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SHORT NOTE [NOTA CORTA]

INTAKE, DIGESTIBILITY, RUMEN METABOLISM AND GROWTH PERFORMANCE OF GOAT KIDS RAISED UNDER DIFFERENT PRODUCTION SYSTEMS

[CONSUMO, DIGESTIBILIDAD, METABOLISMO RUMINAL Y DESEMPEÑO DE CRECIMIENTO DE CABRAS CRIADAS BAJO DIFERENTES SISTEMAS DE PRODUCCIÓN]

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SUMMARY

Forty-five wether goat kids (BW of 21.76 ± 0.76) were randomly assigned to one of three production systems for 14 weeks to evaluate intake, digestibility and goat performance. Production systems were: 1) feedlot (FL), housed in individual pens and fed 40% protein pellets, 40% soybean hulls and 20% bermuda grass hay; 2) grazing continuously on 1 hectare bahia grass pasture (BP) supplemented daily with 150 g of protein pellets/h/day; and 3) browsing rotationally on 4, 0.5 hectare mimosa (MB) supplemented daily with 100 g cracked corn/h/day. Body weights were recorded every two weeks. Feed intake and digestibility were measured on eight goats from each treatment groups. Goats were fitted with canvas fecal collection bags, allowed for 3 days of adjustments followed by 5 days of fecal collection. Feces, feed offered, pasture and browse samples were analyzed for acid insoluble ash to determine digestibility and predict intake. Rumen fluid and blood samples were collected to measure volatile fatty acids and blood urea nitrogen (BUN). Total feed and medication costs also were recorded. Goats on FL system gained faster ($P<0.05$) and reached highest ($P<0.05$) final BW in less days as compared with MB and BP, with BP goats having the lowest ($P<0.05$) growth performance. Estimated DMI and digestibility for goats on FL system was highest ($P<0.05$) when compared to other systems, with goats on MB having the least ($P<0.05$) intake and digestibility. However, gain efficiency was highest ($P<0.05$) for goats on MB when compared to others, with goats on BP having the least ($P<0.05$) gain efficiency. Rumen pH was lowest ($P<0.05$) for FL goats and highest ($P<0.05$) for MB goats. Molar proportion of acetate was lowest ($P<0.05$), and isobutyrate and isovalerate were highest ($P<0.05$) for MB goats with no change ($P>0.10$) in butyrate and valerate. However, acetate: propionate was lower ($P<0.05$) for FL goats. Blood urea nitrogen was higher ($P<0.05$) for MB goats before feeding, one, or two hours after feeding. Goats on FL and BP system had similar ($P>0.10$) BUN. Numerically, browse system was most cost effective and bahai grass pasture was most expensive in terms of animal production.

INTRODUCTION

In the southeastern U. S. goats are gaining popularity because of changes in population demographic. Also this region is home to many forage species and browse favored by goats. A production system should provide the quality and quantity of forage or supplementation needed to ensure optimum nutrition for growing animals to achieve the target rate of gain. Grazing areas with few species of vegetation, such as an all grass pasture, will not provide good nutrition for goats over a long period of time (Lusigi et al., 1984). Browsing is an inherent feeding behavior of goats, thus, the development and utilization of alternative production systems that incorporate and utilize the abundant browse species available in the southern U. S. may improve production and profitability of meat goats. Efficiency of feed conversion has a marked influence on the productivity of a production system. Goats generally have lower average growth rates and feed conversion efficiencies than sheep. In a comparative trial involving four breeds of sheep and the Boer goat, the Boer goat kids grew at 124 g/d while the average gain for the four breeds of sheep was 166 g/d (Casey and Van Niekerk, 1988). However, Naude and Hofmeyr (1981) concluded that for a given growth rate or feed intake, Boer goat kids are as efficient as lambs.

Forage intake is a function of digestibility that reflects reticulo-ruminal rates of fermentation and passage. Digestion can be viewed as a simple balance between what the animal consumes and the amount of waste produced. Variability among animals given the same feed is less for digestibility than for intake, therefore digestibility is usually predicted with greater precision than intake. Yet, intake has been suggested to be the more important parameter for estimating forage quality and animal performance (Minson, 1990; Moore, 1994; Coleman et al., 1999). A forage-based production system may be the key to a profitable meat goat operation. Therefore, this experiment was conducted to compare growth performance, feed intake, digestibility and rumen fermentation of a feedlot, pasture and browse systems using goats.

