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# Growth and slaughter traits of Boer × Spanish, Boer × Angora, and Spanish goats consuming a concentrate-based diet[1,2]

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**ABSTRACT:** The number of Boer crossbred meat goats has been increasing rapidly, although how their growth and slaughter traits compare with those of Spanish goats and influences of maternal genotype have not been thoroughly evaluated. This information would be useful to achieve optimal meat goat production systems and yield of goat products desired by consumers. Therefore, postweaning growth (9 to 24 wk of age) and slaughter traits (212 ± 5.0 d of age) of Boer × Spanish, Spanish, and Boer × Angora wethers (n = 16, 18, and 18 for growth measures, respectively, and n = 6 per genotype for slaughter traits) consuming a concentrate-based diet were compared. Over the 16-wk performance period, ADG, DMI, and ADG:DMI were greater ($P < 0.05$) for Boer crossbreds than for Spanish goats (ADG: 154, 117, and 161 g; DMI: 646, 522, and 683 g/d; ADG:DMI: 263, 235, and 261 g/kg for Boer × Spanish, Spanish, and Boer × Angora, respectively). Dressing percentage (46.3, 47.3, and 47.0% of BW; SE = 1.21) and quality grade score (11.17, 9.67, and 11.17 for Boer × Spanish, Spanish, and Boer × Angora, respectively; SE = 0.66 [12 = Choice$^+$; 11 = Choice; 10 = Choice$^-$; 9 = Good$^+$]) were similar among genotypes. Weights of some noncarcass components were greater for Boer crossbreds than for Spanish goats, but relative to empty BW, noncarcass component weights were similar among genotypes. Concentrations of moisture, ash, fat, and protein in carcass and noncarcass components did not differ among genotypes. Contributions to the carcass of different primal cuts were similar among genotypes, and there were few differences in concentrations of separated lean, bone, and fat in primal cuts. In conclusion, when consuming a concentrate-based diet, early postweaning growth rate was similar between Boer × Spanish and Boer × Angora wethers and greater for Boer crossbreds than for Spanish wethers. Slaughter traits were primarily related to differences in final BW.

Key Words: Genotypes, Goats, Growth, Slaughter

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## Introduction

The rising demand for goat meat, loss of government support for mohair production, and introduction of Boer goats in the United States are factors contributing to an increasing interest in raising goats for meat. However, the U.S. meat goat industry is not yet well developed. Many slaughter goats in the United States are culls from dairy and fiber-producing herds. The predominant type of goat used for meat, the Spanish goat, has been primarily employed for brush control in low-input production systems (Shelton, 1990). Hence, goats in the United States used for meat have not been selected for meat production traits, resulting in variable market weight and carcass traits (Glimp, 1996).

Breed differences in performance characteristics offer an opportunity to improve efficiency of meat goat production and product uniformity. Boer goats are known for large frame size, high growth rate, and carcass attributes (Casey and Van Niekirk, 1988; Van Niekirk and Casey, 1988). Thus, the use of Boer bucks as terminal sires should yield crossbred kids that grow faster and produce a more uniform and well muscled carcass compared with kids from sires of other goat types such as the Spanish. However, few studies have compared performance and slaughter traits of Boer × Spanish, fullblood Spanish, and Boer × Angora goats (Lewis et al., 1997; Oman et al., 1999, 2000). Therefore, the objectives of this study were to compare postwean-

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ing growth and slaughter traits of Boer × Spanish, Spanish, and Boer × Angora goats.

## Materials and Methods

The experimental protocol was approved by the Langston University Animal Care Committee.

### *Animals*

Forty-five Spanish does were randomly naturally mated with four Boer bucks, another 88 Spanish does were bred to four Spanish bucks, and 67 Angora does were randomly mated with two of the four Boer bucks. Angora does were originally allocated to all four Boer bucks. However, because two bucks had difficulty breeding the Angoras, after approximately 1 mo Angora does assigned to these bucks were randomly redistributed among the remaining two Boer bucks. Boer bucks had been purchased from two private herds and represented South African and New Zealand bloodlines. One month before birth, does were dewormed (2 mL of Ivomec orally; Merck Ag Vet Division, Rahway, NJ), injected with vitamins A, D, and E (200,000, 20,000, and 600 IU, respectively; Schering-Plough Animal Health, Kenilworth, NJ), and vaccinated for *Clostridium perfringens* type C & D plus tetanus toxoid (Colorado Serum Co., Denver, CO). Following birth, kids were eartagged and weighed and their navals were dipped in iodine. At 12 wk of age, kids were castrated by banding with an elastrator.

