ACCURACY OF REAL-TIME ULTRASOUND SYSTEMS FOR FAT THICKNESS ESTIMATION IN LIVE CATTLE

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SUMMARY

Ultrasound scanning is an objective method for estimating subcutaneous fat thickness (SFT) in live cattle. It is particularly useful in beef cattle genotype evaluation and marketability research. Estimates of SFT at 12/13th rib and P8 rump sites were made with two real-time imaging ultrasound systems and one echo-ranging system on live steers. Relative accuracies of these systems were compared using regressions of ultrasound estimates on carcase fat measurements, together with frequency distributions of the differences between estimates and measurements. The real-time systems had similar levels of accuracy to the echo-ranging system (residual standard deviations ranged from 1.0 to 2.5 mm), provided more detailed displays of tissue interfaces, but were less portable. Care was needed for the correct location of scanning sites and interpretation of interfaces.

Keywords: ultrasound scanning, beef cattle, fat thickness, accuracy.

INTRODUCTION

Fatness is an important specification for the description of beef cattle. It is one of the characteristics which determine the yield, quality and market suitability of carcases. The most common methods for estimating subcutaneous fat thickness (SFT) in live cattle are visual and manual assessments. However, these methods are subjective and require experienced assessors. The accuracy achieved is not sufficient for most experimental work (Kempster et al. 1982).

Ultrasound scanning provides an objective method for estimating SFT. Several systems have been evaluated for use on live cattle (Tulloh et al. 1973, Thwaites 1984, Upton et al. 1984, and Sundstrom 1986). In this paper we compare the accuracies of estimates of SFT on live cattle made by a currently used echo-ranging system and by two real-time imaging systems.

MATERIALS AND METHODS

'Live cattle ultrasound estimates and carcase measurements of SFT were made at the commonly used standard 12/13th rib and P8 rump sites on two groups, of yearling steers. The first group comprised 133 mixed breed' steers judged in a carcase competition. The second group comprised 31 yearling Angus steers fattened in a feedlot. Where necessary, steers were restrained in a crush.

The 12/13th rib site was located at a point 2/3rd s the width of the M. longissimus from the midline by palpation. The P8 rump site was located. at the intersection of a line parallel to the spine from the tuber ischium (pin bone) and a line perpendicular to it from the spinus process of the third sacral vertebra: Vegetable oil was applied liberally at each scanning site.

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The echo-ranging ultrasound system, the "Scanoprobe II" (Sp) [model 731C, with 2MHz transducer frequency, Ithaco Inc, Ithaca:, New York] was used by a highly experienced operator in group 1 and by a less experienced operator in group 2. The two real-time imaging ultrasound systems, the "Vetscan" (Vs) [3.5MHz, Fischer, Edinburgh] and the "Vu-300" (Vu) [5MHz, Solus, Sydney], were compared with the Sp in group 2. The Vs was used by an experienced operator and the Vu was used by an inexperienced operator.

Carcase fat thickness at the appropriate sites was determined in the chiller by cut and measure techniques. Measurers were experienced, but different for each group.

Accuracies of estimates made with each ultrasound system were compared using the regression constants, regression coefficients, residual standard deviations (standard errors of estimate Y) and correlation coefficients for the regressions of ultrasound estimates (Y) on carcase measurements (X). Frequency distributions of differences between estimates and measurements (Y-X) were also used to compare accuracies of systems used in group 2.

RESULTS

Mean carcase measurements of SFT for the steers in group 1 were 6.5 mm (range 2-11 mm) at the 12/13th rib and 9.4 mm (range 3-12 mm) at the P8 rump sites. The corresponding means for steers in group 2 were 7.2 mm (range 5-11 mm) and 10.1 mm (range 7-13 mm).

Table 1 summarises the statistics for regression of live cattle ultrasound estimates of SFT on carcase measurements of SFT. At both rib and rump sites in group 1, low regression constantsand RSD s together with high coefficients of regression and correlation indicated high accuracy for estimates made by the Sp. At the rib site in group 2, RSD s for the Sp, the Vs and the Vu were similar to those for the Sp in group 1. At the rump site in group 2, however, they were much higher. At both sites, correlation coefficients were lower in group 2 than in group 1.

Table 1 Regression constants (a), 'regression coefficients (b), residual standard deviations (RSD) and correlation coefficients (r) for regressions of live animal ultrasound estimates (Y mm) on carcase measurements (X mm) of subcutaneous fat thickness at the 12/13th rib and P8 rump sites in two groups of steers.

