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carcass characteristics of lambs of different breeding and sex

AGRICULTURAL EXPERIMENT STATION
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summary

Two hundred and nine market lambs representing 5 breeds and 3 crosses were compared using linear live animal and carcass measurements and scores, carcass cutout, physical separation (lean, fat and bone) and organoleptic tests. Carcasses of the blackface breeds and crosses excelled in conformation and quality grades. Suffolk and Suffolk-cross lambs had significantly larger loin eye area and more pounds of lean. Panama lambs had higher consumer scores for palatability. The whiteface breeds generally had less subcutaneous fat but more internal carcass fat. No significant breed differences were found for aroma and flavor of the loin chop nor were sex differences important in the comparison made of Panama x Targhee wether and ram lambs. When expressing carcass composition on an absolute (weight) basis age-regression coefficients had negative values with lean and bone, and positive coefficients with measurements of fat.

About this research

This study was supported in part by the Idaho Agricultural Experiment Station and partly by Western Regional Project W-61, "Development of selection criteria for the genetic improvement of carcass merit in sheep."

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Early studies comparing carcasses of different breeds of sheep emphasized dressing percentage and overall carcass grade since these were the criteria determining market price. In recent years, more attention has been given to the yield of lean cuts or "yield grade" as a factor in price determination. Sheepmen and research scientists are looking for breeds or breed crosses that will best produce desirable, high-yielding carcasses.

Rambouillet lambs have been found to have longer bodies, longer bones, and deeper chests than either Columbia, Hampshire or Suffolk-whiteface crossbred lambs (Knight and Foote, 1965). Hampshire and Suffolk lambs were wider through the chest, loin and hips than Rambouillets, while blackface crosses and Columbia lambs were intermediate in these characteristics.

Bell et al. (1967) also found Rambouillet lambs were narrower and more upstanding, with lower carcass conformation, condition and overall grade scores than Panama, Targhee or crossbred lambs from these breeds. Rambouillet lamb carcasses had a higher percentage of lean and a lower percentage of fat than carcasses of Panama, Targhee, or Panama x Targhee crossbred lambs. Panama and Panama x Targhee crosses were more heavily muscled than Rambouillet lambs, but these differences were small when expressed as a ratio of carcass weight. Rambouillet lambs had the highest ratio of bone to carcass weight. Targhee lambs had smaller loin eyes than lambs from the other breeds and their crosses.

As wool breeding changes from coarse to fine the percent of lean cuts increases and the relative degree of fatness decreases (Cramer, 1970). Furthermore, lambs from fine wool breeding (Rambouillet) tend to have heavier kidney knobs, more fat trim and smaller loin eyes than lambs from half-blood (Targhee) and quarter-blood (Indian) breeding (Ray and Mandigo, 1966; Ray, 1972). Hampshire and Dorset sired lambs tend to fatten faster than Rambouillet, Suffolk or Columbia sired lambs (Shelton and Carpenter, 1970).

Suffolk x Columbia lambs slaughtered at heavy weights (135 lbs.) have been shown to be superior to Columbia lambs in cutability and most carcass characteristics (Botkin, 1972). However, Suffolk x Columbia crossbred lambs tend to be fatter but less tender than Columbia lambs (Galgon, 1972).

Most studies have shown little difference in desirability of meat from different breeds of sheep (Fox, 1964; Light, Johnson and Faller, 1970). However, Gates (1964) found that Suffolk x Panama lambs were more tender than either Panama or Suffolk lambs.

Numerous researchers have reported sex differences in carcass characteristics. Knight and Foote (1965) found only small differences between ewe and wether lambs in loin eye size, cutout proportions and carcass component percentages. Oliver (1967) and Carpenter (1969) found ewe lamb carcasses were fatter and less muscular than ram or wether lamb carcasses. Cunningham (1967) reported wethers were wider through the shoulders than ewe lambs.

