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EVALUATION OF THREE MEAT GOAT BREEDS FOR DOE FITNESS AND REPRODUCTIVE PERFORMANCE IN THE SOUTHEASTERN UNITED STATES

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INTRODUCTION

Goat production in the United States is characterized as an emerging, non-traditional, alternative, agricultural enterprise. Reproductive output of the doe herd is a major determinant of profitability in a commercial meat goat enterprise. The Boer goat from South Africa is a breed developed for meat production that evolved from selection pressures placed on common goats of the region by farmers (Casey & Van Niekerk 1988). The Kiko from New Zealand is a composite goat breed exported to the U.S. in the mid-1990s that was developed for meat production through systematic crossbreeding of selected feral does with dairy bucks and interbreeding of crossbred offspring (Batten 1987). Boer and Kiko importations created opportunities for U.S. producers to introduce new, unique germplasm into breeding programs. No goat breed in the U.S. had been developed for meat production. Milk, fiber, and brush control were primary reasons of raising goats with meat being a by-product (Glimp 1995). Non-descript range goats not of dairy- or fiber-type commonly called "Spanish" goats evolved through natural selection from stock first imported to the semi-arid southwestern U.S. by Spanish explorers (Shelton 1978; Mason 1981).

Reproductive merit is an important consideration when evaluating the strengths and weaknesses of new breeds in particular production environments. Maternal breed has received limited research attention in meat goats. Breed of dam affects kid performance among various sire breeds (Goonewardene et al. 1998; Ward et al. 1998); however, such studies have not focused on doe reproductive rates. An exploratory study suggested that Kiko does have higher reproductive rates than Boer does (Browning et al. 2004). Reproduction and survival are fitness traits strongly influenced by environmental origins and(or) associated selection pressures (van der Waaij 2004). This report focused on reproductive rates and other fitness indicators of Boer, Kiko, and Spanish does under the humid, subtropical pasture conditions of the southeastern United States.

MATERIAL AND METHODS

Animals. Boer (n = 66), Kiko (n = 51), and Spanish (n = 51) straightbred (94 to 100%) does were managed together on pasture over two years (September 2003 to August 2005). The Spanish population was represented by six seedstock farms and at least 13 sires. The Boer and Kiko groups were from larger numbers of seedstock farms and sires. Does were between 1.5 and 5 years old with age and parity balanced across breeds. All goats were managed on the Tennessee State University research station in Nashville, Tennessee, USA (36°17'N, 86°81'W). Nashville is 183 m above sea level and has a 30-year annual precipitation amount of 1222 mm. The 12-month precipitation amount during the study was 1434 mm for Year 1 (September, 2003 to August, 2004) and 1338 mm for Year 2 (September, 2004 to August, 2005).

Protocol. Does were managed on tall fescue (*Festuca arundinacea*) and bermudagrass (*Cynodon dactylon*) pastures supplemented with orchardgrass hay (*Dactylis glomerata*) for *ad libitum*

consumption and 454 g/d of a commercial concentrate (160 g CP/kg, 69% TDN, as-fed) medicated with monensin. Stocking rates were approximately 15 does/hectare. Does were exposed for 45 days each fall to Boer, Kiko, and Spanish bucks in a three-breed diallel mating scheme and kidded on pasture in March and May. The breeding program resulted in a total of 98 Boer, 89 Kiko, and 97 Spanish doe matings across the two years. Kids were not creep-fed and buck kids were not castrated. Dams and kids were weighed at birth and at weaning (3 months). Does were strategically dewormed against *Haemonchus contortus* twice each year, including individual doe anthelmintic treatments at kidding. Additional dewormings were administered to does displaying clinical signs of internal parasitism (e.g., weakness, anemia, diarrhea, edema). Fecal samples were collected from a subset of does around weaning to determine fecal egg count as an indication of internal *H. contortus* burden. Does were also treated individually for hoof scald/hoof rot upon observation of lameness. The herd was not vaccinated for hoof rot.

Statistics. Data were tested with ANOVA techniques using MIXED model procedures of SAS (SAS Institute, Cary, NC, USA). Fixed effects in the models included breed of doe, service sire breed, month of kidding and study year. Animal within breed of doe was specified as a random term in the mixed effects models. Fecal egg counts (FEC) were log-transformed using a log10(FEC+100) conversion before analysis. Binary responses such as successfully weaning kids and doe survival were also analyzed using MIXED models. Probability levels less than .05 for the F-statistic indicated significant differences among breeds of doe. The Tukey-Kramer means separation test was used to compare least squares means for all traits (alpha = 0.01).

RESULTS AND DISCUSSION

The proportion of doe matings resulting in at least one live kid at birth was lower for Boer (81.1 ± 3.1%) than for Kiko (95.2 ± 3.3%; $P < 0.01$) and Spanish does (91.8 ± 3.2%; $P < 0.04$). Spanish dams at kidding were lighter ($P < 0.01$) than Boer and Kiko dams (43.2 ± 1.0 vs. 49.7 and 48.4 ± 1.0 kg). Litter size and litter weight at birth did not differ ($P > 0.4$) between Boer (1.85 ± 0.07 kids, 6.32 ± 0.21 kg), Kiko (1.89 ± 0.07 kids, 5.93 ± 0.22 kg), and Spanish dams (1.94 ± 0.07; 6.20 ± 0.22 kg). Stillbirths were not included in the dataset. Litter characteristics at birth were not affected by breed of dam. However, Boer does exhibited lower levels of fertility as expressed by parturition rates as compared with Kiko and Spanish doe contemporaries.

