DIFFERENCES IN GROWTH AND CARCASS CHARACTERISTICS IN YOUNG GOATS OF DIFFERENT GENOTYPES

A Thesis

by

BRAD WILLIAM ROEDER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2000

Major Subject: Animal Science

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ABSTRACT

Differences in Growth and Carcass Characteristics in Young

Goats with Different Genotypes. (May 2000)

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One hundred seventy five spring born wether goats consisting of five breeds: Boer-Spanish (BxS), Boer-Angora (BxA), Angora-Spanish (AxS), Spanish (S), Angora (A), and 12 Boer-Spanish intact males (BxSint) were used. Wethers were randomly assigned by breedtype to pen and treatment (11hd in each of 2 pens and 13 hd on pasture), while BxSint were divided into 2 pens each with 6 hd. Goats had ad libitum access to feed containing 64 % TDN and 14% CP. Goats were adjusted to feed for 20 d then weighed in 14 d intervals for 154 d with refusals taken every 3 d. Pasture goats were grazed on native Texas range and weighed on the same 14 d interval as fed goats. Goats were slaughtered, chilled and measurements were taken. BxS had the highest AGD followed by the BxA and S (143 g/d, 119 g/d and 116 g/d). A and SxA had the lowest ADG (81g/d and 91 g/d). Feed efficiency and intake followed the same trend as ADG with BxS consuming the most feed (1.15 kg/hd/d) and A consuming the least (.89 kg/hd/d). BxS were the most efficient while A were least efficient (7.55 kg/kg vrs 11.70 kg/kg). Generally, BxS had the heaviest carcasses, least fat at the 12^{th} rib, largest loineye area, largest leg circumference, highest percent kidney and pelvic fat (KP), and produced the longest carcasses. Generally A had the lightest carcasses, lowest dressing percentage, most fat at the 12^{th} rib, smallest loineye area, smallest leg circumferences, lowest percent KP, and shortest carcasses. Goats did deposit more fat in their body wall than over their loineyes (1.91 cm vrs .16 cm- all breed avg.). Few differences were observed due to breed type in pasture goats. A were removed from this portion of the study due to loss in numbers from predation and starvation. Fed goats gained faster and produced fatter, heavier muscled carcasses than pasture goats. Castration increased feed efficiency, percent hindsaddle, body wall thickness and percent KP; while decreasing leg circumference and carcass length.

DEDICATION

Dedicated to my family and friends who make life worth living.

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INTRODUCTION

The goat industry in the United States has undergone drastic change in the past four years. The shift was initiated by the phasing out of the mohair incentive program. Additionally, there was a corresponding decrease in mohair prices resulting in liquidation of many Angora herds (Gipson, 1995). Some producers utilized the benefits of crossbreeding by crossing meat type sires on foundation Angora does. In January of 1993, the five-year quarantine in New Zealand expired allowing the Boer goat to be imported into the United States with out restriction. The arrival of the Boer goat shifted industry emphasis from primarily the production of fiber, mohair and cashmere, to meat production. Because of this industry shift, there has been a change in commercial goat production in Texas, as well as the United States.

One aspect, which increased the interest in meat goats, is their ability to produce a very lean carcass. Goats generally have higher lean and lower fat content than other domestic breeds of livestock (Glimp, 1995). Johnson et al. (1995) compared goat meat to beef and chicken; an 85-gram sample, of goat meat had 7.2 grams less fat than beef and .5 grams less fat than chicken. Johnson found no difference in protein content in comparing the three species.

The largest market for goat meat today is in the ethnic communities where goat meat consumption is interwoven with religious beliefs and customs (Pinkerton, 1993). The number of immigrants entering the United States was 61,150 individuals in 1981-

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This thesis follows the Journal of Animal Science Style and Form.

more than double the number in 1960. Ethnic cultures want to keep their identification from being merged into the dominant society. Both food preference and religious beliefs are ways of retaining their separate identities.

Goats have also been utilized in biological brush control (Glimp, 1995). The Spanish and Angora goats have been historically used to control brush that reduces the stocking rates for cattle and sheep. Stocking rates may be increased for sheep and cattle because goats are not in direct competition for forage. Goats are primarily browse consumers with little if any consumption of grasses. When grazed in conjunction with cattle and/or sheep they provide a desirable control of browse species on the rangeland. By controlling the browse, grass production is increased due to decreased water uptake and less shading.

There are several types of goats that are available for producers to use in a production enterprise: the Angora, Spanish, Boer, Dairy breeds, and Myotonic. The Angora is primarily a fiber type-producing breed, which produces a product known as mohair. Poor reproductive efficiency has been a problem in the commercial production of Angoras (Shelton and Groff, 1984). The Angoras have been selected for many generations for hair production traits while reproduction, skeletal conformation, and lean muscle mass have largely been ignored.

The Spanish goat breed can be described as a feral goat where several different breeds contribute to its genetic base (Gipson, 1995). Additionally, the breed composite is not the same for all geographical locations. Spanish goats require low labor input, and are prolific, as they usually have twins when nutrition is adequate. Characteristically, they are a wild goat with only a handful of producers in the industry making an effort to improve the breed.

The Boer goat is a native of South Africa is one of the few breeds of goat that has been selected primarily for meat production (Gipson, 1995). The Boer breed has also been selected for being docile and having a certain color pattern while maintaining maternal abilities.

There are several dairy breeds that have been intensively selected for milk production and are classed together: the Nubian, Alpine, Sannen, Toggenburg, and LaMancha. They are characterized as large framed, docile goats. The dairy breeds can develop large pendulous udders, which inhibit their use under range conditions (Gipson, 1995).