To mitigate potential maternal effects on preweaning performance, kids were removed from dams within 72 h of birth and individually hand-reared. Details for kid rearing until weaning were described by Luo et al. (2000). In short, kids were limit-fed acidified milk replacer (Lamnurs; Evergreen Mills, Ada, OK) and given ad libitum access to a commercial pelleted diet (Super Goat Pellet; Acco Mills, Oklahoma City, OK), with an analyzed composition of 90% OM, 4.37 Mcal GE/kg, 25% CP, 18% ADF, and 35% NDF (DM basis). Ingredients were soybean meal, oats, corn, dehydrated alfalfa meal, processed grain byproducts, blood meal, fish meal, dried whey, cane molasses, cottonseed hulls, ammonium chloride, vitamins, and minerals. Kids were offered the starter diet at 3 wk of age and weaned at 8 wk. Vaccinations at weaning and a booster 4 wk later were given for *Clostridium perfringens* type D, *Corynebacterium pseudotuberculosis*, and tetanus toxoid (Colorado Serum Co.).

### *Experimental Procedures*

*Performance and Digestibility.* At 8 wk of age, 18 males of each genotype were randomly selected and allocated to individual steel-mesh cages (91 × 91 × 76 cm). At 16 wk of age, these same kids were moved to another facility and placed in 61- × 107- × 91-cm individual metabolism cages for a second 8-wk phase, with the same procedures as in the first. Animals were fed the pelleted diet once daily at approximately 110% of consumption on the preceding few days. Feed offered and refused was recorded daily, and goats had free access to water. A diet sample was collected weekly and individual BW was recorded every 2 wk.

At 17 wk of age, six animals per genotype were randomly selected for determination of apparent total tract digestibilities. The diet was sampled on d 1, 3, and 5 of the 5-d collection period, and total feed refusals were collected daily. Subsamples (20%) of refused feed and feces were collected each day. Feces were collected by placement of a wire mesh screen under the metabolism cages. Samples of feed, feed refusals, and feces were dried in a forced-air oven at 55°C for 48 h, and feed and feed refusal samples were composited on a DM basis. Weekly diet samples were dried and composited on a monthly basis. Diet, feed refusal, and fecal sample composites were ground to pass a 1-mm screen in a Wiley mill and analyzed for DM, ash, CP, GE (AOAC, 1984), NDF, and ADF (filter bag technique; ANKOM Technology Corp., Fairport, NY).

*Slaughter Measures.* After the 16-wk performance evaluation period, six goats per genotype were randomly selected and assigned to two slaughter groups (nine per group). Feeding procedures were the same from the performance period until slaughter. Each group was slaughtered in 1 d, with a 5-d interval between groups; average age at slaughter was 212 ± 5.0 d. On the morning of the slaughter day, goats were weighed and transported to a commercial abattoir. Goats were slaughtered in sets of three (one per genotype) via stunning with a captive bolt pistol and exsanguination. Blood was collected and weighed, limbs were disjointed at the carpus (forelimb) and tarsus (hindlimb), and all bone and tissue distal to the carpus and tarsus were discarded. The head and hide were removed and weighed as one component. After evisceration, kidney and associated pelvic fat were removed, and noncarcass components were separated into pluck (trachea, lungs, liver, kidneys, heart, spleen, and pancreas) and digestive organs (esophagus, reticulo-rumen, omasum, abomasum, small intestine, and large intestine plus cecum). For each group of organs, total weight (including all associated fat) was recorded. Associated fat (pluck: kidney, heart, and pelvic; digestive tract: ruminal, omental, and mesenteric) was removed and organ groups were reweighed. Individual weights were recorded for the heart, lungs (including the trachea), liver, and kidneys. Digestive organs were separated into three components: reticulo-rumen, omasum, and abomasum (including the esophagus); small intestine; and large intestine plus cecum. Components were weighed full, emptied, washed, blotted dry, and reweighed. Gut digesta mass or fill was determined as the difference between full and empty weights, and empty BW was live BW minus gut fill. A pool of noncarcass components (blood, head and hide, organs, and fat) was ground (Model 801 Autiogrinder, Autio Company, Astoria, OR) three times through a plate with a 10-mm aperture. After the third grind, the sample was hand-mixed and four 250-g subsamples were collected and stored at –20°C.

Carcasses were washed, weighed, and hung in a cooler for 72 h (5°C). This length of time was used because a holiday and weekend followed the first day of slaughter. After 72 h, carcasses were graded by an experienced grader generally according to lamb standards (USDA, 1992), weighed, and split down the dorsal midline using a band saw. The right half was ground, sampled, and stored as previously described for noncarcass components; the left half was retained for dissection analysis. Area of the longissimus muscle was measured at the 13th vertebrae. Backfat thickness was measured on the 13th vertebrae at two sites: 1) dorsal to the spinal process of the 13th vertebrae (spinal) and 2) 7.62 cm distal to the longissimus muscle (rib).