The proportion of doe matings resulting in at least one live kid weaned was lower ($P < 0.04$) for Boer (69.5 ± 3.7%) than for Kiko (91.7 ± 3.9%) and Spanish does (86.2 ± 3.8%). Within the population of does delivering kids, the proportion of does that weaned kids tended to be higher for Kiko (95.9 ± 2.7%; $P = 0.02$) and Spanish (93.7 ± 2.6%; $P = 0.08$) compared with Boer (85.8 ± 2.6%). Spanish dams at weaning were lighter ($P < 0.01$) than Boer and Kiko dams (43.1 ± 1.0 vs. 50.2 and 48.1 ± 1.0 kg). Does did not experience significant weight loss during the preweaning period. Reproductive performance and efficiency as characterized by litter traits as weaning were generally lower for Boer does than for Kiko and Spanish does in the herd (Table 1).

Postpartum weight loss would not seem to explain the differences expressed between the dam breeds for reproductive output at weaning. Internal parasitism and hoof infections are obstacles to efficient, profitable goat production in high rainfall regions. Annual cases of lameness and internal parasitism requiring treatment in this study were more numerous in Boer does than in Kiko and Spanish does (Table 2). A larger proportion of Boer does experienced lamensss (78.3 ± 5.2%), multiple incidents of lameness (53.5 ± 4.6%) and required unscheduled anthelmintic treatment (43.2 ± 4.0%) than Kiko (40.1 ± 5.5%, 12.7 ± 4.9%; 9.8 ± 4.2%) and Spanish (41.6 ± 5.3%, 22.5 ± 4.7%; 13.9 ± 4.1%) does

per year. Geometric mean fecal egg counts for Boer, Kiko, and Spanish does were 521.7, 298.1, and 181.3 eggs/g, respectively. Survival rates in Table 2 include does that died and does culled due to proven infertility or chronic health problems.

Table 1. Litter traits at weaning as influenced by breed of doe.

	Breed of doe			
Trait	Boer	Kiko	Spanish	s.e.
Per doe weaning kids				
Litter size, kids/dam	1.51 [B]	1.69 [AB]	1.79 [A]	0.07
Litter weight, kg	26.5	30.2	28.0	1.2
Litter weight / unit doe wt, %	53.5 [B]	64.3 [A]	66.7 [A]	2.6
Per doe exposed to bucks				
Litter size, kids/dam	1.03 [B]	1.54 [A]	1.54 [A]	0.09
Litter weight, kg	18.4 [B]	28.1 [A]	24.2 [A]	1.6

[AB] Means with different letters differ significantly.

Data pertaining to fitness indicators may help to explain the lower reproductive rates of the Boer does. The need for frequent anthelmintic treatments (at 4- to 6-week intervals) in Boer-influenced herds is a common remark of producers in this region. Doe genotypes with hardiness on parasite-contaminated pastures would benefit these producers. Internal parasite resistance has been demonstrated in other doe breeds (Baker et al. 1998). Spanish and Kiko does seem to possess this characteristic. An unexpected result was Spanish does performing at levels similar to the Kiko. It was thought that Spanish does would perform more like Boer does given their similar semi-arid origins as opposed to the humid origin of the Kiko. In computer simulations involving Boer and Spanish does, reproductive traits under excellent forage conditions were similar for the breeds or tended to favor Boer does, whereas Spanish does had higher reproductive output under poor forage conditions (Blackburn 1995). The separation of Spanish and Boer does in the current project concur with Blackburn (1995) for moderate to low forage conditions. The divergence of Kiko and Boer does in the current project agree with the earlier exploratory project at this research station (Browning et al. 2004). Reasons for relatively poor reproductive performance and generally poor disease resistance of the Boer does are not clear. Explanations may lay in relationships between selection for growth traits under less than challenging environments and correlated negative responses for reproductive and health traits as environmental sensitivities develop (van der Waaij 2004). Blackburn (1995) and van der Waaij (2004) both suggest that genotype x environmental interactions can exist that put larger, high growth rate genotypes at a disadvantage in a limited resource environment. Unimproved goats have been reported to be more disease resistant than Boer goats in South Africa (Ramsay et al. 1978).

Table 2. Fitness indicators as influenced by breed of doe.

	Breed of doe			
Trait	Boer	Kiko	Spanish	s.e.
Lameness, cases/doe/yr	2.02 [B]	0.58 [A]	0.79 [A]	0.16
Internal parasitism, cases/doe/yr	0.54 [B]	0.10 [A]	0.17 [A]	0.06
Fecal parasite egg counts, eggs/g [C]	2.79 [B]	2.60 [A]	2.45 [A]	0.06
Annual doe survival rate, %	78.5 [B]	99.1 [A]	93.9 [A]	3.1

[AB] Means with different letters differ significantly.
[C] Log-transformed means.

CONCLUSIONS

Reproductive performance of the doe herd has a major impact on the sustainability and profitability of a commercial meat goat enterprise. Under the environmental conditions of this research station, Boer does were not as fit or productive as Kiko or Spanish does. Poor fitness in a herd results in lower reproductive output, higher maintenance costs, and(or) higher attrition rates. Each of these responses would be expected to increase break-even prices, thus reducing the chance of profit. Grazing environments are dynamic and often less than ideal. In the southeastern U.S., efficient meat goat production is difficult because warm, humid pasture environments provide ideal habitat for gastrointestinal parasites and hoof pathogens. Spanish and Kiko does displayed general disease resistance and appear to be more suited for commercial meat goat production in this humid, subtropical region.

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