The Myotonic or fainting goat is thought to have originated in Tennessee. The Myotonic goats suffer from a genetic condition that causes their muscle to contract or stiffen when frightened or startled. They are heavy muscled goats, but are small framed when compared to other breeds. The fainting of the Myotonic goat causes some concern for range producers, as goats may be unable to escape predators (Gipson, 1995).

With the availability of the above-mentioned breeds of goats in crossbreeding programs, it would be beneficial to the industry to obtain insight into the performance of the possible crossbred offspring of these goats. The intent of this study is to document the impact of crossbreeding of the various breeds on: average daily gain, feed efficiency and carcass traits.

LITERATURE REVIEW

Effects of breed type on average daily gain.

There is limited data available for goat production traits. Research has been done in the cattle, sheep and swine industries that indicates there will be differences in growth rate due to differences in breed type. Smith et al. (1976) reported differences in growth rate and feed efficiency due to breed effect in crossbred steers and heifers. Thonney et al. (1981) also reported that small framed Angus steers had diminished growth rates, reduced feed consumption and had higher feed/gain ratios at similar body weights than Holstein steers. Crouse et al. (1981) reported that Sullfolk sired lambs had higher average daily gain (ADG) than Rambouillet sired lambs. Lloyd et al. (1981) also reported that Sullfolk- Targhee lambs had higher ADG than Targhee lambs.

Hass et al. (1983) reported the Boer goat when crossed on the Small East Africa Goat (SEAG) improved ADG to 65 g/d as compared to the 32 g/d expressed by the full SEAG. Waldron et al. (1995) and Machen et al. (1996) also reported that Boer cross goats had higher ADG and were more efficient at converting feed to lean than our Spanish goats. Waldron et al. (1995) performed a two-year study between Spanish and Boer-Spanish crosses (BxS). They reported that in both years, under feedlot conditions, the Boer crossbred goats had higher ADG than Spanish by .036 kg/d. However, under poor range conditions, with limited forage availability, there was no difference in ADG; but under moderate range conditions, the Boer crossbred animals had higher ADG than Spanish goats. Waldron et al. (1995) suggested that there tended to be an environment-breed interaction.

Machen et al. (1995) determined the ADG of Spanish (.11 kg/d) were lower than Boer cross (.15 kg/d) and (.22 kg/d) fullblood Boer goats. This suggests that only a small amount of the Boer goat is needed to improve ADG.

Huston and Waldron (1996) reported similar results with BxS having the highest ADG, but Spanish were the lowest when compared with BxA and SxA. The same bucks did not sire Spanish and SxA therefore the difference in ADG between Spanish and SxA could be due to sire effect instead of heterosis. In another experiment, the same bucks sired the two breeds and no differences in ADG were observed between the two groups (Huston and Waldron, 1996). They reported that Boer-sired kids grew 35 % faster than Spanish-sired kids.

McGrown and McKenzie-Jake (1996) also looked at the differences in growth in Florida Native (FN) as compared to Boer x Florida Native (BxFN) kids. They found that BxFN kids had higher ADG than FN kids in preweaning trials, but FN had higher ADG than BxFN in postweaning trials.

Hart et al. (1993) found breed effects with Alpine, Nubian and Angora in ADG, but differences between means were not the same on wheat pasture as compared to bermuda grass ($P < .001$). On wheat pasture the Alpine, Angora and Nubian breeds gained 46.5 g/d, 61.8 g/d and 44.1 g/d, respectively; on Bermuda grass their gains were 24 g/d, -7.6 g/d, and 18.6 g/d, respectively. There may have been a genotype-environment interaction, as the Angora performed the best on wheat pasture ($P < .05$); yet it had the lowest ADG on Bermuda grass ($P < .05$). The Angora's nutrient requirement for hair production may limit their ability to adapt, making them more vulnerable to nutritional stress (Hart et al. 1993).

Effects of breed type on feed consumption and efficiency

Waldron et al. (1995) reported that Boer sired kids had higher feed consumption but with better feed efficiency than Spanish kids. Boer crossbred kids consumed 1.43 kg/d and converted 6 kg of feed / kg of gain, while Spanish consumed 1.3 kg/d and converted 7.5 kg of feed per kg gain. They stated that when feed consumption was expressed as a percent of body weight, all goats consumed the same amount. However, Machen et al. (1996) found that Boer-Spanish cross kids consumed more feed even when converted to a percent of body weight. Boer influenced kids also were more efficient, with Boer and Boer crosses converting less than 8.3 kg of feed per kg of gain; while the Spanish required 2.5 kg more feed per kg of gain.

Effects of breed type on carcass characteristics

Carcass data with large numbers of goats has been limited in Texas due to the fact that large slaughtering facilities have not been available. Both Waldron et al. (1995) and Machen et al. (1996) slaughtered a representative sample of the goats from feeding trials. Waldron et al. (1995) reported that in the 1994, Spanish had higher dressing percentages than Boer cross (56.1 vs. 54.7). In addition, Boer crosses were fatter, had more KPH and larger loin circumference than Spanish goats. In 1995 Waldron et al. (1995) found no differences in carcass traits except trends for loin area were the same. Machen et al. (1996) found Boer crosses had heavier carcasses, larger loineye areas and less cooler shrink than Spanish goats. They also stated there were no dressing percentage. Riley et al (1989) reported that Spanish goats had higher dressing percentages, larger loineyes and more KPH than Angora goats. However, he reported that Spanish goats tended to have a higher percentage of lean and lower percentage of fat than Angoras.

