THE DISTRIBUTION AND PARTITIONING OF FAT IN SOUTHDOWN SHEEP SELECTED FOR HIGH AND LOW DEPTHS OF BACKFAT

I.T. KADIM, R.W. PURCHAS, A.L. RAE and R.A. BARTON, Department of Animal Science, Massey University, Palmerston North, NEW ZEALAND.

SUMMARY

Southdown rams from two lines selected for high and low weight-corrected fat depths (assessed ultrasonically at position C over the longissimus muscle at the last rib) were compared for fat partitioning and distribution. The partitioning of fat was such that, at the same total side fat weight, the high-backfat line had more subcutaneous and intramuscular fat, less intermuscular fat, and similar weights of omental fat and kidney plus pelvic fat. When compared at the same total subcutaneous fat weight, the distribution of subcutaneous fat between four cuts differed little but was slightly higher in the rib and loin area. Similar results were obtained for intermuscular fat. In terms of the relative size of line effects on different subcutaneous fat depths, there was a suggestion that fat depths corresponding more closely to the point where live-animal ultrasonic assessments were made showed larger between-line differences.

INTRODUCTION

The way in which fat is partitioned and distributed has been shown to vary to a greater extent between genetic groups than muscle or bone (Kempster 1980; Butterfield 1988), and the resulting variation can have important practical implications. For example, it is desirable from a consumer's point of view that not more than a shallow layer of subcutaneous fat be present and that this layer be evenly spread over the carcass so that drying out is minimized. Intermuscular fat on the other hand makes no useful contribution to meat product quality and many standard meat cuts can not be prepared if excess fat in this depot has to be trimmed. The partitioning of a greater proportion of fat into non-carcass depots has the advantage of leading to leaner carcasses at the same level of total body fat, but it also has the disadvantage of lowering dressing-out percents. In light of the known variability and practical importance of these characteristics it is prudent to check for changes in them when selection has been on the basis of a single fat depth measurement.

The objective of the work reported here was to establish whether selection for high or low backfat depth in a population of Southdown sheep had brought about changes in the partitioning of fat between several depots or in the distribution of fat amongst a group of four cuts within the subcutaneuos and intermuscular fat depots.

EXPERIMENTAL METHODS

The 15 to 18mo Southdown rams used in this study were from the Massey University backfat selection lines (Purchas et al 1982), which have been selected for either increased or decreased levels of weight-corrected backfat depths since the base population was assembled in 1976. Results reported here are from 78 rams born in three years, but they were not random selections from the two lines; as some culling on weight and fatness had taken place at an age of approximately 9mo

(Kadim 1988), and 2 rams to be used as sires were set aside for each line each year.

Details of slaughter procedures, the four cuts within each side (shoulder, rack, loin, leg), and dissection methods have been given by Kadim (1988). Measurements of fat and tissue depths (Kirton and Johnson 1979) were made at the time of cutting, and intramuscular fat within the longissimus muscle of the rack cut was determined by extraction with petroleum ether.

Models for statistical analysis included various covariates, a line effect, a year effect, and appropriate interactions. Although significant in some cases, year effects will not be presented here. Interactions were not significant.

RESULTS

Mean carcass weights for rams from the two lines were very similar (Table 1), but they differed considerably in fatness with the percent of carcass dissectible fat and intramuscular fat being 19.8 and 47.8 percent higher, respectively, in the high backfat line (Table 1).

At the same total side fat weight, animals from the high backfat line had more fat in the subcutaneous depot, more intramuscular fat in the longissimus muscle, less

Table 1. Least-squares means for carcass weight and two measures of fatness for rams from high and low backfat lines. Intramuscular fat values are for 24 animals per line.

Item	Backfat selection line		
	High	Low	Effect
Number of animals	36	42	
Carcass weight (kg)	29.5	29.5	
Carcass fat (%)	32.1	26.8	***
Intramuscular fat (%) (longissimus muscle)	7.08	4.79	***

Table 2. Least-squares means within backfat selection lines for weights of various fat depots after adjustment to a constant total side fat (TSF) weight. Coefficients of determination (R^2) and residual standard deviations (RSD) are given for the full model fitted in each case.

Fat depot	Backfat selection line			Covariate	R^2	RSD
	High	Low	Effect			
Subcutaneous (kg)	2.52	2.40	***	TSF***	0.97	0.12
Intermuscular (kg)	1.78	1.91	***	TSF***	0.90	0.12
Intramuscular (g)	26.5	19.0	***	TSF***	0.67	4.3
Omental (g)	1081	1106	ns	TSF***	0.71	175
Kidney plus pelvic (g)	738	749	ns	TSF***	0.53	180

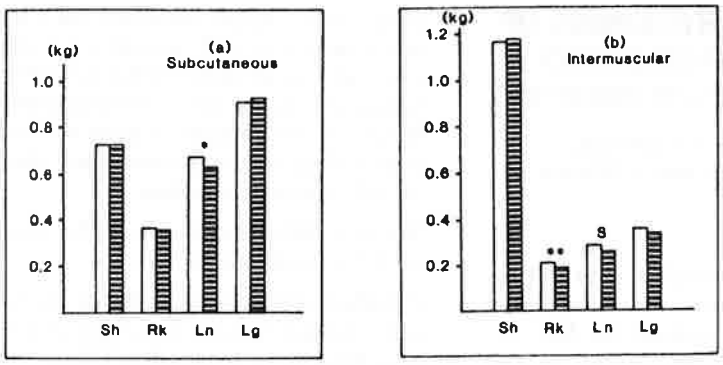

Figure 1. (a) Least-squares means showing the distribution of subcutaneous fat among 4 cuts (Sh=shoulder, Rk=rack, Ln=loin, Lg=leg) after adjustment to a constant total side subcutaneous fat weight. The high and low backfat lines are shown as open and shaded bars respectively. (S=P<0.10)
(b) As for Figure 1(a), but for intermuscular fat.

intermuscular fat, but similar weights of the internal fat depots (Table 2). Total weight of side fat was used as the covariate in preference to total body fat because this was considered to be a more precise measurement. When subcutaneous and intermuscular fat weights were analysed using the allometric equation, line effects remained highly significant (P.001) and allometric growth coefficients were 1.11 (SE = 0.04) and 0.84 (SE = 0.06), respectively.

