Muscle distribution in lamb progeny from several breeds

A.H. KIRTON, D.M. DUGANZICH, G.J.K. MERCER, J.N. CLARKE, J.L. DOBBIE AND J.A. WILSON

AgResearch, Ruakura Agricultural Research Centre, Hamilton, New Zealand.

ABSTRACT

Leg and shoulder composition (fat, muscle and bone) and some linear fat and muscle distribution measurements were taken on 458 lambs produced by 39 strains and breeds of ram born in 1992, 1993 and 1994. Lambs were either Romney or Romney-cross.

Texel-cross lambs had the highest proportion of muscle in the leg and shoulder cuts with the Poll Dorset-cross lambs having a similar amount. Southdowns, American Suffolks and Romney strains had least muscle, and apart from the American Suffolk, also had most fat. The fat selected Southdown-cross had the highest % carcass fat. There was no significant difference between any of the sire groups in the proportion of the major defatted leg primal cuts. All genotypes had a similar leg muscle cut distribution, breed differences being only in the relative proportions of muscle to fat and bone. The Texel-cross had the highest weight (at the same carcass weight) of psoas muscle and the ultrasonically selected Poll Dorset progeny had the highest proportion of measured lean as longissimus muscle.

Keywords: genetic sources; composition; muscle distribution; lambs.

INTRODUCTION

There is increasing interest in the size and distribution of lamb muscle cuts with the potential to add value in some export markets. The overseas discovery of the callipyge gene with its associated muscle hypertrophy (Koohmaraie *et al.*, 1995) has heightened interest in muscle distribution in lambs from genetic material available in NZ. Also, the recent overseas discovery of larger sized longissimus muscles in a Poll Dorset ram possibly from a strain originating in NZ has also increased interest in the possibility of locating such animals in NZ. Results from the first year of this trial (Kirton *et al.*, 1995b) have shown differences in carcass muscle content from Texel and Oxford-cross Romney lambs and straight Romney lambs. The present trial covers three years' lamb crops and was planned to investigate the muscle distribution (muscling) from lambs sired by rams from a range of NZ genetic sources.

MATERIALS AND METHODS

Animals

Measurements were taken on 458 lambs sired by 39 rams representative of several crosses and strains. Muscle distribution was determined by dissection on five Romney strains [Clarke and Hight 12 month liveweight selection lines with their controls (Clarke and Johnson, 1993; Johnson *et al.*, 1995) and a Weaning Weight selection line]. Of these the two control lines and the Weaning Weight selection line comprise the Mixed Romneys as defined in the tables. Lambs from the Wiremu lean lamb selection line and Romney crossbred lambs sired by Texels, American Suffolks, Poll Dorsets, Oxford Downs, Dorset Downs, Southdown fat and lean strains were also dissected. The Poll Dorset sires were selected for their high eye muscle area deviation from a flock with a background of some sheep having on average larger eye muscle measurements. The lambs in this trial were produced over 3 years and in the 3rd year nutritional levels producing two different growth paths were applied.

Carcass measurements

Some carcass measurements [A, B, C (mm)], longissimus muscle cross sectional area (EMA, cm^2), GR (mm), and weights (g) of the biceps femoris, semitendinosus, knuckle (quadriceps femoris), topside with cap, rump, supraspinatus, infraspinatus, as well as the total longissimus and psoas major muscles weights were taken on the right side of each carcass. The leg cuts largely comprised the Meat Board defatted primal leg cuts (Meat Board, 1991). The total weights of subcutaneous fat, other fat (mainly intermuscular), total fat, total muscle and bone weights for the leg and shoulder as well as total longissimus and psoas (mainly major) muscle weights from the loin and rack and elsewhere were recorded as described by Kirton *et al.* (1995b).

Statistical methods

Means presented in tables were obtained using the residual maximum likelihood (REML) procedure in the Genstat 5 statistical package (Genstat, 1994). Birth rank and rearing rank were merged into a factor grouping lambs of single, mixed and multiple ranks. For hot carcass weight, components of the fixed model were sire breed, dam breed, sex, year and nutritional path nested within age group and birth/rearing rank with adjustment by covariance for slaughter age within age group. Components of the random model were sire and where significant, slaughter mob.