Oman et al. (1995) conducted a study that included Spanish, Angora, Spanish-Angora (SxA) and Boer-Spanish (BxS). They reported that SxA and BxS had heavier carcass weights than Angora and Spanish goats. Angoras also had smaller loineye area, shorter carcass length and smaller leg circumferences; but the Angora and the SxA had the highest marbling score. The Angora and the SxA were the highest in adjusted fat while the Spanish were the leanest over the loineye.

When examining percentages of lean, fat and bone, Oman et al. (1995) stated that BxS and Spanish had the highest percent lean with Angora having the lowest lean percentage. In addition, SxA and Angora goat carcasses had the highest percent fat with Spanish goat carcasses having the lowest percent fat. Angora carcasses also had the highest amounts of seam fat. When evaluating percentages of wholesale cuts, Oman et al. (1995) found that Spanish goat carcasses had the highest percentage of shoulder, while Angora carcasses had the highest percentage of rack.

Koch et al. (1976) found significant differences in the growth rate of retail products, fat trim and bone among sire breed groups. Koch et al. (1976) also found that there was a positive association between growth rate and percentage of retail product or bone and a negative association with fat trim.

Effects of plane of nutrition on growth rate

In other species, the plane of nutrition has been shown to play an important role in growth and development of young animals. Studies on Angora goats have focused on hair production and fiber diameter rather than growth. Huston and Waldron (1996) summarized studies that compared lower levels of nutrition to high levels of nutrition in a variety of breeds of goats. They stated that Angora goats where the only breed that appeared to have a protein requirement above 14% CP. Huston and Waldron (1995) reported that when Spanish and BxS goats were grazed on pasture or fed a ration with either 14% CP or 16% CP, there was a significant difference between the pasture goats and the fed goats for ADG (9.9 g/d vs. 137 g/d, respectively). There was no difference between the 14% CP and the 16% CP treatments. Huston and Waldron (1995) also reported that although goats on a low roughage diet gained slower and consumed less, they were more efficient, than goats on a high roughage diet.

Effects of plane of nutrition on carcass characteristics

Johnson and McGowan (1996) conducted a study where kids were fed either a 16% CP ration with peanut hay fed ad libitum (intensive) or fed .23 to .34 kg/hd/d of cracked corn and grazed continuously on millet and Bahiagrass (semi-intensive). Kids from the intensive program were heavier, had heavier carcass weights, higher dressing percentages, and larger loineyes. They reported no significant difference in percent muscle, bone or fat between the two treatments.

Oman et al. (1995) reported that fed goats produced heavier carcasses that had higher dressing percentages than pasture goats. In addition, the fed goats had larger loineye areas, greater leg circumferences, longer carcass lengths, more fat over the loineye and thicker body walls than pasture goats. When goats were broken down into percent lean, muscle and bone, fed goats had higher percent lean and fat and less bone than pasture goats.

Effects of castration on growth rate

Waldron et al. (1995) reported intact males (Boer-Spanish and Spanish) tended to have higher ADG than wethers by .017 kg/d under feedlot conditions. Mahgoup and Lodge (1996) studied the effects of castration on Batina goats and found that intact males had higher ADG than wethers from 8 weeks of age to 24 weeks of age. However, Sidhar et al. (1978) reported that castration of native Indian goats improved ADG through twelve months of age. Both Misra et al. (1986) and Chawla and Nath (1979) reported no decrease in ADG due to castration.

Effects of castration on carcass characteristics

Mahgoup and Lodge. (1996) studied the effect of castration on the Batina goats that were 6 months old. They found no difference in carcass weight and dressing percentage due to castration. They found that intact males had a higher percentage of lean and bone while containing less fat. Ruvana et al. (1992) found the same effects with castration when Toggenburg and Nubian sires were crossed on East Africa goats and the Galla goats. Trends were similar on Iraqi indigenous black goats (Tahir et al. 1994) and with Alpines and Sannen goats (Anous and Shahin, 1993). Johnson et al. (1995) reported there was no advantage in dressing percentage or carcass weight due to castration; but wether goats had more KPH, more fat over the loineye and higher marbling using Florida native goats and their crosses on Nubians and Spanish goats. Additionally, they reported an increase in fat and decrease in muscle due to castration.

MATERIALS AND METHODS

One hundred seventy five spring born wether goats were bought directly from producers to eliminate stress and exposure to disease. They consisted of 5 breeds: Boer-Spanish (BxS), Boer-Angora (BxA), Angora-Spanish (AxS), Spanish (S) and Angora (A); and Boer-Spanish intact males (BxSi). Upon arrival at the Texas A & M Sheep and Goat Center, goats were given levamisole phosphate (Tramisol)* according to body weight. Goats assigned to the wether treatment were castrated using elastrator bands. All goats were dehorned using a Barnes dehorner and identified with a numerical ear tag. All goats were vaccinated with 2 cc of clostridium perfringens (types C & D) and tetanus (Anchor)* subqutaneously and given a booster three weeks later. A topical antibiotic (Furox)* was applied to wounds initially and fly repellant applied as needed. Angoras, BxA and AxS were shorn prior to initiation of study. Goats were fed the trial ration for 25 d as an adjustment period to the feed and to allow for healing from castration and dehorning. Seven days before the trial started, goats were weighed and randomly assigned to treatment groups. Distributions of the goats within breed type and feeding regimen are reported in Table 1.

