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A comparison of the carcass and meat quality of Awassi-cross and Texel-cross ram lambs

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ABSTRACT

The Awassi is a fat-tailed sheep breed from the Middle East that has recently been imported into New Zealand for live-sheep export and for milk production. The aim of the current trial was to compare the carcass and meat quality of Awassi-cross and Texel-cross ram lambs. There were 36 lambs in each sire-breed group with an equal number from Romney and Poll Dorset ewes. Lambs were allocated at random within breed-cross groups to groups of 9 that were slaughtered in either May or August to give an overall mean carcass weight of 19.7kg.

The Awassi-sired group had a lower dressing-out percent (44.4 vs 44.8; $P<0.01$), similar GR tissue depths (7.6 vs 8.4 mm) but more weight-adjusted leg fat (537 vs 446g. $P<0.001$). The most clear-cut difference was in carcass shape with Awassi-cross lambs having longer carcasses (1068 vs 1013 mm), longer legs, and longer, heavier leg bones at a constant carcass weight (all $P<0.001$). The shape difference at a common carcass weight was also reflected in the Awassi-cross lambs having lower leg muscle to bone ratios (3.49 vs 3.88), muscle weight (2047 vs 2172 g), and muscularity values (0.436 vs 0.488) than the Texel-cross lambs, and shallower *longissimus* muscle depths (28.0 vs 29.8 mm)(all $P<0.01$). Differences between Awassi and Texel-sired lambs in tenderness (shear values) and colour (L*, a*, b* values) of the *semimembranosus* muscle were not significant.

Differences between dam-breed groups were generally small, although, relative to the Poll Dorset, the Romney-cross group had lower weight-adjusted *longissimus* depths (28.2 vs 29.6 mm) and leg muscle to bone ratios (3.57 vs 3.80)(both $P<0.01$). When adjusted to the same carcass weight, lambs slaughtered in August had lower dressing-out percentages (42.6 vs 46.6), lower GR depths (6.7 vs 9.3 mm), longer carcasses (1063 vs 1018 mm), and poorer leg muscularity (0.450 vs 0.474) than those slaughtered in May (all $P<0.02$).

In this study Awassi-cross carcasses were inferior to those of Texel-cross lambs in terms of composition and shape, but differences in meat quality were not apparent.

Keywords: Awassi; Texel; Poll Dorset; Romney; carcass characteristics; meat quality; muscularity.

INTRODUCTION

The fat-tailed Awassi sheep breed, which is the most numerous and widespread type of sheep in South West Asia (Epstein, 1985), is primarily a meat sheep, although a strain has been developed in Israel for milk production (Fisher and Gooden, 1986). The improved Israeli dairy type of Awassi has been imported into New Zealand mainly for milk production, but in addition the male offspring may be exported to the Middle-East where local consumers prefer a lean, fat-tailed sheep compared to the type of animal currently being shipped there (Fisher and Gooden, 1986). There are no published comparisons between carcass and meat quality of Awassi-cross sheep and other breeds or crosses raised under New Zealand conditions. The Texel is a recognised terminal sire breed with the ability to produce lean, heavy carcasses (Wolf *et al.*, 1980; Kempster *et al.*, 1987; Clarke and Kirton, 1990), with large eye muscle areas (EMA) and small GR tissue depths (Clarke *et al.*, 1988; Clarke and Kirton, 1990).

The object of this study was to compare the carcass and meat quality of Awassi-cross with Texel-cross ram lambs in order to evaluate the suitability of the Awassi breed for meat production.

MATERIALS AND METHODS

Experimental design

The experiment involved 72 October-born ram lambs in a 2 x 2 x 2 factorial design with two sire breeds (Texel and Awassi), two dam breeds (Romney and Poll Dorset) and two slaughter dates (May and August). Two slaughter dates were used to ensure that the range of carcass weights within each breed group showed sufficient overlap to permit adjustments to a common carcass weight.

On the days prior to slaughter (12 May and 5 August), lambs were weighed directly off pasture in mid-morning with this liveweight being used in the calculation of dressing-out percentage.