The Idaho Experiment Station, as a contributor to Western Regional Research Project W-61, was interested in examining carcass differences between breeds and breed crosses adapted to Idaho. Physical dissection and separation were done for the lean, fat and bone from half carcasses of wether lambs of the Suffolk, Targhee, Rambouillet, Hampshire and Panama breeds, Targhee x Panama and Suffolk x Panama 2-way crosses, and Rambouillet x Panama x Targhee 3-way crosses. Ram and wether lambs of the Suffolk x Panama cross were compared to ascertain sex differences. These investigations were conducted during the 5 year period 1964-68.

Table 1. Least square means and standard deviations for live measurements of height, width and depth after shearing.*

Group	N	Height at shoulder	Width behind shoulder	Width of loin	Depth of chest	Depth of leg at twist
Overall	209	44.0	16.4	9.8	23.7	18.3
Suffolk	36	46.4a	17.6a	10.5a	23.5bc	18.7a
Targhee	14	42.3bc	16.1bcd	9.6bc	24.4a	18.7a
Rambouillet	29	41.9c	14.9d	8.8d	23.4bc	17.4b
Hampshire	15	46.8a	17.3ab	10.2ab	23.1c	18.2a
T x P	30	43.2b	16.3c	10.0abc	24.1ab	17.8b
Panama	39	43.1bc	16.1c	9.7bc	23.6abc	18.5a
S x P	28	45.3a	17.1abc	10.2ab	23.5abc	18.7a
R x P x T	18	42.9bc	15.8cd	9.4c	24.2ab	18.7a
Days age partial regression		-.019**	-.002	-.001	-.006	.003
Standard deviation		1.78	1.09	.83	1.04	1.51

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

** $P \leq .01$.

experimental methods

The 209 lambs in this study were slaughtered at an average weight of 107.3 lbs. (Table 3). Lambs ranged from 4 to 5½ months old and would be classed as milk-fat genuine spring lambs.

Extensive live animal measurements and scores were recorded for the lambs in both unshorn and shorn conditions. Body width and height were measured with metal calipers; length and circumference were measured with a flexible metal rule or tape. Circumference and length of the leg were measured with the lamb hanging by its hind legs for comparison with similar carcass measurements. Live conformation quality scores and grades were estimated for each lamb. Lambs were slaughtered after evaluation and without shrinking.

Chilled weight, linear carcass measurements and subjective grades and scores were taken 24 to 48 hours after slaughter. Carcass measurements taken are described by Ney (1966). The carcasses were cut into wholesale cuts using the W-61 (1959) recommended method with slight modifications. Weights of untrimmed wholesale cuts were recorded. Fat and loin eye area were measured at a point between the 12th and 13th rib. Each wholesale cut from half of each carcass was physically separated (lean, fat and bone) and weighed. Carcass fat and lean were thoroughly mixed, ground and analyzed chemically by AOAC methods for protein, moisture and fat content. Specific gravity of all wholesale cuts taken from the left side (before trimming) was determined by the method of Brown (1951). Organoleptic studies were made of loin and leg chops as described by Gates (1964). Models were fitted by least-squares procedures and tested by Duncan's Multiple Range test (Harvey, 1960).

Table 2. Live lamb measurements of circumference and length after shearing (inches).*

Group	Forecannon	Circumference Arm	Circumference Leg	Length of body	Length of loin	Lenght of forecannon	Length of leg
Overall	3.5	11.2	15.9	28.8	6.3	4.4	25.3
Suffolk	3.7a	11.5a	17.0a	28.7a	6.3a	4.1c	27.6a
Targhee	3.4c	10.9ab	15.4b	29.1a	6.4a	4.6ab	24.4abc
Rambouillet	3.4c	10.6b	15.5b	28.7a	6.3a	4.8a	24.5bc
Hampshire	3.7a	11.7a	15.8b	27.9b	5.8b	4.0c	27.3ab
T x P	3.5bc	11.2ab	15.7b	28.9a	6.2a	4.6ab	22.2c
Panama	3.5bc	10.9b	15.7b	28.8a	6.3a	4.6ab	23.2ab
S x P	3.6ab	11.1ab	16.0b	29.0a	6.3a	4.4b	25.9ab
R x P x T	3.5bc	11.4ab	15.8b	29.1a	6.5a	4.4b	25.1abc
Age regression	-.003**	.001	.010*	-.001	.002	.001	.011
Standard deviation	.23	.79	1.16	.90	.43	.29	4.29