Table 1. Distribution of goats with in breed type and feeding regimen.

Breed type	Feeding regimen	
	Feedlot	Pasture
Angora	11 hd	0 hd
Boer- Angora	11 hd	9 hd
Boer- Spanish	11 hd	10 hd
Boer- Spanish intact males	6 hd	0 hd
Spanish	11 hd	10 hd
Spanish- Angora	11 hd	10 hd

The trial was started on August 26, 1996 (d 1). Goats were weighed at 0700 prior to morning feeding. Goats were separated into pens that measured 2.4 m wide and 12.20 m long with 2.14 m of feeder space per pen. The exception was the intact males, which had 1.2 m of feeder space. Feeders were placed on the outside of each pen 45.7 cm off the ground, so any feed spilled on the ground could be measured as refusals. One 30-liter water trough, supplied two pens with fresh water. Goats were penned randomly, except for BxSi which were placed in pens 1 and 5 due to limited trough space. Goats were fed a pelleted ration containing 14 % crude protein and 67 % total digestible nutrients (Table 2). Feed was offered twice a day. Refusals were collected and weighed every third day. Pasture wethers were confined on native Texas pasture along the Brazos River at the Texas A & M Beef Center, without feed supplementation. Pasture goats were penned every night due to predators, until 103 d when guard dogs were placed with goats.

All goats were treated orally with 1 cc of Ivomectin (Ivomec)* on d 35 as fecal egg counts exceeded the threshold (2500 eggs per gram) in the penned Angoras (Fecal counts were done according to guidelines established in Texas A & M Extension bulletin L-5094). Goats were treated again with same procedure on 88 d as fecal egg counts in pasture goats exceeded preset threshold. They were also given 2 ml of tylosin (Tylan 200)* intramuscularly in the neck on days 46 d and 58 d due to exhibition of upper respiratory irritation most likely caused by change in weather (wet and cooler). On d 164, Angoras BxA, and SxA were shorn. All goats were isolated from feed and water 24 hr before final weight collection 169 d. Average daily gain was recorded for each individual goat. Feed efficiency and intake were measured as an average of the pen, as pens were group fed. Feed intake as a percent of body weight was measured with the weight at the beginning of each period used as the body weight for that weight period.

Goats were allowed water and slaughtered the next day at Rosenthal Meat Science Center. Hot carcass weights were taken on the kill floor to measure dressing percentage. Carcasses were chilled for 24 hrs before measurements and cold carcass weights were taken. Dressing percent was calculated with KP fat left in and percent cooler shrink was the difference between hot and cold carcass weight, as a percent of hot carcass weight. Carcasses were split between the 12^{th} and 13^{th} rib for fat and loineye measurements. Fat thickness at the 12^{th} rib was measured one-third of the way around the loineye from the midline. Body wall thickness was measured 5.1 cm from the edge of the *longissimus dorsi*. Carcass length was measured from the point of the hock to the point of the shoulder.

Table 2. Pelleted feed nutrients and ingredients

Nutrient	Unit	Amount	Ingredients	Amount (kg)
Protein	%	14.52	Corn	272.4
Fat	%	2.62	Milo	301.5
Fiber	%	9.61	Ammonium Sulfate	3.6
Calcium	%	.72	Cottonseed Meal	112.6
Phosphorous	%	.36	Ammonium	9.1
Available	%	.12	Chloride	90.8
Phos.	%	67.5	Cottonseed Hull	.204
TDN	Mcal/kg	77.0	Deccox	45.4
NE M	Mcal/kg	48.1	Dehy. Alfalfa 17%	22.7
NE G	%	14.7	Dried Lignin	12.3
ADF	%	23.3	Ground Lime	2.27
NDF	%	2.12	Sheep Fort.	2.27
NPN	%	10.0	Salt Mixing	
R.F.	%	.39		
Salt	%	.69		
Potassium	%	.36		
Sulfur	%	.23		
Magnesium	ppm	44.3		
Manganese	ppm	165.64		
Iron	ppm	9.28		
Copper	ppm	.67		
Cobalt	ppm	36.14		
Zinc	ppm	.99		
Iodine	ppm	.43		
Selenium	ppm	.89		
Chlorine	%	.12		
Sodium	IU/kg	11983.7		
Vit. A	IU/kg	553.3		
Vit. B	IU/kg	22.6		
Vit. E	IU/kg	.36		
Vit. K	%	90.4		
D.M.		1.97		
Ca:P				

