Comparison of new composite breeds with the Suffolk breed as terminal sires in an extensive production system: carcass characteristics

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INTRODUCTION

Crossbreeding can provide the U.S. sheep industry with improvements needed to be competitive in the global protein market (Leymaster, 2002). Mating terminal sire breeds with excellent carcass characteristics to wool-type maternal breeds can add value despite fluctuating markets that are influenced by seasonality of production, import volume, and a variation in supply and demand (NRC, 2008).

Evaluations of multiple terminal sire breeds suited for improving carcass traits in crossbred lambs reared in a rangeland system have been investigated at the U.S. Sheep Experiment Station (USSES). Initial results indicated Suffolk-sire crossbred lambs excel in many growth and carcass traits, but no single breed excelled in all carcass traits measured (Mousel et al., 2012; Notter et al., 2014).

At present, the U.S. sheep industry and USSES developed terminal-sire composite (TSC) breeds for evaluation. Initially, an industry composite (Siremax) was developed from Hampshire, Suffolk, Columbia, and Texel breeds with focus on structural soundness, longevity, and lean growth. More recently, the Suffolk, Columbia, and Texel breeds were used to develop the USSES TSC breed, with selection emphasis placed on lamb survival, growth, efficiency, and carcass traits. To date, the TSC and Siremax breeds have not been compared with breeds traditionally used as terminal sires (e.g., Suffolk) in western U.S. range production systems. We hypothesized that the composite breeds would produce crossbred lambs with similar consistency and yield of carcass characteristics as Suffolk-sired crossbred lambs. The objective of this study was to compare the carcass characteristics of lambs produced by the TSC, Siremax composite, and Suffolk rams, when used as terminal sires mated to range-type ewes. The results described herein are the carcass component of a 3-yr study with a broader focus of comparison, including lamb survival, growth, efficiency, and retail traits.

MATERIALS AND METHODS

The USSES Institutional Animal Care and Use Committee (Dubois, ID) reviewed and approved all animal handling, treatment, and management procedures used in this study.

The experimental design, animal management, and sampling protocols for this study were previously described by Leeds et al. (2012) and Notter et al. (2012). Briefly, mature (2- to 7-yr-old) USSES Targhee (n = 213), Polypay (n = 206), and Rambouillet (n = 208) ewes were single-sire mated (10 to 15 ewes per sire) to Suffolk (n = 24), Siremax (n = 24), or TSC (n = 24) rams in October 2015, 2016, and 2017. Suffolk and Siremax sires were purchased from flocks that participated in the National Sheep Improvement Program. The TSC sires were developed at the USSES. Lambs were born in March and April, and male lambs were

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castrated shortly after birth. Ewes and their lambs were managed on sagebrush steppe and subalpine range through the spring and summer. Lambs were weaned in July at approximately 114, 122, and 115 d of age in 2016, 2017, and 2018, respectively. Lambs were sorted by sire breed, sex, and within sex by sire breed, further sorted by dam breed and individual sire within maternal-breed cross and ranked according to body weight (BW). Lambs of each sex and sire breed were assigned randomly to one of four pens, resulting in 7 to 12 lambs per pen with an approximate equal representation of each dam breed and individual sire and similar BW means for each pen. Lambs were assigned to 1 of 24 total pens, with 12 pens per sex and 8 pens per sire breed. Lambs were finished and treated for illnesses as described in Notter et al. (2012).

Within each pen, lambs were randomly assigned to one of three slaughter groups with a targeted mean harvest BW of 56, 61, and 66 kg. Lambs were weighed weekly. At harvest, lambs were weighed and transported by a commercial hauler to Mountain States Lamb abattoir in Greeley, CO. Across the 3 yr, 755 lambs (385 ewes and 369 wethers) were evaluated and actual BW means were 54.4, 61.2, and 68.0 kg for first, second, and third slaughter groups, respectively.

