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An Evaluation of Different Energy Supplements for Lambs Consuming Endophyte-free Tall Fescue

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Summary

Twenty-five, growing, Dorset and Dorset cross wether lambs (avg BW of 32.8 kg) were used in a completely random design to evaluate the effect of source of supplemental energy on total tract digestibility, N balance, and serum metabolites. Following an initial 10-d adaptation to fresh-chopped, boot stage tall fescue, another 14-d adaptation period was used to allow lambs to acclimate to one of five experimental treatments. A 7-d total fecal and urine collection followed, and approximately 7 mL of whole blood was collected via venipuncture of the jugular vein on d 7 of the collection period. Treatments included: 1) fresh-cut forage only (CON); 2) CON plus dried molasses (MOL); 3) CON plus dried beet pulp (BEP); 4) CON plus soybean hulls (HUL); and 5) CON plus ground corn (GRC). Supplements were formulated to provide 27.1 g of ruminally degradable nitrogen (RDN)/kg of ruminally digestible OM (RDOM). Isolated soy protein was used to increase the RDN of the BEP, MOL, and GRC diets so that all supplements were isonitrogenous (avg N intake = 13.4 g/d). Total tract DM digestibility was greater ($P < 0.05$) for BEP, HUL, and GRC compared to MOL and CON. Nitrogen balance did not differ ($P = 0.15$) among treatments; however, urinary N excretion tended ($P < 0.08$) to be greater for unsupplemented lambs when compared to BEP, HUL, and GRC with MOL being intermediate. Additionally, serum urea nitrogen (SUN) concentrations were less ($P < 0.05$) for all supplemented wethers. Serum glucose concentrations did not differ ($P = 0.40$) across treatments. Greater SUN concentrations for lambs fed fresh-chopped tall fescue resulted in slightly greater urinary N excretion, suggesting that N utilization was better for supplemented lambs. Balancing RDN:RDOM with supplemental dried beet pulp, soybean hulls, or ground corn may be a management strategy to reduce N excretion by lambs consuming tall fescue pastures.

Key words: Lambs, Supplementation, Serum metabolites, Nitrogen balance

Introduction

Vegetative, cool-season grasses often contain large amounts of ruminally degradable nitrogen (RDN). Forcherio (1994) suggested that supplemental energy in the form of fermentable carbohydrates could be used to capture some of the excess ruminal ammonia associated with rapid degradation of vegetative tall fescue N. The NRC (1985) estimated that the proper balance between ruminally available N (both intake N and recycled N) and ruminally digestible OM (RDOM) to optimize microbial yield is 26.13 ± 1.3 g N per kg of RDOM. Dietary N and energy are balanced when apparent digestion of N in the rumen equals 0 (ARC, 1980). Using a broad range of forage types and maturities, Gunter et al. (1995) predicted that apparent RDN would equal 0 at an RDN:RDOM ratio of 27.03 ± .71 g/kg. The objectives of this study were to evaluate the effect of supplemental energy source formulated for sheep consuming green-chopped tall fescue based on an RDN:RDOM ratio of 27.1 g/kg.

Materials and Methods

Animals were used in accordance to a University-approved Animal Care and Use protocol. Twenty-five Dorset and Dorset cross wether lambs (avg BW of 32.8 kg) were used in a 21-d N balance study. Lambs were housed in a temperature-controlled room (24 to 27° C; continuous lighting), restrained with neck collars in stainless steel crates, and fed individually in two equal allotments twice daily. Diets included: 1) fresh-cut forage only (CON; Table 1); 2) CON plus dried sugarcane molasses (MOL); 3) CON plus dried beet pulp (BEP); 4) CON plus soybean hulls (HUL); and 5) CON plus ground corn (GRC). Isolated soy protein was included in the supplements to equalize N intake across treatments. We assumed that isolated soy protein was completely degraded in the rumen. Lambs were offered one half of their daily ration (2% of BW) at 0700 and 1900, where supplements were top-dressed onto the forage. The amount of forage and supplement offered and refused was quantified, recorded, and orts collected before diets were delivered. Daily feed refusals were not common, and were never more than 10% for any given lamb.

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Endophyte-free tall fescue was harvested in the boot stage at a height of 3 to 5 cm with a forage chopper (mean chop length = 25 cm). Immediately after harvesting, forage was packed into 208-L metal barrels and stored at -20° C until being fed. Dry ice was added to the forage as it was packed to ensure rapid freezing of the forage. Forage was thawed at room temperature before being fed.