Following slaughter, tails were collected for subsequent weighing and the length of the carcass was measured on both sides (LB of Moxham and Brownlie, 1976). Within two hours of slaughter a supervising grader of the New Zealand Meat Producers Board made GR measurements on both sides of the carcass and a visual muscularity assessment using the EUROP scale (E representing the greatest degree of muscularity and P the least; Kempster *et al.*, 1982). As carcasses went through the cutting room on the day following slaughter, the right hind leg (removed

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by a cut between the last and second to last lumbar vertebrae) was collected for dissection and the loin was collected temporarily for measurement of the depth (B) and width (A) of the *longissimus* muscle and the fat depth above the *longissimus* muscle (C) at the last rib (Palsson, 1939).

Legs were frozen for 1 to 28 days at -20°C and were thawed at room temperature for 23-28 hours before dissection. Leg length was measured from the cranial end of the exposed cut on the pelvic bone to the distal tip of the tarsal bones. All pelvic fat and the loose flap was removed before weighing so that legs were uniform at the beginning of dissection. Legs were then weighed and dissected into subcutaneous fat, intermuscular fat, muscle, and bone. Five muscles surrounding the femur, the *semitendinosus*, *semimembranosus*, *adductor femoris*, *biceps femoris* and the *quadriceps femoris*, were weighed individually. The weight, length and minimum circumference of the tibia and femur were recorded.

Muscle to bone ratios were calculated as total leg muscle weight divided by total bone weight, and as weight of the five muscles around the femur divided by femur weight. Muscularity (MUSC) was calculated as proposed by Purchas *et al.*(1991) as the square root of the weight of the five muscles around the femur divided by the femur length (cm) all divided by femur length (cm).

ie. MUSC = √[(5 muscle weight) / (Femur length in cm)] / (Femur length in cm)

The *semimembranosus* muscle from the second slaughter group only was assessed for tenderness and colour. Tenderness of 25 mm-thick cooked (90 minutes at 70°C) steaks was measured using a Warner-Bratzler (WB) shear machine (Purchas and Aungsupakorn,1993). Values were obtained for the peak force (PF), the mean force (mean; described as the "Work Index" by Purchas and Aungsupakorn, 1993), and the initial yield force (IY). Colour was measured on slices exposed to the atmosphere for 90 minutes at 0-3°C by reflectance spectrophotometry using a Minolta chromameter (Warner, 1989) to obtain L*, a* and b* values.

Statistical analysis

Data were analysed as a 2 x 2 x 2 factorial using a general linear model in the SAS computer program (SAS Institute Inc. 1987) with carcass weight as a covariate for measures of composition. Two-way interactions amongst the main effects and between the main effects and the covariate were tested. For the meat quality data, a 2 x 2 factorial design was used as data were available for only the August slaughter group.

RESULTS

Growth rate

Texel-cross lambs grew faster than Awassi-cross lambs after May, and lambs from Poll Dorset ewes grew faster than those from Romney ewes over this period, but there were no differences between the sire and dam groups between weaning and May (Table 1).

TABLE 1: Mean average daily gain (ADG) of lambs from weaning to the first slaughter date (ADG-1) and between the first and second slaughter dates (ADG-2).

	Sire Breed[a]			Dam Breed[b]			
	Aw	Tex	Sig[c]	Rom	PD	Sig[c]	RSD[d]
ADG-1(g)	124	135	ns	139	128	ns	23
ADG-2(g)	108	157	***	120	145	*	35

[a] Aw = Awassi, Tex = Texel
[b] Rom = Romney, PD = Poll Dorset
[c] *** = P< 0.001, ** = P< 0.01, * = P<0.05, ns = P> 0.05
[d] RSD = Residual standard deviation

Carcass Measurements

Results for carcass weight and carcass measurements adjusted to a common carcass weight are shown in Table 2.

The significant interaction between sire breed and slaughter date for dressing-out percent arose from the fact that mean values were 6.8% greater for Texel-cross lambs in the May slaughter group and 1.3% greater for Awassi-cross lambs in the August slaughter group. Lambs slaughtered in May had a considerably higher dressing-out percent than the August group (P<0.001), and lambs from Poll Dorset ewes had higher dressing-out percentages than those from Romney ewes.