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

Table 3. Live and slaughter score, grades, weights and dressing percentage.*

Group	Live conformation score**	Slaughter grade**	Live weight (lb.)	Cold carcass weight (lb.)	Carcass dressing percentage	Carcass grade**
Overall	11.5	11.5	107.3	51.6	48.0	11.5
Suffolk	13.7a	13.0a	109.2a	54.1ab	49.5a	12.4b
Targhee	10.1de	10.9bc	108.6a	51.4abcd	47.1ab	11.1d
Rambouillet	9.4e	9.3d	100.0b	47.9d	47.7ab	9.8f
Hampshire	13.7a	12.8a	105.6ab	50.4bcd	47.7ab	12.9a
T x P	10.7cd	11.5b	110.0a	52.7abc	47.8ab	11.6c
Panama	10.9c	11.3b	107.2a	52.9ab	49.0a	11.2d
S x P	12.6b	12.5a	109.8a	54.6a	49.4a	12.3b
R x P x T	10.4cd	10.5c	107.8a	49.2cd	45.8b	10.4c
Age regression	.003	.006	-.115**	-.024	.028**	.001
Standard deviation	.92	1.07	7.32	4.66	2.73	.31

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

** Numerical scores correspond to ⅓ grades as follows: 12 = high choice, 11 = average choice, 10 = low choice, etc.

results and discussion

Tables 1 and 2 list means for 12 live linear measurements by breed, crosses and total. These tables show Suffolk, Hampshire and Suffolk x Panama (SxP) lambs were not significantly different from each other for leg circumference and cannon length. In contrast, Rambouillet lambs measured average or lower. Targhee, Targhee x Panama (TxP), Panama and Rambouillet x Panama x Targhee (RxPxT) lambs were intermediate in structural size and usually not significantly different from each other.

Table 3 lists means for several subjective live animal and carcass scores in addition to live and carcass weight and dressing percentages by breed, cross or total. Suffolk, Hampshire and the SxP lambs were superior to other breeds and crosses for live conformation score, slaughter grade and carcass grade. Rambouillet lambs were significantly inferior for these traits. They also had lighter carcasses reflecting less efficiency in rate of gain.

The dressing percentage is lower for all breeds and crosses than normally would be expected because lambs were killed without prior fasting or shrinking.

Means for several carcass measurements are listed in Table 4. Although lambs from "mutton-type" breeds differed from "wool-type" breeds for these several measures, there are few significant differences between the breeds and crosses.

Tables 5-10 list measurements of carcass composition.

Table 4. Carcass measurements of width, length, depth and circumference (inches).*

Group	Width of leg	Depth of chest	Depth of twist	Length of leg	Length of carcass	Circumference Both legs	Circumference Heart girth
Overall	18.6	24.4	7.8	17.1	25.1	25.7	29.8
Suffolk	19.4a	23.9bd	7.1c	16.0b	25.1abc	26.6a	29.8ab
Targhee	18.1cde	24.9ab	8.3ab	17.9a	25.6ab	25.3de	30.1ab
Rambouillet	17.7e	24.5abcd	8.4a	17.9a	25.3abc	24.9c	29.1c
Hampshire	19.2ab	23.6bd	7.2c	15.8b	24.3d	26.2abc	29.5abc
T x P	18.7bcd	24.9a	8.0b	17.4a	25.8abc	25.8bcd	30.3a
Panama	18.4cd	24.8abc	8.1ab	17.5a	24.9c	25.7cd	30.2a
S x P	18.8abc	24.4abcd	7.3c	16.3b	24.9bc	26.3ab	30.3a
R x P x T	18.1dc	24.5abcd	8.1ab	17.5a	25.6a	25.2dc	29.3bc
Age regression	-.006	-.003	-.004	-008**	-.006**	-.004	-.001
Standard deviation	.89	1.32	.44	.85	.72	.87	.95