MATERIALS AND METHODS

Animals and Diets

Twenty four high percentage, with average initial body weights of 23.1 ± 0.74 kg and twenty one low percentage, with average initial body weights of 19.0 ± 0.79 kg, Boer wether goat kids were used to evaluate potential breed differences that represent the meat goat industry in the Southeastern United States. The Tuskegee University Animal Care and Use Committees approved the animal care, handling and sampling procedures. Animals were weighed for two consecutive days, stratified by body weight (BW) and randomly assigned within breed to one of three production systems: 1) feedlot diet (FL) containing 40% protein pellets, 40% soybean hulls, and 20% bermudagrass hay; 2) ad libitum consumption of bahiagrass pasture (BG) supplemented with 150 g/head/day protein pellets; and 3) ad libitum consumption of mimosa browse (MB) supplemented with 100 g/head/day of cracked corn. The feedlot animals were housed individually in 1.8 m x 2.1 m pens with raised mesh floors. Fresh water, salt blocks and feed were supplied daily. The BG animals were grazed on a 1-hectare pasture and fed once daily the protein pellet. The MB animals were rotated every two weeks between four mimosa plots with trees trimmed to a height of 1.2 m and fed cracked corn once daily. Body weights were recorded after a four-hour withdrawal from feed and water, for two consecutive days every two weeks. The growth period consisted of 14 wk. Pasture, browse, hay and supplement samples were collected weekly during the entire trial, ground and pooled by month for chemical analysis.

Intake and Digestibility

Intake and digestibility were measured on eight goats from each treatment group for 10 days during the performance period repeated twice. Rumen fluid was collected by stomach tube to determine pH and volatile fatty acids (VFA) and blood samples were collected for blood urea nitrogen analysis (BUN). Goats were fitted with canvas fecal collection bags and allowed three days to adapt to the bags before initiation of a five-day fecal collection period. Fecal collection bags were emptied twice daily. Daily feces were weighed, mixed, and a constant percentage from each animal was taken, dried at 55 °C; this was followed by a 24-hour air equilibration to determine air-dried fecal output. Daily fecal samples were pooled to provide a representative sample of the five-day collection period. Samples of pasture, browse, hay and supplements were taken daily, composited, and subsampled. Feed and fecal samples were analyzed for DM. Nitrogen, determined by the combustion method (AOAC International, 1998) utilizing the Leco FP-2000 (Leco Corporation, St. Joseph, Michigan) and crude protein (CP) was calculated as N x 6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, acid detergent lignin (ADL), and acid insoluble ash (AIA) were analyzed as described by Van Soest et al. (1991) modified (Komarek et al., 1993) for use in an Ankom fiber apparatus (Ankom Technology, Fairport, NY).

RESULTS AND DISCUSSION

Quality of warm season grasses drop from June to October. Bahai grass had higher neutral detergent fiber (NDF) that increased from 68 to 76 %, and lower crude protein (CP) levels that decreased from 12.1 to 7.0 % from June to October. Mimosa browse had lower NDF (37, 40, 40, 39, and 34 %, for June, July, August, September and October, respectively) and higher CP (24.2, 17.1, 16.2, 20.9, and 21.2 % for June, July, August, September, and October, respectively) that stayed relatively the same throughout the season Figure 1. Composition of ingredients used in 40:40:20, protein pellets, soy hulls, and Bermuda grass hay feedlot diet and corn are in Table 1.

Performance of goats on pasture, browse, and feedlot diet is presented in Table 2. Initial body weights of goats on different feeding systems were similar ($P > 0.10$); however, goats on bahaia grass pasture gained the least (46.2 ± 4.57 kg; $P < 0.05$) followed by mimosa browse (82.4 ± 4.45 kg). Goats on feedlot system grew faster (124.1 ± 4.77; $P < 0.05$) and reached slaughter weight (35.2 ± 2.68 in 104 ± 2 days) sooner. Goats on mimosa browse system took 3 weeks longer to reach the slaughter weight (33.1 ± 2.75 kg in 127 ± 2 days) and pasture system could not achieve that goal (29.9 ± 1.94 kg in 131 ± 2 days). Although goats can withstand a lower digestibility of nitrogen, NDF, and organic matter than sheep (Hadjigeorgiou et al., 2001), high NDF, ADF and low CP in bahaia grass pasture impacted the performance. Bahaia grass Pasture is a commonly practiced system in the Southeastern U.S. and these results clearly documents the failure of this system for goat production in the region.