Awassi-cross lamb carcasses were appreciably longer than those of Texel-cross lambs and lambs out of Poll Dorset ewes were slightly shorter than those out of Romney ewes. After adjusting to a constant carcass weight, carcasses of the lambs slaughtered in August were longer than those slaugh-

TABLE 2: Least-squares means for carcass weight (CW) and other carcass measurements adjusted to a constant carcass weight. The carcass weight was significant as a covariate for all measurements (P<0.001).

	Sire Breed[a]			Dam Breed[b]			Slaughter Date[e]			
	Aw	Tex	Sig[c]	Rom	PD	Sig[c]	May	Aug	Sig[c]	RSD[d]
CW (kg)	18.08	21.35	***	19.33	20.1	*	17.31	22.12	***	1.64
Dress %	44.4	44.8	f	44.3	44.9	**	46.6	42.6	f	1.5
Length (mm)	1068	1013	***	1044	1037	*	1018	1063	***	19
Tail wt (g)	367	131	***	264	234	*	255	233	ns	61
GR (mm)	7.6	8.4	ns	8.0	8.0	ns	9.3	6.7	*	2.4
C (mm)	2.9	2.7	f	3.1	2.6	*	3.6	2.3	f	1.0
A (mm)	58.6	59.7	f	58.9	59.4	ns	58.6	59.8	f	2.5
B (mm)	28.0	29.8	**	28.2	29.6	**	29.0	28.8	ns	2.2

a, b, c, d, See footnotes to Table 1.
e = Slaughter lot, May and August
f = Sire x slaughter group interactions were significant (P<0.01). The nature of these interactions is described in the text.

TABLE 3: Least-squares means for leg composition characteristics adjusted to a constant carcass weight by covariance. The carcass weight effect was significant for all measurements (P<0.05).

	Sire Breed[a]			Dam Breed[b]			Slaughter Date[c]			
	Aw	Tex	Sig[c]	Rom	PD	Sig[c]	May	Aug	Sig[c]	RSD[d]
Muscle (g)	2047	2172	***	2070	2150	**	2072	2148	ns	105
Fat (g)	537	446	***	512	470	**	517	465	*	64
Bone (g)	603	559	***	590	573	**	546	617	***	42
Leg length (mm)	410	384	***	400	395	*	390	405	**	14
Femur measurements:										
-weight (g)	170	157	***	166	162	*	154	174	***	11.7
-length (mm)	182	173	***	178	177	ns	173	182	***	5.6
-circumference (mm)	67.9	67.9	ns	69.5	66.2	***	66.8	69.0	ns	3.4
M:B[f]	6.94	7.92	***	7.16	7.70	***	7.76	7.10	*	0.55
MUSC[f]	0.436	0.488	***	0.455	0.468	*	0.474	0.450	*	0.023

a,b,c,d,e See footnotes to Tables 1 and 2.

[f] Based on the weights of 5 muscles around the femur and femur weight (M:B) or femur length (MUSC).

tered in May. Tails of the Awassi-cross lambs were more than 2.5 times heavier than those of Texel-cross lambs and were slightly heavier for lambs from Romney ewes than Poll Dorset ewes.

Awassi-cross lambs had similar GR measurements to Texel-cross lambs, and lambs slaughtered in August had a lower GR measurement than those slaughtered in May. Fat depth C for the May slaughter date was 34.3% higher for Awassi-cross lambs, but for the August date Texel cross lambs had C values 21.5% greater.

The interaction between sire breed and slaughter date for eye muscle width (A) was due to the Texel-cross lambs having mean values that were 5.6% greater in the May slaughter group but only 1.7% greater in the August slaughter group. Depth of the eye muscle (B) was greater for Texel-cross lambs, and was greater for lambs out of Poll Dorset ewes, but did not differ between slaughter groups.