Hot carcass weight (HCW) was recorded for each lamb and unribbed carcasses were analyzed using the lamb vision scanning system (Brady et al., 2003). The resulting images were used to assign "camera" yield grades to each carcass. After chilling (2 to 4 °C; 24 h), carcasses were ribbed (12th and 13th ribs) and trained personnel subjectively assigned muscling, flank streaking, and maturity scores and United States Department of Agriculture (USDA) yield grades to carcasses according to USDA (1992) guidelines. Fat depth was measured at the midpoint of the longissimus muscle (LM) and body wall thickness was measured at approximately 12.7 cm from the dorsal midline of both right and left sides of the carcass. Right and left LM perimeters were traced on acetate paper and later measured with a pork grid to obtain LM area. Measurements for fat depth, body wall thickness, and LM area of the left and right sides were averaged. The predicted percentage of boneless, closely trimmed retail cuts (%BCTRC) was calculated for each carcass as follows: %BCTRC = 49.936 – (0.0848 × HCW, pounds) – (4.376 × 12th-rib fat, inches) – (3.53 × body wall thickness, inches) + (2.456 × LM area, square inches; Tschirhart et al., 2002). Weights of closely trimmed retail cuts (EstBCTRCwt) were estimated by multiplying %BCTRC by HCW. Following ribbing, a calculated yield grade was also assigned (USDA, 1992) as follows: [12th-rib fat (inches) × 10] + 0.4); resulting values were truncated to determine the final yield grade.

HCW, calculated and camera yield grades, 12th-rib backfat, body wall thickness, LM area, %BCTRC, and EstBCTRCwt were analyzed using the Mixed Model Procedure of SAS (v9.4; SAS Inst. Inc., Cary, NC). The model included fixed effects of sex, year, sire breed, dam breed, slaughter group, sire breed × year interaction, and year × slaughter group interaction and a random effect of sire nested within sire breed. Orthogonal linear contrasts were used to compare Suffolk-sired lambs to the average of Siremax- and TSC-sired lambs and to compare lambs sired by the composite breeds. Orthogonal linear contrasts were also used to compare lambs out of Polypay dams to the average of lambs out of Rambouillet and Targhee dams and to compare lambs from Rambouillet and Targhee dams. Other two-way interactions among fixed effects and the random effect of pen (nested within sex and sire breed) were tested in preliminary analyses but were not significant for any trait and were removed from the final models. Results were interpreted using an alpha of 0.05.

RESULTS

The year × slaughter group interaction was significant (P = 0.001 to 0.03) for HCW, 12th-rib fat depth, body wall thickness, LM area, %BCTRC, EstBCTRCwt, and calculated yield grade, but was not significant (P = 0.76) for camera yield grade. The effect of year was significant (P < 0.0001) for HCW, 12th-rib fat depth, body wall thickness, LM area, %BCTRC, EstBCTRCwt, and calculated and camera yield grades (Table 1). The effect of year was significant (P ≤ 0.006) for HCW, body wall thickness, LM area, %BCTRC, EstBCTRCwt, and camera yield grade, but was not significant (P ≥ 0.20) for 12th-rib fat depth or calculated yield grade. These results were expected, with differences in average lamb age of approximately 1 mo between adjacent slaughter groups for each study year. Sire breed effects were significant (P = 0.0004 to 0.043) for HCW, 12th-rib fat depth, body wall thickness, %BCTRC, EstBCTRCwt, and calculated yield grade, but were not significant (P > 0.07) for LM area and camera yield grade (Table 2). Sex effects were significant (P ≤ 0.02) for HCW, camera yield grade, LM area, and EstBCTRCwt, but sex had no effect (P > 0.30) on 12th-rib fat depth, body wall thickness, %BCTRC, and calculated yield grade.

Table 1. Least-squares means and SE by year for carcass characteristics of crossbred lambs sired by TSC, Siremax, and Suffolk rams bred to range-type ewes

	Year				
Trait[a]	1	2	3	SE	*P*-value
Hot carcass weight, kg	32.31	30.13	31.17	0.31	<0.0001
12th-rib fat, mm	6.25	5.79	5.94	0.20	<0.0001
Body wall thickness, mm	23.09	25.77	22.51	0.38	<0.0001
LM area, cm^2	18.70	17.22	19.25	0.20	<0.0001
Calculated %BCTRC[b]	46.72	46.27	47.30	0.13	<0.0001
EstBCTRCwt[c]	15.03	13.87	14.70	0.13	<0.0001
Calculated yield grade	2.86	2.68	2.73	0.08	<0.0001
Camera yield grade	—	3.21	3.48	0.07	<0.0001

[a]Measures of LM area, 12th-rib fat, and body wall thickness were taken between the 12th and 13th ribs of both sides of the carcass and averaged for analysis.