Carcass and noncarcass components were analyzed for DM by lyophilization (Model CRVP-195P Dura Stop, FTS Systems, Stone Ridge, NY). After drying, samples were reground in a hand blender and analyzed for CP, ash, and GE (AOAC, 1984); fat was determined by supercritical fluid phase extraction (Model SFX 220, ISCO, Lincoln, NE).

*Primal Cut Measures.* At present, no standards exist for jointing and cutting of goat carcasses in the United States. Therefore, after weighing, the left half of each carcass was physically fabricated into seven primal cuts (breast, shoulder, leg, shank, flank, rack, and loin) according to Institutional Meat Purchase Specifications (USDA, 1996). Primal cuts were weighed and dissected into separable lean, fat, and bone; separated tissues were weighed. The bone portion included any cartilage; major tendons remained with muscles. For the breast and rack, pericostal muscles were left intact and included as part of bone. Dissection losses accounted for less than 2% of original side weights and, therefore, were disregarded. Weights of all dissected components were summed to give a corrected left side weight to estimate contributions of cuts to the total carcass.

### *Statistical Analyses*

Two Boer × Spanish kids died before 16 wk of age, and one Boer × Spanish kid used for measurement of apparent digestibilities developed diarrhea during the collection period; these data were omitted from analyses. Thus, the number of observations for Boer × Spanish, Spanish, and Boer × Angora genotypes was 16, 18, and 18 for performance, 5, 6, and 6 for digestibilities, respectively, and 6 per genotype for slaughter traits. Data were analyzed as a completely randomized design using GLM procedures of SAS (SAS Inst. Inc., Cary, NC). Animal was the experimental unit, and residual variation was used as the error term. Differences among means were determined by least significant difference with a protected $F$-test ($P < 0.05$). For determinations over time, data were analyzd as a split-plot, with a main plot of genotype and subplot of time. Animal within genotype was the error term for genotype, and residual error was used to test effects of time and the interaction between genotype and time. Orthogonal contrasts were used to test linear, quadratic, and cubic effects of time. Correlations were determined with PROC CORR of SAS.

## Results and Discussion

### *Digestibility and Performance*

Apparent total tract digestibilities were similar among treatments, averaging 69, 71, 70, and 69% for DM, OM, GE, and CP, respectively. Given the composition of the diet, differences among genotypes in apparent total tract digestibilities were not expected. Apparent total tract digestibilities were similar to other reports for goats consuming high-concentrate diets (Hadjipanayiotou, 1990; Pralomkarn et al., 1995).

Initial BW was slightly greater ($P < 0.05$) for Boer crossbreds than for Spanish goats (Table 1). The relatively small difference between Spanish and Boer crossbreds in initial BW may have at least partially resulted from restricted milk replacer consumption before weaning (Luo et al., 2000). Waldron et al. (1995) also noted only a 0.63-kg difference in 90-d weaning weight between Boer × Spanish and Spanish goats. The difference between Boer crossbreds and Spanish goats in final BW ($P < 0.05$) was of greater magnitude than that at the beginning of the experiment. Average daily gain during the 16-wk performance period was approximately 40 g greater ($P < 0.05$) for Boer × Spanish and Boer × Angora than for Spanish goats. Live weight gain during the eight 2-wk periods increased linearly ($P < 0.05$) as the performance period progressed, from approximately 120 g/d in the early portion of the experiment to 180 g/d in the final week for Boer crossbreds, and from 75 to 120 g/d for Spanish goats.

Average DMI for the 16-wk performance period was greater ($P < 0.05$) for Boer × Spanish and Boer × Angora than for Spanish goats (Table 1). Likewise, Waldron et al. (1995, 1996) noted greater DMI for Boer crossbreds than for Spanish goats. As the performance period advanced, DMI increased quadratically ($P < 0.05$). The quadratic effect appeared largely as a result of relatively low intake in the first 2 wk, perhaps due to weaning at 8 wk of age and the transition from a liquid diet to one of dry feed only. Dry matter intakes for Boer crossbred vs Spanish kids were approximately 260 vs 200 g/d at 9 to 10 wk of age and 460 vs 380 g/d at 11 to 12 wk. Dry matter intake increased steadily to approximately 940 vs 700 g/d at 23 to 24 wk of age. Dry matter intake as a percentage of BW changed quadratically ($P < 0.05$) with advancing time, being lowest at 9 to 10 wk of age, reaching a plateau at 11 to 20 wk, and slowly declining thereafter (Figure 1). Averaged over the entire performance period, DMI as a percentage of BW was similar between Boer × Spanish and