Leg Dissection

Results obtained from dissection of the leg cut (Table 3) show that at the same carcass weight Awassi-cross lambs had longer and heavier femur bones than Texel-cross lambs and also more total leg bone and fat. Texel-cross lambs had more muscle than Awassi-cross lambs and higher muscle to bone ratios (M:B) based on the weights of five muscles relative to femur weight. Leg muscularity (MUSC) was also higher for the Texel-cross lambs as was M:B ratio based on total leg muscle and bone (Figure 1).

Sire breed differences in subjective assessments of muscularity (Figure 2) paralleled differences in the objective measurement (Table 3).

Lambs out of Poll Dorset ewes had more leg muscle and less leg bone than lambs from Romney ewes and as a consequence had a higher M:B ratio and higher MUSC values. The smaller difference in MUSC was because femur length differed slightly less than femur weight. Lambs had longer and heavier leg bones at the August slaughter date than in May (Table 3), which led to higher M:B ratios and higher MUSC values for lambs in May than in August.

FIGURE 1: Leg Muscle to bone ratios of Awassi-cross and Texel-cross lambs at May (open symbols) and August (closed symbols) based on total leg muscle and bone. Linear regression lines within slaughter dates are shown with 99% confidence limits. These are unadjusted regression lines rather than being derived from the general-least squares factorial analysis. The slopes of the regression lines are made greater by the fact that the Texel-cross lambs had higher M:B ratios and were also heavier within slaughter dates.

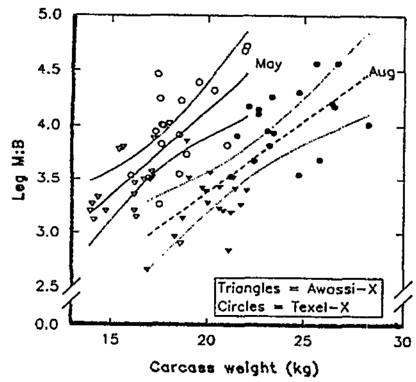
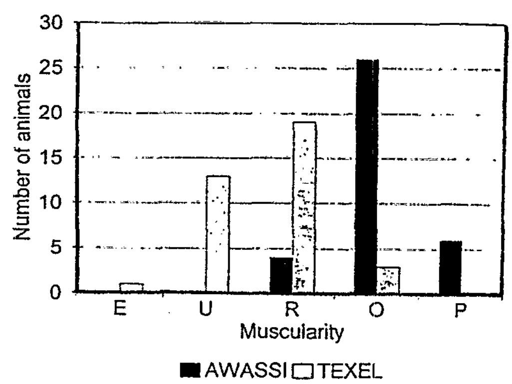


FIGURE 2: Frequency of subjective muscularity scores on the EUROP scale (E = highest muscularity) for Awassi-cross and Texel-cross lambs.



Meat Quality

There was little difference in meat quality between the breeds (Table 4). Colour of the meat from the Texel-cross lambs had a slightly greater degree of yellowness than that of

Awassi-cross lambs, but differences for all other measurements were non-significant.

TABLE 4: Least-squares means for measurements of meat tenderness and colour made on M. *semimembranosus*

	Sire Breed[a]			Dam Breed[b]			
	Aw	Tex	Sig[c]	Rom	PD	Sig[c]	RSD[d]
Warner-Braztler parameters							
MF (Work Index)	3.46	3.63	ns	3.56	3.52	ns	0.72
IY (kg)	8.69	9.03	ns	9.15	8.57	ns	2.61
PF (kg)	11.48	11.84	ns	11.99	11.33	ns	2.99
Meat Colour:							
L* (lightness)	34.36	35.46	ns	34.82	35.0	ns	1.15
a* (redness)	20.70	21.61	ns	21.73	20.59	ns	1.70
b* (yellowness)	8.94	9.76	*	9.53	9.18	ns	1.10
Cooking loss (%)	35.56	35.38	ns	35.81	35.13	ns	1.27

a,b,c,d See footnotes to Table 1.

DISCUSSION

The trend in growth rates was for Texel-cross lambs to grow faster than Awassi-cross lambs though the difference was significant only between the first and second slaughter dates. Knight *et al.* (1994) also found that growth rates for Awassi-cross lambs were lower than Texel-cross lambs. Lambs in this trial were a subset of the 214 ram lambs used in the trial of Knight *et al.* (1994).