RESULTS AND DISCUSSION

Effects of breed type on average daily gain (ADG) with in fed goats

BxS had a higher ADG (.143 kg/d respectfully) (P<.05) than all other breeds, while Angoras and SxA did not differ (P=.23) and had the lowest ADG (P<.05) compared to other breeds (.081 kg/d and .091 kg/d respectfully). BxA and Spanish did not differ (P=.70) in ADG (.119 kg/d and .116 kg/d respectfully) (Table 3). Huston et al. (1996) reported that the protein requirement may be higher than 14% for Angora. Waldron et al. (1996) and Machen et al. (1995) reported the same differences in BxS and Spanish goats. Machen also reported that 1/4 Boers (3/4 Spanish) also out performed Spanish, suggesting that maybe only 1/4 Boer is need to influence ADG. Huston et al. (1996) reported similar results with BxS having the highest ADG, but Spanish were the lowest when compared with BxA and SxA. The same bucks did not sire Spanish and SxA and therefore the difference in ADG between Spanish and SxA could be due to sire effect instead of heterosis. In another experiment the same bucks sired the two breeds and no differences in ADG was observed between the two groups (Huston et al.1996). When goats are broken down into breed of sire, we see that Boer-sired kids gained 26% faster than Spanish-sired kids. Huston reported that Bore-sired kids grew 35 % faster than Spanish-sired kids. Mcgrown et al. (1996) present the only research where Spanish wethers out performed BxS. This trial was preformed in Florida and the postweaning feed only had 58 % TDN as compared to 70 % TDN in the majority of the other trials. The Florida native goats may be more adapted to the tropical environment and an environmental-breed interaction could have occurred environmental-breed interaction have been reported in cattle when animals that were developed in a more temperate area were moved into a tropical area. In the tropical region of Australia, Hereford-Shorthorn crossbreds (HS) were crossed with Brahmans to produce an F1 cross (BX) (Firch et al. 1982). Firch reported that under more temperate conditions the HS out performed the Brahman in ADG. In year one the BX had the highest ADG, with the Brahman only being 20 g/d over the HS. The next year the Brahman had the highest ADG gaining 20 % faster than the BX and 127 % faster than the HS.

Table 3. Mean growth rates, feed efficiency and intake for feedlot goats by breed type.

Items	P value	Angora	Boer x Angora	Boer x Spanish	Spanish	Spanish x Angora	RSD
ADG (kg/d)	.0001	0.081	0.119	0.143	0.116	0.091	0.028
Feed intake (g/hd/d)		818.3	893.5	1043.8	893.5	855.6	
Feed efficiency (kg/kg)		11.70	8.150	7.550	8.550	10.00	

[abcde]Means in same row with different superscript letters are different (P<.05).

Effects of breed type on feed intake with in fed goats

Feed intake reported in Table 3, followed the same trend as ADG. BxS had the highest intake among the breeds followed by BxA and Spanish, which were the same (1043.8 g/d, 893.5g/d and 893.5 g/d). Angora had the lowest feed intake with SxA only being slightly above Angoras (818.3 g/d and 855.6 g/d). This is similar to findings by both Waldron et al. (1996) and Machen et al. (1996) with BxS and Spanish goats. Huston et al. (1996) also reported that BxS consumed more feed than Angoras.

both Waldron et al. (1996) and Machen et al. (1996) with BxS and Spanish goats. Huston et al. (1996) also reported that BxS consumed more feed than Angoras.

When feed intake is expressed as a percent of body weight, all goats for the first two months of the study consumed 37 % to 89 % more than the last two months of the trial. The last two months, the Angoras consumed a higher percent of their body weight (2.3 %), while Spanish consumed the lowest (1.7 %). BxA and BxS consumed 2.0 % of their body weight for the last two months of the trial. This is consistent with the results reported by Machen et al. (1996) between Spanish and BxS, but both breeds more than doubled their feed intake as a percent of their body weight, as BxS consumed 6.1 % of body weight, while the Spanish consumed 5.3 % of body weight.. This could be due to the fact that the goats were older in Machens trial and may have experienced some compensatory gain. In addition, the trial only lasted two months. Waldron reported that both Spanish and BxS consumed around 3.0 % of their body weight.

Effects of breed type on feed efficiency with in fed goats

Feed efficiency that is reported in Table 3 also followed the same trends set by feed intake and ADG. BxS where the most efficient with BxA, Spanish, SxA and Angora following in respective order (7.55 kg/kg, 8.15 kg/kg, 8.55 kg/kg, 10.0 kg/kg and 11.7 kg/kg respectfully). Angora also produced 6.8 lbs. of mohair, which was not calculated into the feed efficiency and thus would make their cost of production go down when the mohair is sold. This dual-purpose breed will have its place in the meat goat industry if mohair prices go up and more emphasis is put on the conformation and growth of Angora. Boer-sired kids were 18 % more efficient than Spanish-sired kids.

Waldron et al. (1996) and Machen et al. (1996) reported similar findings between BxS and Spanish. Huston et al. (1996) reported that BxS were more efficient than Angora.

Effects of breed type on hot carcass weight with in fed goats

Hot carcass weights follow the same patterns as ADG. As the weight of the live goat and the dressing percent are the two main factors that effect carcass weight (Table 4). BxS had the highest ($P<.05$) carcass weight (26.8 kg), while Angora had the lowest ($P<.05$) hot carcass weights (15.8 kg). BxA and Spanish were higher ($P<.05$) in their hot carcass weights than SxA, but did not differ ($P=.38$) (22.0 kg, 22.8 kg and 19.9 kg respectfully). Machen et al. (1996) reported similar findings as BxS had heavier carcass weights than Spanish. Oman et al. (1995) did disagree in that SxA did hang heavier carcasses than Spanish. But the same sire did not produce Spanish and SxA, so this difference could have been due to sire effect. (Huston et al. 1996).

Effects of breed type on dressing percent with in fed goats

Angoras had the lowest ($P<.05$) dressing percent (51.9%) among the breeds. This is partly due to 2.5 % heavier hide weights, which has also been reported as a reason for lower dressing percent in Simmental cattle (Adams et al. 1973). Other offal weights in Angoras are lighter when compared in kg but are the same or heavier when compared as a percent of carcass weight (Oman et al. 1995). Van Koevering et al. (1995) reported that dressing percent is dependent upon two major factors, carcass fatness and offal weights. There were no differences among BxA, BxS, Spanish and SxA ($P>.43$) in dressing percent (56.7%, 56.4%, 57.1% and 56.6%) (Table 4). A two year study by

Table 4. Carcass measurements of feedlot goats with in breed type.