**Table 1**. Growing performance of Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet

| Item | Genotype<br>Boer × Spanish | <br>Spanish | <br>Boer × Angora | SE |
|---|---|---|---|---|
| Body weight, kg | | | | |
| Initial | 7.3$^a$ | 6.6$^b$ | 7.2$^a$ | 0.20 |
| Final | 24.4$^b$ | 19.5$^c$ | 25.2$^a$ | 0.25 |
| Average daily gain, g/d | 154$^a$ | 117$^b$ | 161$^a$ | 5.6 |
| Dry matter intake | | | | |
| g/d | 646$^a$ | 522$^b$ | 683$^a$ | 21.5 |
| % of BW | 3.91$^{ab}$ | 3.83$^b$ | 4.04$^a$ | 0.058 |
| ADG:DMI, g/kg | 263$^a$ | 235$^b$ | 261$^a$ | 8.0 |

$^{a,b,c}$Within a row and comparison, means without a common superscript letter differ ($P < 0.05$).

Spanish but greater ($P < 0.05$) for Boer × Angora than for Spanish goats. Conversely, Waldron et al. (1996) noted slightly greater DMI as a percentage of BW for Boer × Spanish than for Spanish goats (3.15 vs 2.87% of BW).

Efficiency of feed conversion (ADG:DMI) over the 16-wk performance period was greater ($P < 0.05$) for Boer crossbreds than for Spanish goats (Table 1). Waldron et al. (1996) also observed greater efficiency of feed conversion for Boer × Spanish kids than for Spanish kids in a feedlot experiment (167 vs 133 g ADG:kg DMI). Lewis et al. (1997) noted numerical differences in efficiency of feed conversion among Boer × Angora, Boer × Spanish, and Spanish goats (117, 143, and 98 g ADG:kg DMI, respectively). Efficiency of feed conversion decreased quadratically ($P < 0.05$) as the performance period advanced from more than 300 g/kg at 11 to 12 wk of age to less than 200 g/kg at 23 to 24 wk.

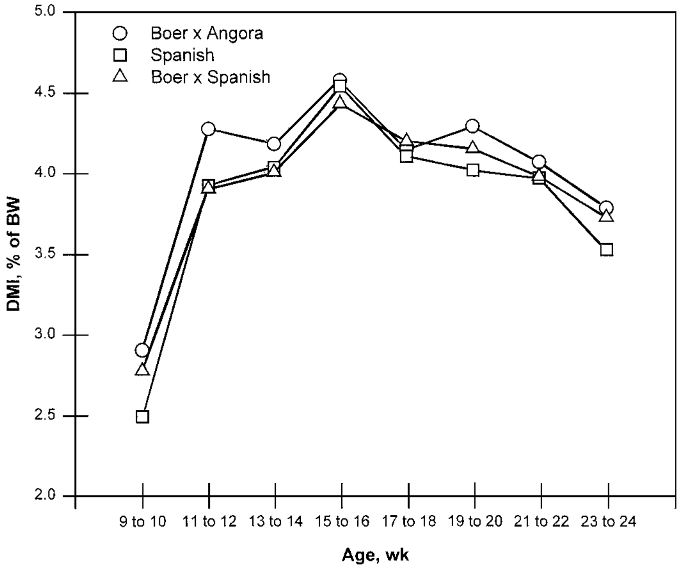

**Figure 1**. Dry matter intake (% of BW) for Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet in 2-wk periods from 9 to 24 wk of age.

Because maternal genotype for Boer crossbreds had little influence on performance, with intensive production conditions growth rate of goats from Angora dams sired by Boer bucks should not markedly differ from that of goats from Spanish dams. However, mature weight affects rates of protein and fat accretion; thus, it is possible that at greater ages performance of Boer × Spanish and Boer × Angora goats might differ from our observations at 9 to 24 wk of age.