Estimated intake and digestibility are in Table 3. Intake and digestibility of goats on feedlot system were higher (P < 0.05) as it was reflected in their performance and the diet composition. The AIA method estimated lowest (P < 0.05) intake for goats on browse system followed by pasture system; however, gain efficiency was lowest (P 0.05) for goats on pasture and goats on browse had similar (P > 0.05) gain efficiency to feedlot goats. Rumen fluid pH was highest (P < 0.05) for goats on browse and lowest (P < 0.05) for feedlot goats, a characteristic of grain fed animals (Table 4). Acetate: propionate ratio for feedlot goats was lower (P < 0.05) than others and iso acids (isobutyrate and isovalarate) molar percentages were higher (P < 0.05) in goats on browse system as was expected. As indicated in the Table 4, goats on browse system had higher pH value in the rumen that may indicate higher levels of ammonia. This is reflected in higher BUN of these goats (Figure 2).

Cost comparisons based on two important variables in goat production are in Table 5. Numerically goat production on browse system in the Southeastern U. S. is the most economical production system whereas commonly used warm season pastures are least cost effective.

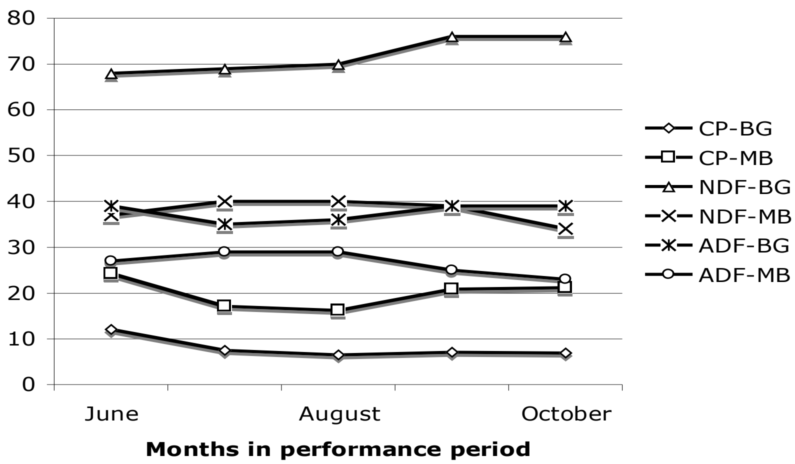

Figure 1. Compositional changes in bahai grass pasture and mimosa browse during performance period.

Table 1. Chemical composition of ingredients used in feedlot diet and corn.

	Performance phase (98 days)				
Item	Hay	Soy hulls	Pellets	Corn	Feedlot
Dry Matter, %	88.0	89.7	92.2	87.0	90.4
Crude Protein, %	11.7	14.1	15.7	7.80	14.3
Neutral Detergent Fiber, %	66.0	60.0	25.0	9.00	47.2
Acid Detergent Fiber, %	32.0	42.0	10.0	3.3	27.2
Metabolizable Energy, Mcal/kg	1.26	1.11	1.74	1.88	1.40

Table 2. Growth performance of pasture-fed, browse-fed and feedlot goat kids.

Trait	Pasture	Browse	Feedlot
No. of animals	15	15	15
	Performance phase (98 d)		
Body weight, kg			
Initial weight	21.2 ± 0.91^{a}	21.2 ± 0.91^{a}	22.8 ± 0.91^{a}
Final weight	25.9 ± 0.93^{c}	29.4 ± 0.93^{b}	35.1 ± 0.93^{a}
ADG, g/day	46.2 ± 4.57^{c}	82.4 ± 4.45^{b}	124.1 ± 4.77^{a}

[abc] Means within the same row with different letters differ P < 0.05.

Table 3. Intake and digestibility from pasture-fed, browse-fed and feedlot goat kids.

Trait	Pasture	Browse	Feedlot
No. of animals	8	8	8
		Digestibility phase (10 d)	
Avg. BW, kg	29.50 ± 1.60[b]	31.40 ± 1.9[b]	34.00 ± 1.75[a]
DMI, g/d	821.40 ± 51.08[b]	610.90 ± 51.1[c]	978.90 ± 29.50[a]
DMI, %BW	2.70 ± 0.32[a]	1.74 ± 0.4[b]	2.71 ± 0.35[a]
Fecal DM output g/d	277.10 ± 16.14[a]	265.90 ± 16.1[a]	273.70 ± 9.32[a]
DM Digestibility, %	63.80 ± 2.58[b]	55.90 ± 2.7[c]	71.40 ± 1.93[a]
Gain Efficiency	0.06 ± 0.01[b]	0.13 ± 0.0[a]	0.13 ± 0.01[a]

[abc] Means within the same row with different letters differ *P* < 0.05.