Two ruminally cannulated steers grazing vegetative, endophyte-free tall fescue were used to determine the ratio of RDN:RDOM ratio of the forage and supplements. Specifically, duplicate Dacron® bags containing approximately 3 g of each dietary ingredient were incubated in the rumen of each steer for 24 h. To correct for contamination, one empty (blank) bag was included with each set of duplicate bags. After removal, bags were rinsed in cold tap water until the effluent was clear, after which bags were placed in a forced-air oven (55° C) for 48 h, then weighed. Duplicate bag contents were composited and the residue was analyzed for DM, OM, and N (AOAC, 1990). Supplements were formulated to provide 27.1 g RDN/kg of RDOM with the addition of the forage (Table 2).

A 10-d adaptation to experimental conditions where lambs were fed forage only preceded a 14-d adaptation to experimental diets. Total amount of feces and urine excreted were then collected for 7 d. Feces were weighed daily and stored (-20° C) until the end of the experiment. Total urine output was measured daily; a 2% aliquot was acidified with 6 N H_2SO_4 and saved each day, and stored as a composite at -20° C. Total feces from the 7 d collection were thawed, mixed, subsampled, dried at 55° C in a forced-air oven, and ground to pass a 1-mm screen. Daily forage, supplement, and ort samples were saved and composited at the end of the collection period. Dried fecal samples, forage, and supplement were analyzed for DM, OM, and N (AOAC, 1990). Forage samples were also analyzed for NDF and ADF (non-sequential procedures; Goering and Van Soest, 1970). Urine samples were analyzed for N (AOAC, 1990). Nitrogen balance was calculated as the difference between N intake and urinary and fecal N excretion. Nitrogen retention was expressed as a percent of N intake.

At 1900, on d 7 of the collection period, approximately 7 mL of whole blood was withdrawn from each wether via venipuncture. Blood was allowed to clot overnight, centrifuged (1000 x *g*) for 10 minutes, serum decanted, and frozen (-20° C) until analyses. Serum was analyzed for urea-N and glucose (Sigma Chemical Co., St. Louis, MO).

Data were analyzed as a one-way analysis of variance using the GLM procedure of SAS (SAS Institute, Cary, NC) with dietary treatment as the source of variation and lamb within treatment as the error term. When a significant F-test was detected, means were compared using the LSMEANS options of SAS (SAS Institute, Cary, NC).

Results

Total OM and N intakes did not differ among treatments (Table 2). Mean OM intake across treatments was 581.3 g/d. Forage OM and N intakes differed ($P < 0.05$) between treatments because forage intake was reduced with addition of dietary supplements. The average RDN:RDOM ratio for the lambs supplemented with energy was 27.1 g/kg. Total tract digestibility of OM was greater ($P < 0.05$) for lambs supplemented with GRC, BEP, and HUL compared to those fed CON or MOL (Table 3). Total tract digestibility of N was lower ($P < 0.05$) for wethers fed MOL compared to GRC and HUL, which were less than lambs fed CON with the BEP supplemented lambs being intermediate. Serum glucose concentration was not different ($P = 0.40$), while serum urea-N concentration was greater ($P < 0.05$) for wethers fed CON. Urinary N excretion was greatest ($P < 0.10$) for wethers consuming CON compared to GRC, BEP, and HUL treatments. Lambs fed MOL retained less ($P < 0.10$) N compared to the other supplemented wethers, with lambs fed CON being intermediate.