[b]Calculated %BCTRC = estimated percentage of boneless, closely trimmed-retail cuts.

[c]EstBCTRCwt = %BCTRC × hot carcass weight.

Table 2. Least-squares means and SE for carcass characteristics of crossbred lambs sired by TSC, Siremax, and Suffolk rams bred to range-type ewes

	Sire breed					Contrasts (*P*-value)	
Trait[a]	Suffolk	Siremax[c]	TSC[d]	SE	*P*-value	Suffolk vs. composites	TSC vs. Siremax
HCW[b], kg	32.31	30.57	30.73	0.33	0.0004	0.00	0.73
12th-rib fat, mm	6.41	5.61	5.96	0.22	0.0429	0.02	0.27
Body wall thickness, mm	24.72	23.16	23.50	0.41	0.0228	0.01	0.57
LM area, cm^2	18.72	18.44	18.02	0.22	0.0738	0.06	0.17
Calculated % BCTRC[e]	46.47	47.05	46.77	0.14	0.0185	0.01	0.17
EstBCTRCwt[f]	14.95	14.33	14.31	0.13	0.0010	0.00	0.89
Calculated yield grade	2.92	2.61	2.74	0.09	0.0431	0.02	0.30
Camera yield grade	3.40	3.37	3.28	0.09	0.6026	0.52	0.46

[a]Measures of longissimus muscle (LM) area, 12th-rib fat, and body wall thickness were taken between the 12th and 13th ribs of both sides and averaged for analysis.

[b]Hot carcass weight.

[c]Siremax was derived from crosses among the Suffolk, Columbia, Texel, and Hampshire breeds.

[d]The USSES Terminal Sire Composite (TSC) was developed at the USDA, ARS, U.S. Sheep Experiment Station, Dubois, ID by crossing the Suffolk, Columbia, and Texel breeds.

[e]Calculated %BCTRC= Calculated percentage of boneless-closely-trimmed-retail cuts.

[f]EstBCTRCwt = %BCTRC × hot carcass weight.

Effects of dam breed ($P > 0.21$) and sire breed × year interaction ($P > 0.07$) were not significant for any traits measured.

DISCUSSION

The use of terminal-sire crossbreeding is expected to improve lamb weaning BW, post-weaning daily gain, and carcass weight (Sidwell, 1971; Mousel et al., 2012). For this study, Suffolk-sired lambs had 0.63-kg (4.21%) heavier EstBCTRCwt ($P = 0.001$) and 1.66-kg (5.14%) heavier ($P < 0.001$) HCW compared with TSC- and Siremax-sired lambs (Table 2). The greater HCW from Suffolk-sired lambs was consistent with previous results reported by Kirton et al. (1995) and Leymaster (1981). Although HCW, 12th-rib fat depth, body wall thickness, LM area, EstBCTRCwt, and calculated yield grade were greater in Suffolk-sired lambs, the TSC-sired lambs were similar ($P \geq 0.17$) to Siremax-sired lambs for calculated %BCTRC and camera yield grade (Table 2). On the basis of this 3-yr study, we reject our initial hypothesis. The TSC- and Siremax-sired lambs did not have similar consistency and carcass yield to Suffolk-sired crossbreed lambs.