All other variates were adjusted to the same hot carcass weight by adding hot carcass weight and its quadratic term as covariates to the fixed model. For composition

variates (collected during dissection) there was a significant dissector effect. This was also included along with time in freezer prior to dissection and its quadratic term. All components of the model were tested for inclusion using the likelihood ratio test.

Because of the range in replication, three average standard errors for differences between sire (strain) breed means are given. The first is for testing any differences between sire groups represented by 2 or 3 sires. The second is for testing any differences between groups represented by 2 or 3 sires and breeds represented by 6 or 8 sires. The third is for testing between breeds represented by 6 or 8 sires. Standard errors for individual differences lie within 75% and 125% of the average standard error of a difference. With these standard errors a critical value from the studentised range is included to allow any pairwise test at the 5% significance level.

RESULTS

Results in Table 1 give numbers of sires represented in the different groups and show there were differences in mean carcass weights between the breeds represented in the trial. Sire breeds/strains are listed ranked from those with highest proportion of leg muscle (Texel) to those with the lowest percentage of leg muscle (Hight Romney). Although overall differences are statistically significant, most weight must be given to groups with larger sire numbers with the remaining groups being only tentatively ranked at this stage. When adjusted by covariance to the same carcass weights, there were differences between breeds and strains in distribution of lean, bone and fat depots in both the leg and the shoulder. The results have shown that the Texel and Poll Dorset-cross lambs from rams selected for longissimus muscle area, closely followed by the Oxford, had a higher proportion of leg and shoulder muscle and a lower proportion of fat compared to the Southdown crosses, American Suffolk crosses and Mixed and Hight Romney strains. The Southdown fat selected line progeny had more leg and shoulder fat as expected (Kadim *et al.,* 1989), but did not differ greatly from the Southdown lean progeny, probably reflecting the minimal number of sires from these two lines dissected to date which masked the expected differences. The Southdown-cross progeny had the lowest percentages of leg and shoulder bone.

The means of the main groups of defatted primal muscle cuts from the leg (Meat Board, 1991) expressed as a proportion of total leg muscle weight for the different breeds are given in Table 2. None of the breed differences in proportions of these individual muscle cuts were significant. This tends to indicate little evidence for changes in carcass leg muscle distribution between the breeds studied in contrast to the overall increase in proportions of leg muscle shown for some breeds in Table 1. Differences would have been expected if the progeny of any of the breeds had shown double muscling tendencies. However, the total longissimus muscle expressed as a percentage of the total leg and shoulder muscle plus longissimus and psoas muscle from the loin and rack did differ significantly ($p < 0.05$) with the largest difference between the longissimus-area-selected Poll Dorset crosses and the Texel-cross lambs. The psoas (tenderloin) muscle remained a relatively constant proportion of the total muscle removed and weighed. Previous work has shown that the muscle weighed in this trial comprised around 75% of total side muscle.

TABLE 1: Differences between Romney and crossbred lambs from several breeds and selection lines. Means for muscle, fat and bone characteristics when compared at the same hot carcass weight (19.5kg).