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

** $P \leq .01$.

Loin-eye area has been used as an index of the degree of muscling and, in some cases, as a predictor of total carcass leanness, although this use has often not proven to be valid. Table 5 shows the breed means for loin eye area taken at 3 carcass locations. Loin eye varied by location and breed. The loin eyes of Suffolk and Suffolk-cross lambs were significantly larger for the average of the 3 locations and when multiplying loin-eye area by carcass length to estimate volume of this muscle (*longissimus dorsi*). With these 2 exceptions, average loin eye x carcass length did not differ by breed. Age showed no influence on loin-eye area after day-age partial regressions approached zero.

Table 5. Loin eye areas (square inches).*

Group	Loin eye area 5th rib	Loin eye area 12th rib	Loin eye area last lumbar	Avg. loin eye area	Avg. loin eye area x carcass length
Overall	1.10	2.07	1.53	1.57	39.4
Suffolk	1.22a	2.25ab	1.63a	1.70a	42.6a
Targhee	.99e	1.92cd	1.46ab	1.46b	37.3b
Rambouillet	1.03cd	2.00cd	1.40b	1.48b	37.4b
Hampshire	1.20a	1.82d	1.54ab	1.54b	37.4b
T x P	1.05c	2.06c	1.55ab	1.55b	39.0b
Panama	1.10b	2.12bc	1.47b	1.57b	39.2b
S x P	1.20a	2.35a	1.68a	1.75a	43.6a
R x P x T	1.00de	2.01cd	1.53ab	1.52b	38.9b
Age regression	.001	.001	-.001	-.000	-.014
Standard deviation	.043	.247	.241	.161	4.35

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

Table 6 lists the percent wholesale cuts by breeds and crosses. In this study, no breed differences were found in the percentage of leg, rack or foreshank. Generally, fatter lambs had a lower percentage leg and a higher percentage loin, rack and breast (note the Panama). Leg volume is 3-dimensional, with length contributing quite heavily. Whiteface breeds generally had the highest percentage of kidney and pelvic fats. Again, data indicates age has an insignificant influence on wholesale cut percentages.

The lean, fat and bone were physically separated for one-half of each carcass. The effects of breed and year including age, partial regression are listed on Table 7. Rambouillet lambs yielded the highest percentage lean and bone and the lowest percentage fat.

Table 6. Wholesale cuts as percent of carcass.*

Group	Leg	Loin	Rack	Shoulder	Breast	Foreshank	Kidney knob
Overall	32.1	9.6	9.8	27.4	13.9	4.5	2.7
Suffolk	32.5	9.6bcd	9.5	27.6ab	14.0b	4.6	2.1b
Targhee	31.7	9.4bcd	9.5	27.5ab	14.2ab	4.5	3.1a
Rambouillet	32.4	9.3d	9.7	27.9a	13.0c	4.6	2.9a
Hampshire	31.9	9.3b-d	9.5	27.2abc	14.8a	4.6	2.6ab
T x P	31.9	9.4-d	9.8	27.5ab	13.9b	4.5	2.6a
Panama	31.9	9.9abc	11.7	27.1bcd	13.8b	4.4	2.8a
S x P	32.1	10.2a	9.6	26.4c-e	14.2ab	4.3	2.6a
R x P x T	32.2	10.1ab	8.8	28.1a	13.0c	4.6	2.7a
Age regression	-0.002	0.009**	0.004	-0.008*	-0.004	-0.004*	0.009**
Standard deviation	1.15	.76	5.88	.91	.92	.47	.66