Group	Ultrasound system	12/13 Rib				P8 Rump			
		a	b	RSD	r	a	b	RSD	r
1	Sp	0.3	0.9	1.3	0.82*	0.7	0.9	1.4	0.88*
2	Sp	2.6	0.6	1.1	0.63*	2.8	0.8	2.5	0.51*
	Vs	2.9	0.5	1.0	0.61*	4.6	0.7	2.2	0.46*
	Vu	3.9	0.4	1.2	0.48*	6.1	0.6	2.3	0.41*

* P<0.05

Frequency distributionsofthe differences between ultrasound estimates and carcase measurements from group 2 are shown in Table 2. At the 12/13th rib site,

77% of estimates made by each of the ultrasound systems were within 1 mm of the carcase measurement. However, at the P8 rump site, estimates by all systems had a much wider range. Less than 52% of these estimates were within 1 mm of the carcase measurement. About 60% exceeded carcase measurements by up to 5 mm.

Table 2 Frequency distributionsof differences between live cattle ultrasound estimates and carcase measurements of subcutaneous fat thickness at the 12/13th rib and P8 rump sites on the 31 steers from group 2 (+ve value is an over-estimate)

Difference (mm)	12/13th Rib			P8 Rump		
	Sp	Vs	Vu	Sp	Vs	Vu
-3	1	2	1	1	2	0
-2	3	4	3	4	2	2
-1	7	11	8	2	4	3
0	12	9	9	5	5	4
+1	5	4	7	9	5	5
+2	3	1	2	3	2	5
+3	0	0	0	2	6	3
+4	0	0	1	1	3	4
+5	0	0	0	3	2	2
+6	0	0	0	0	0	2
+7	0	0	0	0	0	1
+8	0	0	0	1	0	0

DISCUSSION

Relative accuracy of each system was indicated not only by high correlation coefficients for regressions of scan estimates on carcase measurements, but also by low RSD s for predictions of scan estimates, low regression constants and regression coefficients which were close to 1 (Tulloh et al. 1973, Kempster et al. 1982 and Thwaites 1984). RSD s from the regression were a measure of the precision of the relationship. Correlation coefficients were a measure of the intensity or consistency of association, but could be strongly influenced by the number of estimates made and the range of SFT s measured..

A high- level of accuracy was demonstrated for estimates of SFT made with the echo-ranging system when it was used at both 12/13th rib and P8 rump sites in group 1. Similar precision, as indicated by RSD s, was 'also obtained with this system, and with the two real-time imaging systems, at the rib site in group 2. The low correlation coefficients for systems used in group 2 could have been due to the smaller number of steers, the narrower range of SFT s, and possibly the generally lower levels of operator experience in this group than in group 1.

When compared directly in group 2, each of the ultrasound systems accurately estimated SFT at the 12/13th rib site. Our RSD s were lower than those reported for the simple mechanically coupled system, the "Scanogram" (Ithaco Inc., Ithaca, New York), by Tulloh et al. (1973) and for the "Scanoprobe" (Ithaco Inc., Ithaca, New York) by Upton et al. (1984). At the P8 rump site, however, accuracy of all systems was low. Here, high RSD s indicated a lower level of precision than at the rib site, and high regression constants indicated that each system was uniformly over-estimating SFT on the rump.

As seen from the frequency distributions of differences between scans and measurements, most estimates made by each system at the rib site were not

more than 1 mm above or below the carcase measurement. At the rump site, however, many estimates were up to 5 mm above the carcase measurement. This over-estimation of SFT on the rump could have been due to trimming-knife damage in the "rumping-out" process prior to hide-puller attachment on the slaughter floor. However, we thought that it was more likely a result of mislocation of the P8 site on the carcase by measurers in the chiller.

As well as predictive ability, other factors listed by Thwaites (1984) for consideration, when evaluating ultrasonic systems under field conditions, included ease of operation and portability.

A feature in the operation of the real-time imaging systems was the detailed screen display of a cross-section of the skin, the subcutaneous fat and the underlying muscle. Rapidly changing contours of these tissue interfaces were seen, particularly near the P8 rump site, as the transducer was moved across the hide of the animal. SFT at rib or rump sites was estimated from a digital display of the distance between cursors set on appropriate skin/fat/muscle interfaces by the operator. The Vu, with its higher frequency transducer, had a greater axial resolution and provided a more detailed screen display than the Vs. Care was needed to correctly interpret interfaces and avoid inconsistent estimates. With the echo-ranging system, these interfaces were not as visible. Light-emitting diodes provided an all or none indication of tissue interfaces, and some experience was needed by the operator to correctly read the estimate of SFT.

The two real-time imaging systems were desk-top units with a keyboard and video display screen. They required permanent location next to the cattle 'crush, an external power source and protection from weather and glare. On the other hand, the echo-ranging system was a small self-contained, battery-powered unit, easily carried between animals by the operator.

Ultrasound scanning systems have particular application to beef cattle genotype evaluation and marketability research. This comparison illustrated the use of two systems for estimating SFT in live cattle. The real-time systems proved to be as accurate as the commonly used echo-ranging system, provided more detailed screen displays of tissue interfaces, but were also more costly.

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