IMPLICATIONS

An increasing proportion of lamb in the United States is sold to processors using grid-based pricing, in which premiums and discounts are awarded based on carcass weight and yield grade. A heavier carcass, that is not excessively fat, will have an increased dressing percentage, thereby adding value to the carcass on the current grid-based system. Therefore, these data collected from 755 lambs over a 3-yr period indicate that the development of the TSC and Siremax breeds should continue with increased selection placed on carcass weight. Apart from the carcass characteristics quantified in this study, other economically relevant measurements, such as weight of lamb weaned per ewe exposed, also greatly affect the overall profitability of any sheep enterprise. These data, in conjunction with forthcoming pre- and post-weaning production data will clarify the overall utility of the TSC and Siremax breeds as terminal-sire breeds for extensive, rangeland sheep productions systems.

Conflict of interest statement. None declared.

LITERATURE CITED

Brady, A. S., K. E. Belk, S. B. LeValley, N. L. Dalsted, J. A. Scanga, J. D. Tatum, and G. C. Smith. 2003. An evaluation of the lamb vision system as a predictor of lamb carcass red meat yield percentage. J. Anim. Sci. 81:1488–1498. doi:10.2527/2003.8161488x.

Kirton, A. H., A. H. Carter, J. N. Clarke, D. P. Sinclair, G. J. K. Mercer & D. M. Duganzich. 1995. A comparison between 15 ram breeds for export lamb production 1. Live weights, body components, carcass measurements, and composition. New Zealand J. Agric. Res., 38:347–360. doi: 10.1080/00288233.1995.9513136

Leeds, T. D., D. R. Notter, K. A. Leymaster, M. R. Mousel, and G. S. Lewis. 2012. Evaluation of Columbia, USMARC-composite, Suffolk, and Texel rams as terminal sires in an extensive rangeland production system: I. Ewe productivity and crossbred lamb survival and preweaning growth. J. Anim. Sci. 90:2931–2940. doi:10.2527/jas.2011-4640.

Leymaster, K. A. 2002. Fundamental aspects of crossbreeding of sheep: Use of breed diversity to improve efficiency of meat production. Sheep and Goat Res. J. 17:50–59.

Leymaster, K. A., and G. M. Smith. 1981. Columbia and Suffolk terminal sire breed effects. J. Anim. Sci. 53:1225–1235. doi:10.2527/jas1981-5351225

Mousel, M. R., D. R. Notter, T. D. Leeds, H. N. Zerby, S. J. Moeller, and G. S. Lewis. 2012. Evaluation of Columbia, USMARC-composite, Suffolk, and Texel rams as terminal sires in an extensive rangeland production system: III. Prefabrication carcass traits and organ weights. J. Anim. Sci. 90:2953–2962. doi:10.2527/jas.2011-4767.

Notter, D. R., T. D. Leeds, M. R. Mousel, J. B. Taylor, D. P. Kirschten, and G. S. Lewis. 2012. Evaluation of Columbia, U.S. Meat Animal Research Center Composite, Suffolk, and Texel rams as terminal sires in an extensive rangeland production system: II. Postweaning growth and ultrasonic measures of composition for lambs fed a high- energy feedlot diet. J. Anim. Sci. 90:2941–2952. doi: 10.2527/jas.2013–7154.

Notter, D. R., M. R. Mousel, T. D. Leeds, H. N. Zerby, S. J. Moeller, G. S. Lewis and J. B. Taylor. 2014. Evaluation of Columbia, U.S. Meat Animal Research Center Composite, Suffolk, and Texel rams as terminal sires in an extensive rangeland production system: VI. Measurements of live-lamb and carcass shape and their relationship to carcass yield and value. J. Anim. Sci. 92:1980–1994. doi: 10.2527/jas.2013–7154.

NRC. 2008. Changes in the sheep industry in the United States: making the transition from tradition. Washington, DC: Natl. Acad. Press.

Sidwell, G. M. and L. R. Miller. 1971. Production in some pure breeds of sheep and their crosses. II. Birth weights and weaning weights of lambs. J. Anim. Sci. 32:1090–1094.

Tschirhart, T. E., L. A. Rakowitz, D. R. McKenna, D. B. Griffin, J. W. Savell. 2002. Development of a cutability equation for carcasses of show lambs. Sheep and Goat. Wool and Mohair CPR 2002:31–35.

USDA. 1992. Official United States Standards for grade of lamb, yearling mutton, and mutton carcasses. Washington, DC: AMS, USDA.