Carcass measurements	Hot carcass weight (kg)	Hot dressing percentage	Percent shrink	Fat 12^{th} rib (cm)	Percent kidney and pelvic fat	Loineye area (cm. sq.)	Leg circumference (cm)	Carcass length (cm)	Body wall thickness (cm)
P value	.0001	.0001	.0235	.0167	.0191	.0001	.0001	.0001	.0284
Angora	15.8^{d}	51.9^{b}	5.22	0.206^{a}	3.45^{b}	9.29^{d}	36.8^{c}	101.3^{d}	1.59^{b}
Boer x Angora	22.0^{b}	56.7^{a}	4.69	0.201^{ab}	4.08^{ab}	12.13^{bc}	42.1^{b}	106.9^{c}	1.97^{a}
Boer x Spanish	22.8^{b}	56.4^{a}	4.48	0.099^{c}	5.23^{a}	13.42^{a}	44.9^{a}	112.9^{a}	2.11^{a}
Spanish	22.8^{b}	57. 1^{a}	5.38	0.185^{ab}	4.85^{a}	12.90^{ab}	41.9^{b}	110.2^{b}	2.12^{a}
Spanish x Angora	19.9^{c}	56. 6^{a}	5.45	0.147^{bc}	3.96^{ab}	11.74^{c}	40.4^{b}	106.9^{c}	1.91^{a}
RSD	2.9	2.84	2.4	0.091^{a}	2.04	1.68	3.7	4.0	0.45

^{abcd}Means in same row with different superscript letters are different (P<.05).

Waldron et al. (1995), found differences in 1994, with BxS having higher dressing percentages than Spanish fed for 112 d; but observed no difference in 1995 being fed 100 d. There were differences between the two years with the first being dryer than normal and the second being wetter. In addition, in the first year all male kids were left intact and in the second year half the male kids were castrated. Machen et al. (1996) also found no difference in dressing percentage between BxS and Spanish goats. Riley et al. (1989) did report that Spanish had higher dressing percentages than Angoras.

Effects of breed type on fat thickness at the 12th rib with in fed goats

Breed effects were present in fat measured at the 12th rib, which are reported in Table 4. Angora, BxA and Spanish all had the highest amount of backfat with no difference (P>.45) between the breeds (.206 cm, ..201 cm and .185 cm respectfully). BxA and Spanish also showed no significant difference (P>.08) with SxA; but were higher (P<.05) than BxS. SxA and BxS were not different (P>.10)(.147 cm and .099 cm respectfully). Oman et al. (1995) reported that Spanish were the leanest over the loineye with there being no difference between BxS, SxA, and Angora. Goats when compared to other livestock species have very little fat over the loineye (Machen et al. 1996a). This is very advantageous in the aspect that a lean product is produced with less fat trim.

Effects of breed type on percent cooler shrink with in fed goats

There was no breed effect (P=.24) in percent shrink between Angora, BxA, BxS, Spanish and SxA (5.22%, 4.69%, 4.48%, 5.38% and 5.45% respectfully) (Table 4).

Machen et al. (1996) reported that BxS had less cooler shrink than Spanish although there was a 96 hr cooler shrink.

Effects of breed type on body wall thickness with in fed goats

Breed effects were also present in body wall thickness and are reported in Table 4. Angora had the smallest ($P<.05$) measurement for body wall thickness (1.59 cm) while there was no difference ($P>.16$) between BxA, BxS, Spanish and SxA(1.97 cm, 2.11 cm, 2.12 cm and 1.91 cm respectfully). No research has been found in goats dealing with thickness of body wall.

Effects of breed type on percent kidney and pelvic fat (KP) with in fed goats

BxS, Spanish, BxA and SxA showed no significant difference ($P>.05$) between each other and possessed the highest percentage of kidney and pelvic fat (KP) (5.23%, 4.85%, 4.08% and 3.96% respectfully) (Table 4). SxA and BxA were also showed no significant difference ($P>.33$) with the Angora (3.45). Riley et al. (1989) reported that Spanish had more KP than Angora. If we do not consider the SxA, Spanish-influenced breeds had 41 % more KP than Angora-influenced breeds. In 1994, Waldron et al. (1996) reported that no differences were observed for either year between BxS and Spanish. Machen et al. (1996) reported trends that Spanish had a higher percent KP than BxS kids.

Effects of breed type on loineye area with in fed goats

The loineye measurements for BxS, Spanish, BxA, SxA and Angora, are 13.42 sq. cm, 12.90 sq. cm, 12.13 sq. cm, 11.74 sq. cm and 9.29 sq. cm respectfully (Table 4). Angora is different from all the breeds ($P<.05$). No difference was found between BxS, Spanish, BxA, or SxA. The Spanish were not different from the BxA. Both Oman et al. (1995) and Riley et al. (1989) report that Angoras have the smallest loineyes. Waldron et al. (1996) and Machen et al. (1996) reported BxS had larger loineyes than Spanish. When loineye area is converted to a percent of body weight, BxS had the smallest percent loineye with no difference among the other breeds. Waldron et al. (1995) and Machen et al. (1996), both reported there were no differences between BxS and Spanish when loineye area was compared at a constant weight.