### *Slaughter Measures*

*Carcass Traits.* Differences among genotypes in BW at slaughter (Table 2) were slightly different from those at 24 wk of age when the performance period ended (Table 1). Based on empty BW, this may have been a consequence of higher gut digesta fill for Boer × Spanish vs Spanish and Boer × Angora wethers. Slaughter BW, empty BW, and hot carcass weight were numerically greater for Boer crossbreds than for Spanish goats and were similar between Boer × Spanish and Boer × Angora goats (Table 2). Oman et al. (1999) reported greater hot carcass weight for Boer × Spanish than for Spanish males when they were fed a high-concentrate diet but not when on a range feeding regimen. Carcass shrink, dressing percentage, and longissimus muscle area were similar among genotypes in the present experiment. In accordance, Oman et al. (2000) reported similar dressing percentages among Boer × Spanish, Spanish, and Spanish × Angora males at 9 mo of age, averaging 56.2% of live BW. Boer × Spanish and Spanish males studied by Oman et al. (2000) had longissimus muscle areas (12.5 and 11.5 cm$^2$, respectively) fairly similar to values in our experiment, and Waldron et al. (1995) noted comparable longissimus muscle area adjusted for BW for Boer × Spanish and Spanish goats consuming a high-concentrate diet. In the present experiment, backfat thickness at the 13th vertebra (0.25 ± 0.03 cm) was similar among genotypes. Measurements 7.6 cm distal to the longissimus muscle (i.e., rib) were three times

**Table 2**. Carcass characteristics and carcass grade scores for Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet and slaughtered at 212 d of age

| | Genotype | | | |
|---|---|---|---|---|
| Item | Boer × Spanish | Spanish | Boer × Angora | SE |
| Body weight, kg | 32.4 | 25.4 | 30.1 | 2.08 |
| Empty body weight, kg | 27.5 | 23.3 | 27.7 | 1.96 |
| Hot carcass weight, kg | 15.0 | 11.9 | 14.1 | 0.95 |
| Carcass shrink, % | 1.95 | 5.44 | 3.84 | 1.51 |
| Dressing percentage | | | | |
| % of Body weight | 46.3 | 47.3 | 47.0 | 1.21 |
| % of Empty body weight | 50.6 | 51.6 | 51.2 | 1.33 |
| Longissimus muscle area, cm$^2$ | 11.6 | 10.2 | 10.2 | 0.64 |
| Backfat thickness, cm | | | | |
| Spinal[a] | 0.254 | 0.254 | 0.254 | 0.03 |
| Rib[b] | 0.762 | 0.610 | 0.635 | 0.13 |
| Conformation score[c] | 10.50 | 8.17 | 10.33 | 0.87 |
| Maturity score[d] | | | | |
| Lean | 7.50 | 7.67 | 8.00 | 0.50 |
| Bone | 6.83 | 7.50 | 6.00 | 0.73 |
| Quality grade score[c] | 11.17 | 9.67 | 11.17 | 0.66 |
| Leg conformation score[c] | 12.33 | 10.67 | 12.17 | 0.63 |

[a] Subcutaneous fat thickness measured dorsal to the spinal processes of the 13th rib.

[b] Subcutaneous fat thickness measured perpendicular to the 13th rib and 7.62 cm ventral to the longissimus muscle.

[c] 12 = Choice$^+$; 11 = Choice; 10 = Choice$^-$; 9 = Good$^+$.

[d] 9 = A$^+$; 8 = A; 7 = A$^-$; 6 = B$^+$; 5 = B; 4 = B$^-$.

greater (averaged 0.67 ± 0.13 cm) than those determined over the spinal process.

There were no significant differences among genotypes in carcass grade scores (Table 2), although numerically scores for carcass conformation, quality grade, and leg conformation were greater for Boer crossbreds than for Spanish wethers. Oman et al. (2000) noted a greater carcass conformation score for 9-mo-old Boer × Spanish than for Spanish males, and lean maturity score was similar between genotypes.

*Chemical Composition.* Concentrations of moisture, ash, fat, and protein in the carcass, noncarcass components, and total empty body were similar among genotypes (Table 3). The observed concentrations of carcass fat were considerably greater than in most other reports for goats. For example, in a review of eight goat breeds, Warmington and Kirton (1990) reported an average carcass composition of 69% lean, 21.7% bone, and 9.3% fat. However, carcass fat concentrations of 18% have been noted for fullblood Boers (Naude and Hofmeyer, 1981; Van Niekerk and Casey, 1988). High dietary concentrate and high feed intake in the present experiment may explain the high concentration of carcass fat observed not only in Boer crossbreds but in Spanish goats as well.

*Noncarcass Components.* Weights of many noncarcass components were significantly or numerically greater for Boer crossbreds than for Spanish goats (Table 4). However, weights of noncarcass components as a percentage of BW were similar among genotypes. The greater pluck mass for Boer crossbreds than for Spanish wethers ($P < 0.05$) was primarily attributable to the difference in the weight of the liver ($P < 0.05$). Of noncarcass components, the head plus hide composed the greatest proportion of empty BW (20.2 ± 0.84%). Total internal fat mass was approximately 7% of empty BW, with 72.7 ± 1.96% associated with the digestive tract. There have been previous reports of considerable internal fat deposition by Dhofari and Batina goats (Mahgoub and Lu, 1998) and desert goats (Khidir et al., 1998).