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

** $P \leq .01$.

Table 7. Percent and total carcass lean, fat and bone.*

Group	Total percent of physical separation			Grams total carcass		
	Lean	Fat	Bone	Lean	Fat	Bone
Overall	54.1	29.4	15.6	6283	3459	1802
Suffolk	55.3abc	28.3cdef	15.5b	6726a	3502ab	1879a
Targhee	52.7b-d	30.4abc	15.9ab	6105bc	3567ab	1835abc
Rambouillet	56.0a	26.6df	16.6a	6018c	2870c	1775abc
Hampshire	54.2abcd	29.6abcd	15.3b	6128bc	3373ab	1731bc
T x P	53.8bcd	29.5bcde	15.9ab	6342bc	3533ab	1875ab
Panama	52.0d	32.2a	15.1b	6199-c	3855a	1787abc
S x P	53.4b-d	31.3ab	14.2c	6578ab	3884a	1752-c
R x P x T	55.5ab	27.5cdef	16.1ab	6167bc	3084bc	1778abc
Age regression	-.215**	.042***	-.017***	-4.966**	4.315	-2.758**
Standard deviation	2.77	3.54	1.28	542	654	159

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

** $P \leq .01$.

*** $P \leq .05$.

The latter results partially because Rambouillet lambs were lighter in weight than the other breeds. Panama lambs yielded the lowest percentage of lean and the greatest percentage of fat. When lean was expressed as total weight, Suffolk and Suffolk-cross lambs yielded more total pounds of lean. The age-regression coefficient disclosed an increase in weight and percentage of fat and a decrease in the percentage and weight of lean and bone. This was expected and has been established by other researchers.

This study showed small and in most cases insignificant breed differences in the weight of several of the major bones (Table 8).

Specific gravity is a physical measure of the degree of fatness. Values for selected wholesale cuts are listed in Table 9. Leaner cuts have higher specific gravity values. Values for breeds shifted positions for various wholesale cuts; however, Hampshire, Panama, and SxP lambs generally had lower specific gravity values. Conversely, Rambouillet, Suffolk, and RxPxT lambs usually had higher values. All cuts showed negative age-regression coefficients except the shoulder.

Protein, fat and moisture analyses were made of a sample representing the soft tissues of the carcass (Table 10). Rambouillet, Rambouillet-cross and Suffolk lambs generally had significantly less fat and more moisture and protein than Panama and SxP lambs when expressed in percentages. These results support physical separation and specific gravity data. The percentages of fat moisture and protein of the sample were multiplied by chilled carcass weight to convert these percents to actual carcass weight. Suffolk and SxP lambs had 8.2 pounds of protein each as opposed to 7.2 pounds for RxPxT lambs (Table 10). Rambouillet and 3-way cross lambs had less fat. This same pattern was evident for weights of the separated lean, fat and bone. The age-regression coefficients for chemically determined fat, moisture and protein approach zero.

No significant breed differences were found for organoleptic aroma and flavor for the cooked loin chop. Significant (P .05) breed

Table 8. Individual bone weights (grams).*

Group	Radius + ulna	Metacarpal	Metatarsal	Tibia	Femur
Overall	83.8	39.1	44.3	117.8	160.7
Suffolk	87.0a	38.2abcde	42.8bc	119.8a	165.4ab
Targhee	85.3ab	40.2ab	46.4ab	118.8a	162.7abc
Rambouillet	84.5ab	40.7a	46.6a	118.5a	159.2bcde
Hampshire	77.2b	35.8e	39.6c	105.7b	151.5cde
T x P	86.7a	40.3a	46.4a	122.3a	173.5a
Panama	83.7ab	40.0abc	45.4ab	123.4a	162.2bcd
S x P	82.1ab	37.3b-de	42.5bc	116.2a	151.9c-e
R x P x T	84.1ab	39.9abcd	45.0ab	117.4a	159.1bcde
Age regression	-0.134**	-0.050**	-0.058**	-0.139**	-0.230**
Standard deviation	9.31	3.78	4.59	10.64	14.80

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

** $P \leq .01$.

differences were found for the other organoleptic qualities. SxP lambs received highest scores for consumer acceptance. When comparing lamb carcasses of equal weight, these studies suggest that the most desirable carcass traits—less fat, more protein, or lean and higher grades—may be achieved by using Suffolk rams on whiteface ewes.