Effects of breed type on leg circumference with in fed goats

Breed effects also show differences in leg circumferences, reported in Table 4. BxS had the largest ($P<.05$) leg circumference (44.9 cm) with Angoras having the smallest ($P<.05$, 36.8cm). BxA, Spanish and SxA were not different ($P<.05$) and had leg circumferences of 42.1 cm, 41.9 cm and 40.4 cm respectfully. Oman et al. (1995) reports that BxS had the largest leg circumference while not being significantly different from Spanish and SxA. Angoras had the smallest leg circumference not being different from Spanish.

Effects of breed type on carcass length with in fed goats

BxS produced the longest ($P<.05$) carcasses (112.9 cm) with Spanish producing the second longest carcasses (110.2 cm). Both BxA and SxA produced carcasses that were 106.9 cm, while the Angora produced the shortest ($P<.05$) carcasses (101.3cm) (Table 4). Oman et al. (1995) reported that BxS and Spanish produced the longest carcasses while Angoras produced the shortest carcasses.

Effects of breed type on growth and carcass characteristics with in pasture goats

In the pasture study, the environmental conditions adversely affected the Angora breed, which required them to be removed from the range portion of the trial. Predation from coyotes and dogs eliminated the Angora kids on pasture.This leaves BxA, BxS, Spanish and SxA on the pasture part of the trial with results reported in Table 5. There were no differences due to breed effect in ADG (P=.22), hot dressing percentage (P=.085), percent shrink (P=.14), fat at the 12^{th} rib (P=.11), percent KP (P=.58), loineye area(P=.75), or body wall thickness(P=.19). Spanish and SxA tended to have higher dressing percentages, higher percent shrinks, higher percent KP and thinner body walls than BxA and BxS. BxS and Spanish produced the heaviest carcasses with BxA and SxA producing the lightest carcasses (14.0 kg, 13.1 kg, vs 11.4 kg, 11.7 kg, respectively). There also showed to be no difference (P=.07) between Spanish and SxA.. BxS and Spanish possessed the largest leg circumference while BxA and SxA measured the smallest leg circumference (41.12 cm, 40.86 cm vs 38.58 cm 37.82 cm respectively). There also showed to be no difference (P=.052) between

Table 5. Mean carcass measurements of pasture goats with in breed type.

Carcass Measurements	ADG (kg/d)	Hot carcass weight (kg)	Hot dressing percentage	Percent shrink	Fat 12^{th} rib (cm)	Percent kidney and pelvic fat	Loineye area (cm.sq.)	Leg circumference (cm)	Carcass length (cm)	Body thickness (cm)
P value	.22	0.058	.0854	.3602	.110	.5812	.7504	.0037	.0008	.1945
Boer x Angora	0.022	11.4^{c}	52.7	7.07	0.02	0.241	8.71	38.58^{bc}	96.19^{b}	0.86
Boer x Spanish	0.028	14.0^{b}	51.4	6.92	0.04	0.269	8.90	41.12^{a}	101.02^{b}	0.81
Spanish	0.024	13.1^{ab}	55.6	7.31	0.01	0.487	9.03	40.86^{ab}	107.87^{a}	0.65
Spanish x Angora	0.015	11.7^{bc}	54.6	7.82	0.02	0.407	8.45	37.82^{c}	98.98^{b}	0.69
RSD	0.014	1.7	3.82	1.18	0.03	0.444	1.31	2.25	5.84	0.24

[abc]Means in same row with different superscript letters are different ($P<.05$).

Table 6. Mean carcass measurements of goats with in feeding regimen

Carcass measurements	P value	Feedlot	Pasture	RSD
ADG (kg/d)	.001	.113	.023	.031
Hot carcass weight (kg)	.0001	21.90[a]	12.56[b]	4.20
Hot dressing percentage	.0033	55.6[a]	53.6[b]	3.53
Percent shrink	.0001	4.92[b]	7.28[a]	2.18
Fat 12^{th} rib (cm)	.0001	0.16[a]	0.02[b]	0.09
Percent kidney and pelvic fat	.0001	4.15[a]	0.354[b]	1.87
Loineye area (cm. sq.)	.0001	12.19[a]	8.77[b]	2.06
Leg circumference (cm)	.0037	42.39[a]	39.59[b]	5.20
Carcass length (cm)	.0001	108.63[a]	101.27[b]	6.40
Body wall thickness (cm)	.0001	1.91[a]	0.75[b]	0.43

[ab]Means in same row with different superscript letters are different ($P<.05$)

BxA and Spanish for leg circumference. Spanish did produce the longest carcasses (107.87 cm)(P<.012) which was only 2.5 cm shorter than their fed counterparts. BxA, BxS and SxA showed no difference (P>.083) in carcass length (96.19 cm, 101.02 cm and 98.98 cm, respectively).

Effects of plane of nutrition on growth and carcass characteristics

Fed goats out preformed pasture goats in both ADG (113 g/d vs 23 g/d respectively) and hot carcass weight (21.90 kg vs 12.56 kg, respectively) (P=.0001) (Table 6). Fed goats also possessed a higher dressing percent (55.6 % vs 53.6 % respectively) (P=.003).. Fed goats had less cooler shrink (4.92 % vs 7.28 % respectively) (P=.0038), which could be due to the fact that fed goats had more fat over the loineye (.16 cm vs .02 cm respectively) (P=.0001) and thicker body walls (1.91 cm vs .75 cm respectively) (P=.0001). Fed goats also had larger loineye areas (12.19 sq. cm vs 8.77 sq. cm respectively)(P=.0001), larger leg circumferences (42.39 cm vs 39.59 cm respectively) (P=.0037) and longer carcasses (108.6 cm vs 101.3 cm respectively) (P=.0001) than pasture goats. Pasture goats did have a lower percent KP (.354 % vs 4.15 % respectively) (P=.0001) than fed goats.