Sire Breed	Group	No. Sires	No. Progeny	Hot Carcass wt	Leg composition (%) muscle	fat	bone	Shoulder composition (%) muscle	fat	bone
Texel	2	8	82	19.2	66.5	16.4	12.6	60.8	20.7	13.1
Poll Dorset[a]	1	2	25	19.1	66.3	16.7	12.9	60.8	20.0	13.6
Oxford Down	2	6	55	19.4	65.5	16.7	13.5	59.5	20.8	14.2
Dorset Down	1	3	32	22.2	64.6	18.2	13.0	59.0	21.7	13.9
Clarke Romney	1	2	19	17.8	64.5	17.9	13.3	58.6	21.6	14.0
Wiremu	1	2	28	19.2	64.0	18.9	13.0	58.3	22.3	14.0
Southdown fat	1	2	32	19.2	63.7	20.8	11.3	57.6	25.0	12.0
Americ. Suffolk	1	2	12	19.3	63.7	18.7	13.7	58.4	22.0	14.3
Southdown lean	1	2	29	20.3	63.5	20.2	12.3	57.4	24.4	12.6
Mixed Romney[b]	2	6	52	17.5	63.3	20.1	12.6	57.2	24.9	12.9
Hight Romney	2	6	52	17.5	63.1	19.9	12.9	56.8	24.1	13.5
Sed[c] - within group 1				1.15	1.5	1.4	0.40	1.2	1.3	0.49
- between groups 1 & 2				0.99	1.3	1.2	0.34	1.0	1.1	0.41
- within group 2				0.77	1.0	0.9	0.27	0.8	0.9	0.32
Critical value (5%)				3.54	3.53	3.53	3.54	3.54	3.55	3.57
Significant breed effects[d]				**	*	**	***	**	**	**

[a] selected ultrasonically for large crossectional area of longissimus muscle

[b] from a weaning weight selection line plus two control sires

[c] group 1 being those breeds represented by 2 or 3 sires, group 2 being the rest

[d] *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

When compared at the same carcass weight (Table 3) sire breed and strain had a large effect on longissimus depth (B) and area (EMA) but none on longissimus width (A) when these measurements were made immediately posterior to the last thoracic vertebrae. Poll Dorset rams ultrasonically selected for large EMA over the 12th rib produced progeny that had the largest B and EMA dimensions while the width A neared the top end of a non

TABLE 2: Differences between Romney and crossbred lambs from several breeds and selection lines. Means for muscle groups as a % of leg muscle weight and longissimus and psoas as a % of the meat in the leg & shoulder plus longissimus and psoas from the loin and rack combined when compared at the same hot carcass weight (19.5kg).

			Major leg muscles (%)					Back muscles (%)	
Sire Breed	Group	No. Sires	Biceps femoris	Semitend-inosus	Quad-riceps	Topside & Cap	Rump	Long-issimus	Psoas
Texel	2	8	13.4	5.09	18.7	23.2	17.0	12.2	3.53
Poll Dorset[a]	1	2	13.4	5.06	18.8	23.4	17.1	13.7	3.35
Oxford Down	2	6	13.5	5.01	18.5	22.8	17.3	12.5	3.49
Dorset Down	1	3	13.5	4.96	18.8	22.7	16.9	13.0	3.36
Clarke Romney	1	2	13.4	4.74	19.1	22.9	17.2	13.7	3.52
Wiremu	1	2	13.2	4.77	19.0	23.1	17.4	13.0	3.38
Southdown fat	1	2	13.5	5.12	18.4	23.5	17.3	13.5	3.39
Americ. Suffolk	1	2	13.7	5.59	18.9	22.9	17.0	12.9	3.44
Southdown lean	1	2	13.2	5.12	18.2	23.3	17.2	13.3	3.39
Mixed Romney[b]	2	6	13.1	4.84	18.9	23.1	17.3	13.0	3.39
Hight Romney	2	6	13.0	4.91	19.3	23.1	17.4	12.6	3.44
Sed[c] - within group 1			0.35	0.19	0.38	0.44	0.40	0.38	0.097
- between groups 1 & 2			0.30	0.17	0.33	0.37	0.34	0.34	0.086
- within group 2			0.23	0.13	0.25	0.29	0.26	0.30	0.074
Critical value (5%)			3.53	3.53	3.54	3.57	3.57	3.67	3.68
Significant breed effects[d]			ns	ns	ns	ns	ns	*	ns

[a] selected ultrasonically for large crossectional area of longissimus muscle

[b] from a weaning weight selection line plus two control sires

[c] group 1 being those breeds represented by 2 or 3 sires, group 2 being the rest

[d] ns: $p>0.05$; *: $p<0.05$

TABLE 3: Differences between Romney and crossbred lambs from several breeds and selection lines. Means for dimensions of the longissimus, fat cover over the longissimus and weight of the longissimus and psoas when compared at the same hot carcass weight (19.5kg).