## *Carcass Primal Cuts*

*Weight.* Weights of the seven primal cuts were significantly or numerically greater for Boer crossbreds than for Spanish goats (Table 5). However, primal cuts expressed as a percentage of the carcass were not different among genotypes. The primal cuts were grossly categorized into three groups: approximately 25 to 30% (shoulder and loin), 10% (breast, rack, loin, and shank), and 5% (flank) of the carcass. Leg, loin, and rack cuts are considered most valuable by industry standards. These cuts make up nearly 60% of lamb carcasses (Hale and Griffin, 1992). Goats deposit relatively more tissue in forequarters compared with cattle or sheep. In our experiment and other reports (Hale and Griffin, 1992; Hogg et al., 1992), leg, loin, and rack cuts made up 50% or less of the carcass.

**Table 3**. Empty body, carcass, and noncarcass component composition for Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet and slaughtered at 212 d of age (%; as-is basis)

| Item | Genotype | | | |
|---|---|---|---|---|
| | Boer × Spanish | Spanish | Boer × Angora | SE |
| Empty body | | | | |
| Moisture | 56.3 | 58.5 | 56.5 | 1.36 |
| Ash | 2.47 | 2.62 | 2.53 | 0.43 |
| Fat | 17.0 | 16.1 | 17.2 | 1.17 |
| Protein | 21.8 | 20.6 | 20.9 | 0.75 |
| Carcass | | | | |
| Moisture | 56.1 | 57.6 | 56.4 | 1.08 |
| Ash | 3.87 | 3.04 | 3.65 | 0.35 |
| Fat | 18.6 | 16.1 | 18.0 | 1.39 |
| Protein | 20.3 | 19.8 | 20.6 | 0.50 |
| Noncarcass components | | | | |
| Moisture | 55.1 | 57.2 | 54.5 | 1.70 |
| Ash | 1.68 | 2.03 | 1.82 | 0.36 |
| Fat | 19.3 | 19.2 | 20.0 | 1.48 |
| Protein | 19.6 | 19.0 | 18.4 | 1.07 |

*Composition.* Carcass bone, fat, and lean weights were significantly or numerically greater for Boer crossbreds than for Spanish goats (Table 6). Lean as a percentage of the carcass was similar among genotypes, although the percentage of bone was greater ($P < 0.05$) for Boer × Spanish than for Spanish and Boer × Angora wethers, and the percentage of fat was numerically lowest for Spanish. Oman et al. (2000) observed a similar percentage of carcass lean between Boer × Spanish and Spanish male goats at 9 mo of age, and fat comprised more of Boer × Spanish than of Spanish goat carcasses (15.7 vs 13.6%).

There were very few differences among genotypes in bone, lean, and fat percentage of cuts and percentage of carcass tissue in the different cuts (Table 6). The percentage of lean tissue in the shoulder cut was lowest ($P < 0.05$) for Boer × Angora, and the quantity of bone in the leg cut was greatest ($P < 0.05$) for Spanish goats. The percentage of total carcass fat contributed by the rack cut was lower ($P < 0.05$) for Boer crossbreds than for Spanish wethers, and less ($P < 0.05$) carcass lean was in the flank cut of Spanish goats than of Boer crossbreds. Except for the rack, percentage of separable lean, fat, and bone for individual cuts was comparable

**Table 4**. Noncarcass component mass for Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet and slaughtered at 212 d of age

| Item | Genotype | | | | Genotype | | | |
|---|---|---|---|---|---|---|---|---|
| | Boer × Spanish | Spanish | Boer × Angora | SE | Boer × Spanish | Spanish | Boer × Angora | SE |
| | kg | | | | % Empty BW | | | |
| Head plus hide | $5.95^{a}$ | $4.48^{b}$ | $5.74^{a}$ | 0.307 | 20.1 | 19.4 | 21.0 | 0.84 |
| Pluck | $1.83^{a}$ | $1.33^{b}$ | $1.68^{a}$ | 0.117 | 6.14 | 5.76 | 6.10 | 0.196 |
| Lungs | 0.387 | 0.365 | 0.363 | 0.0306 | 1.31 | 1.59 | 1.34 | 0.12 |
| Liver | $0.763^{a}$ | $0.552^{b}$ | $0.698^{a}$ | 0.0525 | 2.56 | 2.38 | 2.54 | 0.09 |
| Kidneys | $0.145^{a}$ | $0.110^{b}$ | $0.120^{ab}$ | 0.0087 | 0.491 | 0.475 | 0.438 | 0.0257 |
| Heart | 0.132 | 0.220 | 0.160 | 0.0719 | 0.449 | 0.899 | 0.569 | 0.2728 |
| Digestive tract, empty | 2.01 | 1.72 | 1.86 | 0.142 | 6.79 | 7.40 | 6.80 | 0.476 |
| Stomach, empty | 0.878 | 0.862 | 0.820 | 0.1057 | 2.96 | 3.70 | 3.01 | 0.409 |
| Small intestine, empty | 0.585 | 0.462 | 0.522 | 0.0351 | 1.98 | 1.98 | 1.94 | 0.129 |
| Large intestine plus cecum, empty | $0.548^{a}$ | $0.395^{b}$ | $0.513^{a}$ | 0.0362 | 1.85 | 1.72 | 1.85 | 0.09 |
| Internal fat | | | | | | | | |
| Total | 2.18 | 1.52 | 2.11 | 0.310 | 7.16 | 6.48 | 7.34 | 0.720 |
| Pluck | 0.608 | 0.428 | 0.560 | 0.0876 | 2.01 | 1.81 | 1.95 | 0.246 |
| Digestive tract | 1.58 | 1.10 | 1.55 | 0.232 | 5.15 | 4.67 | 5.40 | 0.526 |