There was little effect of the dam breed on the growth rates as shown by Knight *et al.* (1994) though the lambs from the Poll Dorset ewes did grow marginally faster from May.

The description by Epstein, (1985) of the Awassi as being a large, long lean animal was borne out in the current results which showed the Awassi-cross group to have longer carcasses and leg bones. While it may appear inconsistent that Awassi-cross lambs had more leg fat but similar fat depths, this finding concurs somewhat with Clarke and Kirton, (1990) who found that Texels were leaner subcutaneously than would be expected from their GR measurements. Deaker and Young, (1992) reported another example of a breed effect on subcutaneous fat distribution.

Greater depth of the *longissimus* muscle (B), higher muscularity values, shorter, lighter leg bones, and more muscle in Texel-cross lambs is consistent with the results of several studies showing the Texel to excel in these characteristics (More O'Ferral and Timon, 1977; Wolf *et al.*, 1980; Clarke *et al.*, 1988; Kempster *et al.*, 1987; Clarke and Kirton, 1990).

Sire breed differences in the subjective assessment of muscularity using the EUROP scale closely resembled differences based on objective assessments in terms of the depth of muscles surrounding the femur relative to the femur length. This concurs with the results of Abdullah *et al.* (1993) who also found a close relationship between subjective and objective measures of muscularity.

Differences between dam breeds were small, but they generally agreed with those of Geenty *et al.* (1979) indicating advantages of the Poll Dorset over the Romney with regard to carcass weight, dressing out percent, carcass length, and B and C measurements. As well, the results of this study showed the Poll Dorset to have a higher leg muscle to bone ratio and muscularity than the Romney, pointing to the Poll Dorset as a superior meat breed (More O'Ferral and Timon, 1977; Clarke and Kirton, 1990).

Lambs slaughtered in May had higher dressing percentages, shorter carcasses, more fat, higher leg muscle to bone ratios and higher muscularity than lambs slaughtered in August after adjustment for carcass weight. It would appear from these results that between May and August, bone grew at a relatively faster rate than muscle or fat. Other studies have shown that over the 10-15 month stage of growth, lambs may increase in carcass weight without an increase in the proportion of fat (Rattray *et al.*, 1976; Kirton *et al.*, 1982). Bray *et al.* (1990) also found that GR measurements of lambs increased at 1mm per month from February 2 to May 25, suggesting they were accumulating a fat store ready for winter, and Purchas *et al.* (1981) reported that lambs at the same weight had lower fat depths at the end of winter than before winter. Fennessy *et al.* (1992) also found significant slaughter date effects on compositional variables adjusted for carcass weight and suggested that there are environmental effects which are uncontrollable with animals at pasture (eg. parasites, temperature) which can affect carcass composition.

CONCLUSION

In terms of carcass composition and shape characteristics, Awassi-cross lambs appear less suitable for meat production than Texel-cross lambs, but differences between these sire breeds for meat tenderness and meat colour are neglible.

Though Poll Dorsets appear to have superior meat characteristics to Romneys, the differences between dam breeds were relatively small compared to those between sire breeds.

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REFERENCES

Abdullah, A.Y.; Purchas, R.W.; Davies, A.S.; Kirton, A.H. 1993. Relationships between objective and subjective measurements of carcass muscularity. *Proceedings of the New Zealand Society of Animal Production* **53:** 397-402.

Bray, A.R.; Moss, R.A.; Burton, R.N.; Saville, D.J. 1990. Postweaning growth and carcass leanness of lambs that differed in preweaning growth rate. *Proceedings of the New Zealand Society of Animal Production* **50:** 287-291.

Clarke, J.N.; Kirton, A.H. 1990. How good are Texels? *Proceedings of the Ruakura farmers' conferenc :* 163-172.

Clarke, J.N.; Parrat, A.C.; Malthus, I.C.; Amyes, N.C.; Uljee, A.E.; Woods, E.G. 1988. Carcass composition of exotic sheep breeds. *Proceedings of the New Zealand Society of Animal Production* **48:** 53-56.