Sire Breed	Group	No. Sires	GR (mm)	A (mm)	B (mm)	C (mm)	Long.[a] area (cm^2)	Long. weight (g)	Psoas weight (g)
Texel	2	8	8.8	55.1	31.0	2.7	12.8	498	141
Poll Dorset[b]	1	2	8.7	55.2	35.2	2.4	14.4	562	134
Oxford Down	2	6	9.2	54.2	30.1	2.9	12.3	494	135
Dorset Down	1	3	10.7	53.7	30.8	2.3	12.2	511	131
Clarke Romney	1	2	7.4	53.0	32.0	2.7	13.1	537	136
Wiremu	1	2	8.9	52.3	31.6	3.0	12.6	517	129
Southdown fat	1	2	12.7	54.0	32.3	4.3	13.4	521	127
Americ. Suffolk	1	2	9.2	55.9	30.3	2.9	12.5	499	130
Southdown lean	1	2	11.3	52.0	31.4	3.0	12.6	513	127
Mixed Romney[c]	2	6	8.6	50.9	31.0	3.3	12.2	494	125
Hight Romney	2	6	8.9	53.5	30.8	3.4	12.3	484	128
Sed[d] - within group 1			1.36	1.6	0.9	0.53	0.56	22	5.2
- between groups 1 & 2			1.17	1.4	0.8	0.46	0.49	19	4.5
- within group 2			0.90	1.1	0.6	0.35	0.38	15	3.6
Critical value (5%)			3.54	3.53	3.55	3.54	3.54	3.54	3.55
Significant breed effects[e]			ns	ns	**	*	*	ns	**

[a] longissimus muscle

[b] selected ultrasonically for large crossectional area of longissimus muscle

[c] from a weaning weight selection line plus two control sires

[d] group 1 being those breeds represented by 2 or 3 sires, group 2 being the rest

[e] ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$

significant range. The Southdown fat strain had the next highest measurements for B and EMA. Southdown-cross lambs have been previously shown to excel in EMA compared with lambs produced by most of the other breeds available in NZ (Kirton *et al.*, 1995a). Fat depth measurement C tended to follow leg and shoulder fat percentages reported earlier, being highest for the Southdown fat progeny and lowest in a group of breeds. The weights of the longissimus and psoas muscles from the breeds/strains represented in the present trial at the same carcass weight were given to compare with the results of Koohmaraie *et al.* (1995) who used this method of expression to report results from callipyge and normal genotype lambs. Whereas he found a 32% increase in longissimus weight relative to carcass weight from callipyge compared with non-callipyge lambs of the same breed, the largest difference found on this basis was 16% between the Poll Dorset-cross and Hight Romney lambs ($p > 0.10$) in the present trial. The leaner breeds did not appear to be disadvantaged by high GR measurements as is sometimes claimed with only the Dorset Down-cross showing up as slightly higher than expected. Otherwise, only the small sample of Southdown-cross lambs had higher GR values.

However, the psoas muscle was 13% larger in the Texel-cross than in the lambs from the Mixed Romney group ($p < 0.01$) whereas Koohmaraie *et al.* (1995) found a 20% difference on this same basis for their callipyge and normal lambs.

The results from this trial show that despite breed differences in the proportion of muscle found in the carcasses from the different breeds and strains studied, there was little evidence for differences between breed groups in muscle distribution when related to the total weight of dissected muscle in the cuts they came from or total dissected muscle in the case of the longissimus or psoas. The ultrasonically selected Poll Dorsets gave indications that the selection for longissimus area was having an effect on the size of the longissimus muscle. Despite the excessive fat found in the positive fat selection of the fat Southdown line, the longissimus muscle formed a high proportion of total muscle, ranking this strain in the top group of breeds in this regard. While offering indications for breeding directions for improving the red meat content of NZ lambs, the results indicate that to date we have not identified sheep with the callipyge type genetic makeup.

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