[a,b]Within a row and comparison, means without a common superscript letter differ ($P < 0.05$).

**Table 5**. Carcass proportions of primal cuts for Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet and slaughtered at 212 d of age

| | Genotype | | | | Genotype | | | |
|---|---|---|---|---|---|---|---|---|
| Item | Boer × Spanish | Spanish | Boer × Angora | SE | Boer × Spanish | Spanish | Boer × Angora | SE |
| | kg | | | | % of Total | | | |
| Shoulder | $1.83^{a}$ | $1.32^{b}$ | $1.63^{a}$ | 0.092 | 25.7 | 24.0 | 24.8 | 0.74 |
| Breast | 0.828 | 0.608 | 0.768 | 0.0813 | 11.5 | 10.8 | 11.3 | 0.61 |
| Rack | 0.703 | 0.588 | 0.640 | 0.0405 | 9.8 | 10.6 | 9.8 | 0.30 |
| Loin | 0.660 | 0.528 | 0.560 | 0.0465 | 9.51 | 9.48 | 9.88 | 0.230 |
| Leg | $2.14^{a}$ | $1.71^{b}$ | $2.00^{a}$ | 0.109 | 29.8 | 30.9 | 31.0 | 1.28 |
| Shank | 0.632 | 0.493 | 0.567 | 0.0546 | 8.69 | 8.88 | 8.57 | 0.446 |
| Flank | 0.350 | 0.258 | 0.370 | 0.0432 | 4.89 | 4.58 | 5.42 | 0.447 |

[a,b]Within a row and comparison, means without a common superscript letter differ ($P < 0.05$).

**Table 6**. Yields and proportions of separable carcass tissues and primal cuts for Boer × Spanish, Spanish, and Boer × Angora wethers consuming a concentrate-based diet and slaughtered at 212 d of age