Differences between the two lines in the ways in which fat was distributed amongst four cuts were small with a slight tendency for a greater proportion of both subcutaneous and intermuscular fat to be in the rack and loin cuts for the high backfat line (Figure 1).

All the fat and tissue depths shown in Figure 2 were significantly higher in the high backfat line, but the proportional size of the line difference was greater for C and L3 than for the other measurements. Fat depth C, taken over the longissimus muscle, corresponds to the fat depth on which selection within these lines of sheep is based, and fat depth L3, which is measured over the gluteus medius muscle, is at a similar distance off the midline but caudal to C. The locations of all other measurements shown in Figure 2 are lateral to C or L3.

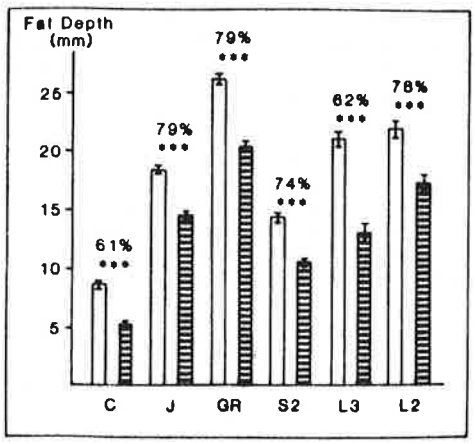

Figure 2. Least-squares means within backfat selection lines for several fat depths and for tissue depth GR. Above each pair of bars is given the value for the low backfat line (shaded bar) as a percentage of the value for the high backfat line (open bar).

DISCUSSION

Evidence for changes in the partitioning and distribution of fat in response to selection for or against fatness is sparse, particularly for comparisons made at a constant level of fatness. Kempster and Evans (1981) reported that dissectable carcass fat of pigs from different breeding companies differed by up to 30g/kg at the same fat depth and carcass weight, but Wood et al (1983) found little evidence for shifts in fat deposition in lines of pigs selected for and against fat depth. Selection of mice for differences in gonadal-fat-pad weight (Sharp et al. 1984) resulted in a bigger change in that characteristic than in total body fat, and sheep selected for differences in backfat depth have been reported to differ more in this characteristic than in other measures of fatness (Fennessy et al. 1982). Such results are consistent with the low to moderate genetic correlations reported between different components of fatness (Wolf et al. 1981), and with the fact that the largest responses in the present results were for fat depths close to that on which selection of live animals was based.

The higher subcutaneous to intermuscular fat ratio at the same total side fat weight for the high backfat rams suggests that they were at a more advanced stage of development, as subcutaneous fat is a later developing depot (Kempster 1980; Butler-Hogg 1984; Butterfield 1988). This in turn implies that they would be smaller at maturity, but the premating live weights of ewes from these lines have not shown such a line effect (Purchas, unpublished data). The higher allometric growth coefficient for subcutaneous fat than for intermuscular fat indicates that the former depot was later-developing in these animals as it is in other sheep (Kempster 1980).

Clear breed differences in patterns of fat partitioning between carcass and non-carcass depots have been reported for sheep, but differences in the relative quantity of subcutaneous and intermuscular depots at the same weight of total side fat, although sometimes present, are generally small (Kempster 1980; Butler-Hogg 1984).

The lower level of intramuscular fat in the longissimus muscle relative to total side fat for the low-line animals is noteworthy because such changes have not always accompanied decreases in fat depth in selection lines of pigs (Bakke and Standal 1975).

CONCLUSION

Selection for changes in fatness in sheep based on weight-adjusted fat depths led to statistically significant effects on fat partitioning, but the absolute differences were not large.

REFERENCES

Bakke, H. and Standal, N. (1975). *Acta Agriculturae Scandinavica* **25**:221.

Butler-Hogg, B.W. (1984). *Animal Production* **39**:405.

Butterfield, R.M. (1988) New Concepts in Sheep Growth. University of Sydney, Sydney.

Fennessy, P.F., Greer, G.J. and Bass, J.J. (1982). *Proceedings of the New Zealand Society of Animal Production* **42**:137.

Kadim, I.T. (1988). A study of the carcass composition and meat quality of Southdown sheep selected for differences in backfat depth. PhD Thesis, Massey University, New Zealand

Kempster, A.J. (1980). *Meat Science* **5**:83.

Kempster, A.J. and Evans, D.G. (1981). *Animal Production* **33**:313.

Kirton, A.H. and Johnson, D.L. (1979). *Proceedings of the New Zealand Society of Animal Production* **39**:194.

Purchas, R.W., Rae, A.L. and Barton, R.A. (1982) *New Zealand Journal of Agricultural Research* **25**:185.

Sharp, G.L., Hill, W.G. and Robertson, A. (1984). *Genetics Research*, Cambridge **43**:75.

Wolf, B.T., Smith, C., King, J.W.B. and Nicholson, D. (1981). *Animal Production* **32**:1.

Wood, J.D., Whelehan, O.P., Ellis, M., Smith, W.C. and Laird, R. (1983). *Animal Production* **36**:389.