.09	2.96	9
EMD	19.45	0.33 LEMD (Frozen)	0.13	2.89	10
EMW	46.35	0.22 LEMW (Thawed)	0.10	4.47	11
EMW	44.05	0.24 LEMW (Frozen)	0.12	4.42	12

Experiment 2

Based on data shown in Table 1 it is apparent that on the carcass, measurements of fat depth at the 3rd lumbar are greater than those at the 12th/13th rib site. There is also an apparent change in muscle dimensions for thawed samples, compared to those frozen.

Models 7 and 8 in Table 2 demonstrate that as fat depth at the lumbar site (measured on frozen or thawed cuts) increases the rate of increase at the rib (measured on chilled product) is half that of the lumbar site. Carcass weight had no significant effect on this relationship. Measurement of fat depth on the frozen midloin was equivalent to that on the thawed loin, with an intercept of zero and a regression coefficient (slope) of 1 ($R^2 = 0.91$). Measurements of LL dimensions showed poor relationships between sites (Models 9-12; Table 2). Frozen measurement of LL depth and width was underestimated from the corresponding thawed measurement by a factor of approximately 7.0mm.

DISCUSSION

The correlation between *in vivo* and carcass measurements of Fat C depth was higher than in the report of Hopkins *et al.* (1995) and similar for muscle depth. However, carcass muscle depth was significantly underestimated by the ultrasound equivalent. These differences were much larger than reported by Hopkins *et al* (1995). Binnie *et al.* (1995) also reported that ultrasonic muscle depth underestimated carcass muscle depth by approximately 4mm, but this was much less than our results. Large errors for estimation of muscle width were evident, again of a greater magnitude than those reported by Binnie *et al*. (1993). Hopkins *et al.* (1993) attributed most of this to the difficulty of establishing boundary definitions at the lateral ends of the muscle. Based on *in vivo* ultrasonic measurements of Experiment 1, it could be concluded that measurement of Fat C at the 12th/13th and lumbar site are similar. This same conclusion is reached from a comparison of the mean values reported for fat depth at the 2 sites by Thorsteinsson *et al.* (1994). However, carcass data at the two sites (Experiment 2) reveals that animals are fatter at the lumbar site than the rib site and a one to one conversion could not be applied. In fact fat depth at the lumbar site increases at double the rate of the rib site based on Models 7 and 8 (Table 2). Ultrasonic data obtained in this study also show a notable similarity in the degree of variation for similar traits measured at different positions, which is not seen for carcass measures. It is probable that this reflects measurement technique and difficulty of defining anatomical boundaries.

Depth of the LL measured ultrasonically at the two sites was similar, but this was not the case for LL width. By contrast, depth of the LL measured on the carcass at the 12th/13th site was much greater than the ultrasonic equivalent with no relationship between measurements of LL width as obtained by the two methods. Carcass measurements of LL dimensions (experiment 2) were greater at the lumbar site. From the computer tomography data of Young *et al.* (1996) the LL dimensions and cross-sectional area increases caudally. Comparison of cross-sectional areas derived from measurements at the two sites confirmed this was the case and also overcame problems of distortion which obviously occurred between measurements taken on the frozen/thawed surfaces (see Table 2).

Measurement of fat and muscle dimensions at the 3rd lumbar has potential to be more accurate because of the greater depths at this site (as indicated by carcass measures), reducing the effect of measurement error. The site also appears to offer equivalent contrast for determining boundary definition to the 12th/13th site. Additionally from the data presented by Thorsteinsson *et al.* (1994) measurements at the lumbar site are as accurate as those obtained at the 12th/13th site for predicting composition. It was noted however, that often the fat layer has a depression over the medial region of the muscle and is less uniform at the lumbar site. The schematic representation of the two sites by Thorsteinsson *et al.* (1994) illustrates this. As a consequence this site may be more difficult for inexperienced operators.

A shift by a national program such as LAMBPLAN to the lumbar site would require new genetic correlations to be established, particularly if fat measurements were converted to GR equivalents and given the findings of this work, greater gain may be made by enhancing measurement techniques for use at the 12th/13th rib site.

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