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Effects of stocking rate and physiological state of meat goats grazing grass/forb pastures on forage intake, selection, and digestion, grazing behavior, and performance

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ABSTRACT

Effects of forage conditions with different stocking rates on performance and grazing behavior of goats could vary with animal physiological state, as influencing nutrient demand and usage. Therefore, Boer goat does nursing two kids (D; 1 month after kidding), growing wethers (G; 4 month initial age), and yearling wethers (Y; 14 month initial age) grazed 0.4-ha grass/forb pastures, with one animal per type in each pasture (four per stocking rate; SR) for a low SR and two for the high SR. The experiment started in late spring and was 114 days in length, with four periods of 33, 28, 30, and 23 days (P1, P2, P3, and P4, respectively). Data were analyzed by mixed models with a repeated measure of period. Forage mass was 2517, 2433, 2506, and 2452 kg/ha for the low SR and 2680, 1932, 1595, and 1393 kg/ha for the high SR in P1, P2, P3, and P4, respectively (SE=335.1). Botanical composition of the diet determined from n-alkane concentration in simulated grazed forage samples and feces was similar among animal types ($P>0.10$). Likewise, chemical composition of forage samples did not differ between animal types ($P>0.10$), with average dietary levels of 11% CP and 53% NDF. Digestibility of OM, determined from the concentration of the n-alkane hentriacontane (C31) in forage samples and feces, was the greatest for growing wethers ($P<0.05$; 63.5%, 67.2%, and 62.0% for D, G, and Y, respectively) and greater ($P<0.05$) for the low than high SR (66.1% vs. 62.3%). Intake of ME estimated from digestibility and fecal output was 1015, 855, and 692 kJ/kg $BW^{0.75}$ for D, G, and Y, respectively (SE=57.4) and greater for the low than high SR in P1 (1204, 789, 682, and 445 for high SR and 1732, 767, 683, and 531 kJ/kg $BW^{0.75}$ for low SR in P1, P2, P3, and P4, respectively; SE=93.5). There was an interaction ($P<0.05$) between animal type and period in ADG (13, −12, −44, −8, 83, 25, −28, 73, 127, 51, −43, and −7 g; SE=21.5) and time spent grazing (7.5, 5.3, 7.4, 8.6, 78.6, 5.6, 10.0, 9.1, 4.8, 5.9, 8.4, and 9.5 h for D-P1, D-P2, D-P3, D-P4, G-P1, G-P2, G-P3, G-P4, Y-P1, Y-P2, Y-P3, and Y-P4, respectively; SE=0.88). Rate of ME intake was greater ($P<0.05$) for D vs. G and Y (49.5, 21.9, and 33.9 kJ/min for D, G, and Y, respectively; SE=5.68) and differed ($P<0.05$) among periods (57.5, 45.3, 24.8, and 12.9 kJ/min in P1, P2, P3, and P4, respectively; SE=5.17). In conclusion, with this forage of moderate nutritive value, levels of forage mass above 1400 kg/ha would not be of benefit to performance of meat goats regardless of physiological state with different nutrient requirements.

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1. Introduction

One important management decision for producers with grazing livestock is stocking rate. Stocking rate, as influencing forage mass, can affect grazing time and perhaps distance traveled depending on pasture size (Animut and Goetsch, 2008), both of which may affect the amount of energy used for activity (NRC, 2007). Moreover, because of the ability of ruminants, particularly goats, to preferentially select certain plant species and parts, stocking rate could impact nutritive value of the diet. In this regard, n-alkanes have been successfully used as internal markers to determine forage selectivity, intake, and digestion (Keli et al., 2008; Mayes et al., 1994).

As an example of the potential effect of forage mass on performance of ruminants, Lippke et al. (2000) and Redmon et al. (1995) found thresholds in mass of wheat forage of 1250 and 850 kg/kg, respectively, for beef cattle heifers, with lower levels limiting performance. Such levels may vary with the nature of available vegetation and animal species. For example, goats are generally more selective than cattle depending on the array and quality of plants available (Animut and Goetsch, 2008). Nonetheless, Goetsch et al. (2004) also concluded that wheat forage mass above 1200 kg/ha was adequate for unrestricted growth of meat goat wethers. However, Animut et al. (2005b) postulated that declining mass of a mixed grass/forb sward of lower quality than wheat forage, though with post-grazing forage mass levels greater than 1000 kg/ha, limited growth by both sheep and goat wethers by lessening selectivity and, thus, nutritional value of the diet rather than by decreasing forage intake.