Deaker, J.M. Young, M.J. 1992. Subcutaneous fat distribution as assessed by ultrasound in Border leicester and Dorset Down ewe hoggets. *Proceedings of the New Zealand Society of Animal Production* **52:** 45-47.

Epstein, H. 1985. The Awassi sheep with special reference to the improved dairy type. F.A.O. *Animal Production and Health paper* **57.**

Fennessy, P.F.; Bain, W.E.; Greer, G.J.; Johnstone, P.D. 1992. Carcass characteristics of progeny from ram lambs selected for high or low ultrasonic backfat thickness. *New Zealand journal of agricultural research* **35:** 177-183.

Fisher, B.S; Gooden, J.M. 1986. An economic and technical assessment of the establishment of an Australian fat-tail sheep industry. Research report number 10, Department of Agricultural Economics, University of Sydney, New South Wales, Australia.

Geenty, K.G.; Clarke, J.N.; Jury, K.E. 1979. Carcass growth and development of Romney, Corriedale, Dorset, and crossbred sheep. *New Zealand journal of agricultural research* **22:** 23-32.

Kempster, A.J.; Croston, D.; Jones, D.W. 1987. Tissue growth and development in crossbred lambs sired by 10 breeds. *Livestock production science* **16:** 145-162.

Kempster, A.J.; Cuthbertson, A.; Harrington. G.; 1982. Carcass evaluation. *In:* livestock breeding, production and marketing. London, Granada.

Kirton. A.H.; Dalton, D.C.; Ackerly, L.R.; Woods, E.G. 1982. Performance of sheep on New Zealand hill country III. Growth and composition of wethers born in three further years and slaughtered at three ages. *New Zealand journal of agricultural research* **25:** 1-3.

Knight, T.W.; Thomson, N.A.; Power, M.T.; Gallen, J. 1994. Growth rates, wool production and health of Awassi and Texel crossbred ram lambs. *Proceedings of the New Zealand Society of Animal Production* **54:** 247-250.

More O'Ferral, G.J.; Timon, V.M. 1977. A comparison of eight sire breeds for lamb production. *Irish journal of agricultural research* **16:** 277-284.

Moxham, R.W.; Brownlie, L.E. 1976. Sheep carcass grading and classification in Australia. *Wool technology and sheep breeding* **23 (2):** 17-25.

Palsson, H. 1939. Meat qualities in the sheep with special reference to Scottish breeds and their crosses. *Journal of agricultural science, Cambridge* **29:** 544-626.

Purchas, R.W.; Aungsupakorn, R. 1993. Further investigations into the relationship between ultimate pH and tenderness for beef samples from bulls and steers. *Meat science* **34:** 163-178.

Purchas, R.W.; Davies, A.B.; Abdullah, A.Y. 1991. An objective measure of muscularity: changes with animal growth and differences between genetic lines of Southdown sheep. *Meat science* **30:** 81-94.

Purchas, R.W.; Rae, A.L.; Barton, R.A. 1981. The repeatability of ultrasonic fat-depth measurements made on sheep up to 18 months of age. *Proceedings of the New Zealand Society of Animal Production* **41:** 133-139.

Rattray, P.V.; Joyce. J.P.; Drew, K.R.; Moss, R.A.; Beetham, M.R. 1976. Production of heavy-weight lambs. *Proceedings of the Ruakura farmers' conference:* 27-33.

SAS Institute Inc. 1987. SAS user's guide. Statistics, version 6 edition. SAS Institute Inc., Cary, NC. USA.

Warner, R.D. 1989. Objective description of meat and fat colour in beef carcasses. Pp. 145-154. *In:* The automated measurement of beef. Ed: Brownlie, L.E.; Hall, W.J.A.; Fabiansson, S.U. Sydney, AMLC.

Wolf, B.T.; Smith, C.; Sales, D.I. 1980. Growth and carcass composition in the crossbred progeny of six terminal sire breeds of sheep. *Animal production* **31:** 307-313.