Sex differences were found only in PxT lambs (Table 11). Compared to wether lambs, ram lambs had significantly less fat and more protein (P .01). However, wethers were significantly (P .01) more desirable in the aroma of the leg slice. Other organoleptic comparisons between rams and wethers were not significant. No significant sex differences were found for shear values of the leg slice; however, the loin eye of the wethers ranked 1.4 units more tender than the rams. (P .05).

Table 9. Coded specific gravity (S.G.-1.000) (10^5).*

Group	Leg	Loin	Rack	Shoulder	Loin eye
Overall	5456	3681	4392	4617	6183
Suffolk	5647abcd	4226a	4964ab	4649abc	6217ab
Targhee	5673abc	3679ab	4347bcd	4442abc	6060b
Rambouillet	6049a	4321a	5192a	4897ab	6496a
Hampshire	4736f	3443bc	4251cd	4577abc	6223ab
T x P	5511bcde	3599b	4187cd	4922ab	6200ab
Panama	5146c-ef	2923c	3694d	3944c	6108b
S x P	5090c-ef	3311bc	3877d	4042bc	6005b
R x P x T	5800ab	3942ab	4627abc	5461a	6154ab
Day age regression	-.510	-5.261	-3.872	1.994	-3.250
Standard deviation	719	805	1038	1175	447

* Means in the same column with different suffixes are significantly different (P ≤ .05).

Table 10. Percent chemical analyses and calculated carcass weights.*

Group	Fat	Chemical analysis % Water	Protein	Pounds calculated carcass weights (based on chemical analyses) Protein	Water	Fat
Overall	28.6	55.5	15.2	7.8	28.4	14.9
Suffolk	27.3bc	56.6ab	15.4ab	8.2a	30.0a	15.0-c
Targhee	30.2ab	54.5bc	14.8ab	7.6bc	27.8b	15.7abc
Rambouillet	25.0c	58.1a	15.8a	7.5c	27.7b	11.9e
Hampshire	29.0abc	55.1abc	15.0ab	7.5c	27.7b	14.7bcd
T x P	29.4ab	54.8bc	15.1ab	7.8abc	28.5ab	15.7abc
Panama	31.3a	53.4c	14.8-b	7.8abc	28.0b	16.6ab
S x P	30.8	53.8c	15.0ab	8.2ab	29.2ab	16.9a
R x P x T	25.4c	57.4ab	15.9a	7.2abc	28.1ab	12.5de
Day age regression	0.030	-0.024	0.002	-0.002	-0.030**	0.015
Standard deviation	4.61	3.62	1.10	.692	2.43	3.42

* Means in the same column with different suffixes are significantly different (P ≤ .05).

** P≤ .01.

Table 11. Least squares means and standard deviations for Panama x Targhee wether and ram lambs.*

Group	N	Grams total carcass		Sensory Tests							
				Acceptance		Flavor		Tenderness		Shear Test	
		Lean	Fat	Loin	Leg	Loin	Leg	Loin	Leg	Leg	Chop
Overall	66	6,386	3,154	6.10	6.02	6.21	5.82	5.65	5.55	8.89	7.19
Sex											
Wether	30	6,358b	3,261a	6.04	6.20a	6.22	5.88	5.69	5.60	8.81	6.50b
Ram	36	6,414a	3,048b	6.16	5.84b	6.20	5.76	5.61	5.31	8.98	7.89a
Days age regression		-13.4	-5.1	.008	.000	.004	.007	.001	.006	.021	.015
Standard deviation		513	652	.81	.57	.96	.55	1.07	.72	1.89	2.58

* Means in the same column with different suffixes are significantly different ($P \leq .05$).

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