Crouse et al. (1981) reported similar finding with sheep. As sheep fed high-energy diets had higher ADG, higher dressing percent, more fat over the ribeye, higher percent KP, and larger loineye areas than those fed low energy diets, when killed at the same age. Arnold et al. (1988) also reported that when lambs were killed at weight constant, high energy fed lambs had higher dressing percent and percent KP while there were no differences in loineye area or leg score. But Crouse et al. (1981) reported that when lambs were killed at weight constant there was no difference in body wall thickness or fat over the loineye. Prior et al. (1977) reported that when cattle were killed at constant weights, small frame cattle fed high energy diets possessed higher ADG and percent KP and less fat over the ribeye with no difference in dressing percent. In large framed cattle off the same trial there was no difference in dressing percentage, percent KPH, fat thickness or ribeye area.

Effects of castration on growth and carcass characteristics

Both ADG (.154 kg/d vs .143 kg/d respectively)(P=.263) and feed efficiency (7.54 kg/ kg vs 7.09 kg/ kg respectively)(P=.728) between Boer-Spanish intact males (BxSint) and the BxS wethers were not different (Table 7). There was no difference for carcass weights (25.8 kg vs 26.8 kg, respectively)(P=.323)for intact males and wethers, but there was a trend for intact males to have lower dressing percents (54.4 % vs 56.4 %, respectively)(P=.056), than wethers. There was also no difference in fat at the 12th rib with both intact male and wethers having .10 cm (P=.323), but intact males had less KP fat (2.84 % vs 5.22 %, respectively)(P=..003), and a smaller body wall thickness (1.70 cm vs 2.11 cm, respectively)(P=.016). Intact males tended to have larger loineye area (14.5 cm sq. vs 13.5 cm sq., respectively)(P=..089); produced larger leg circumferences (52.5 cm vs 44.9 cm, respectively)(P=.0001) and longer carcasses(116.1 cm vs 112.9 cm, respectively)(P=.034) than wethers.

Table 7. Mean growth and carcass measurements of intact and wether Boer-Spanish goats

Carcass measurements	P value	Intact Males	Wethers	RSD
ADG (kg/d)	.263	.154	.143	.027
Feed Efficiency (kg/ kg)		7.09	7.54	
Hot carcass weight (kg)	.323	25.8	26.8	2.93
Hot dressing percentage	.056	54.4	56.4	2.84
Percent shrink	.428	3.78	4.48	2.40
Fat 12th rib (cm)	.890	.10	.10	.09
Percent kidney and pelvic fat	.003	2.84 [b]	5.22 [a]	2.04
Loineye area (cm. sq.)	.089	14.5	13.5	1.68
Leg circumference (cm)	.0001	52.5 [a]	44.9 [b]	3.70
Carcass length (cm)	.034	116.1 [a]	112.9 [b]	4.00
Body wall thickness (cm)	.016	1.70 [a]	2.11 [b]	.45

[ab]Means in same row with different superscript letters are different (P<.05).

In goats, both Mahout et al. (1996) and Ruvuna et al. (1992) reported no difference in dressing percent between intact males and wethers. They both reported that intact males produced less KP fat, had a higher percent muscle and a lower percent overall body fat. When goats were killed at a constant weight, Mahough et al. (1996) reported a decrease in ADG and an increase in subcutaneous fat due to castration. This is similar to Warwick et al. (1964) findings in beef cattle. Warwick also reported a decrease in feed efficiency, ribeye area and percent chuck due to castration. In lambs Jacobs et al.(1972) and Kemp et al. (1970) reported a decrease in ADG and carcass weight and an increase in subcutaneous fat due to castration. Kemp also reported that rams had a lower dressing percent, while there was no difference in loineye area, KP fat or carcass length. However, Jacobs reported that rams did have less KP fat and larger loineye areas.

SUMMARY

In the feeding portion of the trial we see that it is not profitable to pen and feed goats from weaning to slaughter primarily due to poor feed to gain ratio across all breeds. Therefore improvements need to be made in feed conversion and/or in reducing feed cost. The Angora breed could not compete with the other breeds in terms of efficiency of meat production. Mohair prices will always dictate the profitability of the Angora breed. If mohair prices are low, the breed is not profitable to produce. Among the other breeds, there were advantages and disadvantages for each of the breeds examined. The BxS proved to be the most efficient at producing a quality carcass. The main disadvantage across the breeds on feed is the amount of KP that was deposited in the carcasses. Further research is needed to determine ways to reduce the KP in all goats through nutrition or genetics. One area that may solve both the cost prohibiting side of long term feeding and the large percentages of KP is through back grounding goats with some supplementation and finishing them in a feedlot for several weeks. This is backed by the fact that the pasture goats in this trial grew in size as indicated by their carcass length and also possessed very little KP. The major disadvantage with the pasture goat is their decreased dressing percent and their increased cooler shrink. The results of this study indicate the possibility of grazing goats on pasture to obtain skeletal maturity. Then, in order to increase dressing percentage and minimize cooler shrink, feed goats for 30 to 60 d prior to slaughter. In the intact part of the study we see that the intact males had less cooler shrink than the castrated males. The wether goats also

possessed about half the KP of the intact males. There are several areas of concern with intact males like meat quality and increased management. More research needs to be done to improve the marketability and the profit potential of goats before they may be considered a major meat producing species.

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