Discussion

Molasses effects in the diet depend on percentage of dietary molasses and type of roughage. With high-quality hay, for example, digestibility was depressed by increasing dietary molasses from 7.9 to 14.2% (Foreman and Herman, 1953). Decreased total tract digestion of OM for the lambs fed molasses in our study was not surprising because dietary molasses was 27% of OM intake. Decreased N digestibility and N retention by lambs fed molasses is also consistent with the observations of Morales et al. (1989), who reported that increasing dietary molasses up to 8% decreased milk protein percentage, efficiency of milk production, and body weight gain of dairy cows from mid to late lactation. Sanson (1993) noted that supplemental corn and beet pulp increased total tract OM digestibility of lambs fed a low-quality crested wheatgrass hay, with corn being more effective. Our results are similar to those of Bach et al. (1999), who reported that supplementing high-quality pasture forage with readily fermentable carbohydrate supplied by corn, beet pulp, or soybean hulls improved OM digestion in continuous culture. Bach et al. (1999) also suggested that corn and soybean hulls were the most effective energy sources in the stimulation of ruminal N utilization. Greater N digestibility will increase ruminal ammonia production (Siddons et al., 1985), and result in a subsequent increase in serum urea-N concentration. Increased serum urea-N concentration may, in turn, led to an increase in urinary N excretion. Forcherio (1994) indicated that an increase in urinary N was associated with higher levels of ruminally degradable protein, and the addition of readily fermentable carbohydrates decreased urinary N loss. Our data indicate that each of the readily fermentable carbohydrates sources, except molasses, may be an effective energy supplement to increase N utilization by sheep consuming medium- to high-quality tall fescue. Although N balance and retention were not improved with provision of supplement, urinary N loss was reduced when diets were balanced for an RDN:RDOM ratio of 27.1 g/kg.

Conclusions

Application of the RDN:RDOM ratio to formulate supplements for forage-based diets seems to be a useful approach for minimizing N excretion of lambs consuming a medium- to high-quality forage.

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Table 1. Chemical and nutrient composition of tall fescue forage.

N, % of OM	2.5
NDF, % of OM	63.0
ADF, % of OM	26.2
RDN, % of total N[a]	81.0
RDOM, % of total OM[a]	67.4
RDN:RDOM, g/kg	30.2

[a]Ruminal degradability was estimated from a 24-h in situ incubation.

Table 2. Composition of the rations[a].

	CON	MOL	GRC	BEP	HUL	SE
Forage OM, g/d	570.7[b]	424.9[c]	432.9[c]	435.7[c]	412.7[c]	33.6
Molasses OM, g/d	-	161.3	-	-	-	-
Corn OM, g/d	-	-	143.2	-	-	-
Beet pulp OM, g/d	-	-	-	143.1	-	-
Soybean hulls OM, g/d	-	-	-	-	194.4	-
Isolated soyprotein OM, g/d	-	7.4	4.3	6.0	-	-
Total OM intake, g/d	570.7	593.6	580.4	584.9	607.1	71.1
Total N intake, g/d	14.4	13.3	13.1	13.4	13.9	0.8

[a]CON = fresh-cut forage only, MOL = fresh-cut forage plus dried molasses (MOL), GRC = fresh-cut forage plus ground corn, BEP = fresh-cut forage plus dried beet pulp, HUL = fresh-cut forage plus soybean hulls. Rations containing supplemental energy were formulated to provide 27.1 g of RDN/kg of RDOM. The RDN:RDOM (g/kg) ratio was 11.8 for dried molasses, 10.8 for ground corn, 12.2 for dried beet pulp, and 19.5 for soybean hulls.

[b,c]Means in the same row with dissimilar superscripts are different ($P < 0.05$).

Table 3. Total tract digestibility of OM and N, serum metabolites, and N metabolism of lambs fed fresh-cut fescue forage or forage plus supplemental energy[a].

	CON	MOL	GRC	BEP	HUL	SE
OM digestibility, % of intake	67.0[b]	67.2[b]	72.3[c]	71.0[c]	71.9[c]	1.2
N digestibility, % of intake	76.5[d]	69.3[b]	73.4[c]	74.2[c,d]	72.3[c]	1.0
Serum glucose, mg/dL	62.8	56.6	60.1	60.1	61.1	2.3
Serum urea-N, mg/dL	19.3[c]	15.0[b]	14.4[b]	12.3[b]	11.8[b]	1.2
Urinary N, g/d	9.5[f]	8.6[e,f]	8.2[e]	7.7[e]	8.2[e]	0.5
N balance, g/d	1.53	0.66	1.41	2.19	1.80	0.4
N retention, % of intake	10.4[e,f]	5.1[e]	10.9[f]	16.0[f]	12.5[f]	2.4

[a]CON = fresh-cut forage only, MOL = fresh-cut forage plus dried molasses (MOL), GRC = fresh-cut forage plus ground corn, BEP = fresh-cut forage plus dried beet pulp, HUL = fresh-cut forage plus soybean hulls. Rations containing supplemental energy were formulated to provide 27.1 g of RDN/kg of RDOM.

[b,c,d]Means in the same row with dissimilar superscripts are different ($P < 0.05$).

[e,f]Means in the same row with dissimilar superscripts are different ($P < 0.10$).