In addition to differences among ruminant species, nutrient and energy requirements vary among physiological states of grazing livestock, such as greater needs for lactating does vs. growing animals, both being greater than for animals at high stages of maturity not lactating or in late gestation. Therefore, it is postulated that effects of stocking rate on performance would differ among animal types, perhaps with benefits from low stocking rates and high forage mass for some but not all types. For example, the magnitude of adverse effect of high stocking rates and low vegetation mass could increase with increasing nutrient requirements because of a lower threshold of vegetation mass at which increases in rate of biting and grazing time are not fully compensatory for reduced bite size (Burns and Sollenberger, 2002). However, adequate research to support such speculation with grazing ruminants, particularly goats, has not been conducted. Therefore, objectives of this experiment were to determine effects and interactions of stocking rate and physiological state of meat goats, lactating does with twin kids, growing wethers, and yearling wethers, on performance and behavior while grazing grass/forb pastures.

2. Materials and methods

2.1. Animals and treatments

The protocol for the experiment was approved by the Langston University Animal Care Committee. Water and trace mineralized salt were available at all times and each pasture contained a shelter. Animals resided in one of eight 0.4-ha pastures during the experiment. Pastures contained a variety of forages, with most predominant ones of bermudagrass (*Cynodon dactylon*) and ragweed (*Ambrosia spp.*). Pastures were randomly allocated to two treatments, high and low stocking rates.

Thirty-six Boer goats of three physiological states, with 12 per state, were used. Animal types were growing wethers (initial age of approximately 4 months), lactating does each with two kids (beginning at approximately 1 month after kidding), and yearling wethers (initial age of approximately 14 months). There was one animal per physiological state in each pasture for the low stocking rate and two for the high stocking rate. One animal of each physiological state in each pasture was used for data collection. Animals were treated with Cydectin® (Fort Dodge Animal Health, Fort Dodge, IA, USA) before the experiment began. Because additional treatment with anthelmintics was not necessary based on visual appearance of animals, it was assumed that the anthelmintic was efficacious and that the internal parasite burden during the study was not substantially different among physiological states.

2.2. Measurements

The experiment was 114 days in length, beginning in late spring on May 12, 2006. There were four periods, 33, 28, 30, and 23 days. Sunrise was at 06:12 and 07:10 h and sunset was at 20:46 and 19:39 h at the beginning and end of the experiment, respectively. Animals were weighed at the beginning of the experiment and end of each period. Other animal measures, addressed later, occurred during 2 wk in the middle of each period.

Forage mass was measured in the middle of periods by clipping herbage at a height of approximately 1.3 cm in five randomly placed 0.25 m^2 quadrats in each pasture. Outside ambient temperature (T_a) and relative humidity (RH) were determined every 5 min with a Hobo® Temperature/RH Data Logger (Hobo Pro RH/Temp; Onset Computer Corp., Bourne, MA, USA) located in the center of the pasture area. A temperature–humidity index (THI) was determined as: $(0.8 \times T_a) + [(RH/100) \times (T_a - 14.4)] + 46.4$ (Amundson et al., 2006).

Goats in two pastures of each stocking rate were grouped into two sets, with one used for activity measures and the other for collecting feces in the first week. In the second week measures were switched for the two sets. Feces was collected over a 4 or 5 day period by use of canvas fecal bags with perforated bottoms. After weighing feces daily, a 10% aliquot sample was saved to form a composite that was kept frozen between and after days of sampling.

Some of the methods described by Goetsch et al. (2010) were used to characterize grazing behavior. 'IceTag' activity monitors of IceRobotics Limited (Midlothian, Scotland, UK) were attached to the rear left leg to determine the number of steps and time spent standing, lying, and active. Time standing from IceTags encompasses both grazing/eating and non-grazing/eating periods, and 'active' is walking at a relatively fast pace presumably without