Table 4. Rumen fluid measurements of pasture-fed, browse-fed and feedlot goat kids.

Trait	Pasture	Browse	Feedlot
No. of animals	6	6	6
Ruminal fluid pH	6.72 ± 0.10[b]	7.40 ± 0.10[a]	6.07 ± 0.06[c]
		mol/100 mol	
Acetate	55.4 ± 1.17[a]	44.7 ± 1.17[c]	52.2 ± 0.67[b]
Propionate	19.0 ± 5.24[a]	15.8 ± 6.37[a]	29.1 ± 5.64[a]
Acetate:propionate ratio	3.00 ± 0.10[b]	3.02 ± 0.10[b]	2.34 ± 0.06[a]
Isobutyrate	5.92 ± 0.46[b]	8.20 ± 0.46[a]	2.61 ± 0.26[c]
Butyrate	6.67 ± 1.62[a]	5.81 ± 1.62[a]	7.91 ± 0.94[a]
Isovalerate	8.41 ± 1.04[b]	13.8 ± 1.04[a]	4.55 ± 0.59[c]
Valerate	5.03 ± 2.58[a]	9.29 ± 1.78[a]	7.92 ± 1.03[a]

[abc] Means within the same row with different letters differ (*P* < 0.05).

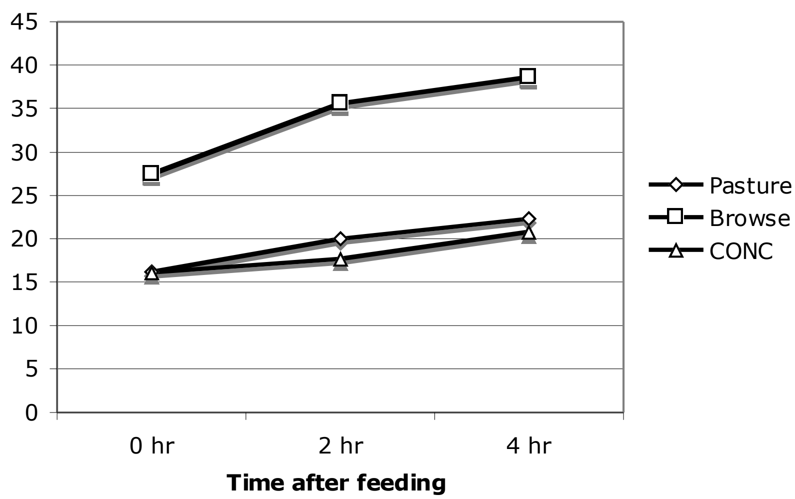

Figure 2. Blood urea nitrogen (BUN) after feeding goats on pasture, browse or feedlot diet.

Table 5. Major variable costs of goat production for pasture, browse and feedlot systems in Southeastern U.S.

Items, $/goat	Pasture	Browse	Feedlot
Feed cost [a]	20.0	5.1	22.9
Medications cost [b]	2.5	1.3	1.1
Goat purchase	45	45	45
Total cost	67.5	51.4	69.0
Profit if sold live [c]	-2.5	18.6	10.7

[a] These are actual costs of feeds including, hay, pellets, soy hulls, corn, liming, NPK based on 2005 prices.
[b] Reflects actual costs of deworming, dusting and vaccination.
[c] Reflects sale of animals @ $2.75/ kg for < 32 kg BW, $2.42/ kg for 32 to 36 kg BW and $2.2/ kg for goats over 36 kg BW.

CONCLUSION

Goats on bahia grass pasture system had the lowest gain followed by goats on mimosa browse and required more days on feed to reach harvest end points. Goats on feedlot system exhibited the highest gain and reached harvest end point two to four weeks faster than pasture or browse systems. Goats on mimosa browse had lower digestibility and intake; however, higher gain efficiency. Higher rumen pH, higher concentrations of iso acids, and blood urea nitrogen in goats on mimosa browse may indicate changes in rumen protein metabolism associated with higher tannin concentration of these feeds. Goats browsed on mimosa had most cost effective gain and commonly used bahia grass pasture even with supplementation did not support economically viable production system.

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