| | Genotype | | | | Genotype | | | |
|---|---|---|---|---|---|---|---|---|
| Item | Boer × Spanish | Spanish | Boer × Angora | SE | Boer × Spanish | Spanish | Boer × Angora | SE |
| | kg | | | | % of Carcass | | | |
| Total carcass half | | | | | | | | |
| Lean | $4.00^{a}$ | $3.12^{b}$ | $3.63^{ab}$ | 0.236 | 57.7 | 57.6 | 55.7 | 0.79 |
| Bone | 1.81 | 1.56 | 1.82 | 0.105 | $26.1^{b}$ | $28.9^{a}$ | $28.0^{a}$ | 0.56 |
| Fat | $1.13^{a}$ | $0.74^{b}$ | $1.09^{a}$ | 0.120 | 16.2 | 13.5 | 16.3 | 1.10 |
| | % of Cut | | | | % of Carcass | | | |
| Shoulder | | | | | | | | |
| Lean | $61.6^{a}$ | $63.5^{a}$ | $58.0^{b}$ | 1.03 | 28.4 | 27.0 | 26.0 | 0.75 |
| Bone | 21.8 | 23.5 | 25.2 | 1.43 | 22.2 | 20.0 | 22.4 | 1.29 |
| Fat | 13.4 | 10.9 | 13.2 | 1.11 | 22.2 | 20.4 | 20.2 | 1.95 |
| Breast | | | | | | | | |
| Lean | 45.6 | 44.2 | 37.0 | 3.17 | 9.4 | 8.6 | 8.0 | 0.86 |
| Bone | 23.7 | 28.5 | 28.4 | 2.48 | 10.8 | 10.6 | 11.4 | 0.74 |
| Fat | 28.6 | 24.1 | 34.2 | 3.59 | 20.8 | 20.0 | 23.5 | 2.22 |
| Rack | | | | | | | | |
| Lean | 44.3 | 41.2 | 45.3 | 2.25 | 7.8 | 7.8 | 8.0 | 0.41 |
| Bone | 39.8 | 40.0 | 38.4 | 2.09 | 15.5 | 15.1 | 13.5 | 0.94 |
| Fat | 14.2 | 15.5 | 13.8 | 2.04 | $8.6^{b}$ | $12.3^{a}$ | $8.2^{b}$ | 0.73 |
| Loin | | | | | | | | |
| Lean | 58.0 | 54.7 | 55.9 | 1.84 | 9.5 | 9.2 | 10.0 | 0.30 |
| Bone | 22.6 | 27.1 | 25.1 | 1.29 | 8.2 | 9.1 | 8.9 | 0.39 |
| Fat | 18.1 | 16.9 | 17.4 | 1.58 | 10.5 | 12.2 | 10.6 | 0.58 |
| Leg | | | | | | | | |
| Lean | 65.0 | 67.6 | 68.1 | 1.81 | 34.8 | 37.1 | 38.1 | 1.24 |
| Bone | $22.6^{b}$ | $26.5^{a}$ | $23.8^{b}$ | 0.92 | 26.6 | 29.0 | 26.6 | 1.21 |
| Fat | 7.3 | 5.4 | 7.8 | 0.97 | 13.7 | 12.7 | 14.8 | 1.60 |
| Shank | | | | | | | | |
| Lean | 65.0 | 65.6 | 64.0 | 0.85 | 10.1 | 10.3 | 10.0 | 0.49 |
| Bone | 28.3 | 28.2 | 28.3 | 1.16 | 9.8 | 8.9 | 8.7 | 0.60 |
| Fat | 5.8 | 4.5 | 6.1 | 0.98 | 3.2 | 3.1 | 3.2 | 0.54 |
| Flank | | | | | | | | |
| Lean | 64.6 | 56.4 | 59.3 | 4.16 | $5.7^{a}$ | $4.4^{b}$ | $5.7^{a}$ | 0.35 |
| Fat | 34.8 | 42.6 | 40.6 | 4.14 | 11.0 | 15.2 | 14.0 | 2.04 |

[a,b]Within a row and comparison, means without a common superscript letter differ ($P < 0.05$).

to values of Oman et al. (2000). Similar to our results, in Spanish × Boer and Spanish male goats fed a high-concentrate diet, Oman et al. (2000) found that proportions of separable lean, bone, and fat in individual primal cuts were not markedly influenced by genotype.

The high carcass lean contributions of leg (36.7%) and shoulder cuts (28.0%) noted in the present study are in close agreement with findings of Hogg et al. (1992) for Saanen goats (35.4 and 30.6% for leg and shoulder cuts, respectively). In the present experiment, breast (21.4%) and shoulder cuts (20.9%) provided the highest quantities of carcass fat. However, Hogg et al. (1992) observed 28.7 and 15.5% of carcass fat in the shoulder and breast cuts, respectively.

*Primal Cut-Carcass Relationships.* Correlation coefficients for weights of separable tissue in primal cuts and the carcass were all highly significant ($P < 0.001$). Correlations for weights of lean between the carcass and the loin, rack, shoulder, shank, breast, flank, and leg were 0.93, 0.83, 0.92, 0.91, 0.82, 0.89, and 0.91, respectively. For weights of fat, correlations between the carcass and the loin, rack, shoulder, shank, breast, flank, and leg were 0.91, 0.70, 0.86, 0.79, 0.91, 0.63, and 0.85, respectively. There were lower correlations between weights of bone in the carcass and the primal cuts (0.83, 0.72, 0.67, 0.76, 0.74, and 0.74 for loin, rack, shoulder, shank, breast, flank, and leg, respectively). Therefore, weights of separable tissue in the loin cut, followed by primal leg cut, were most highly related to weights of separable tissue in the carcass.

## Implications

With consumption of a concentrate-based diet, post-weaning growth from 9 to 24 wk of age was greater for Boer crossbreds than for Spanish wether goats, with little or no difference between Boer × Spanish and Boer × Angora goats. Because of more rapid growth of Boer crossbreds than of Spanish goats, weights of the carcass and primal cuts were greater or tended to be greater for Boer crossbreds. However, relative to carcass or empty body weight, under production conditions similar to those in this experiment, slaughter and carcass variables should be similar for Boer × Spanish, Boer × Angora, and Spanish goats. Further research is warranted to evaluate effects of other production conditions on performance comparisons of different types of meat goats raised in the United States.

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