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Blood, Ruminal And Fecal Measures Of Steers Fed Different Combinations Of Supplemental Energy And Degradable Intake Protein While Grazing Winter Range.

T.N. Bodine, H.T. Purvis II and D.A. Cox

Story in Brief

Fifty-two yearling steers and eight ruminally cannulated steers were individually fed one of four supplements 5 d per week while grazing dormant native tallgrass prairie. Supplements were: corn plus soybean meal, corn plus soybean hulls, soybean meal, or cottonseed hull-based control. Supplements were fed at a rate of 1.3, 1.3, 0.4, or 0.06% BW/feeding, respectively. Weights, fecal grab samples and blood samples were taken monthly within 1 h of feeding on the fifth of five consecutive days of feeding. Fecal samples were analyzed for pH and concentrations of nitrogen and acid detergent fiber. Serum was harvested from blood samples and analyzed for urea nitrogen and insulin. Steers fed corn or soybean meal supplements had increased daily gain, serum insulin, fecal nitrogen and ruminal ammonia. Steers fed corn plus soybean meal had greater daily gain, insulin and fecal nitrogen than those fed corn or soybean meal alone. Steers fed supplements with corn had decreased ruminal pH, acetate concentrations and acetate:propionate ratios, as well as increased propionate concentrations than those not fed supplemental corn. Corn-fed cattle had reduced fecal pH and fecal acid detergent fiber than steers not fed grain. Cattle fed supplements with soybean meal had greater serum urea nitrogen than those without soybean meal. Stocker cattle grazing dormant native range had the greatest response in animal performance and physiological measures when supplements were balanced for ruminally degradable protein and energy.

Key Words: Grazing Cattle, Rumen, Blood, Fecal, Nitrogen

Introduction

Cattle grazing low-quality dormant native range in Oklahoma may encounter several nutrient deficiencies. Supplementation is necessary to allow stocker cattle to gain weight during this period. While protein is typically considered the primary limiting nutrient, increasing forage intake with protein supplements may not result in adequate energy intake for animal performance to achieve desired levels. In order to effectively use supplementation, a measure of animal performance is needed to determine if added feed will improve animal performance. Previous research (McCollum and Galyean, 1985) has indicated that ruminal ammonia may limit utilization of low-quality forages. In order to find a measure that is simpler to use than ruminal ammonia, other researchers have suggested the use of fecal nitrogen (Lyons and Stuth, 1992) or blood urea nitrogen (Moore, 1992). This study was undertaken to determine if physiological measures could be used to explain the observed differences in animal performance as a result of different supplementation strategies involving energy, protein, and the combination.

Materials and Methods

Study Site, Vegetation and Stocking Rate. The study was conducted on 130 ha of native tallgrass prairie stocked at 2.1 ha/(steer·96 d) located 15 km southwest of Stillwater, OK. Predominate forage species were big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*) and indiangrass

(*Sorghastrum nutans*). Forage mass was estimated from clipped quadrats.

Animals. Fall-born calves grazed late summer native tallgrass pastures without supplementation prior to the initiation of the trial. Cattle were weighed without removal of access to feed and water 1 d prior to the initiation of the trial and approximately every 21 d to calculate supplementation intake. Steers were weighed at the initiation and completion of the trial following an overnight (14 h) removal of access to feed and water to determine performance.

Diets and Feeding. Treatments (Table 1) consisted of: 1) 0.75% BW/d of dry-rolled corn and adequate soybean meal to balance total diet DIP:TDN (CRSBM); 2) 0.75% BW/d of dry-rolled corn and soybean hulls, equal supplemental TDN to CRSBM (CORN); 3) soybean meal with equal supplemental DIP to CRSBM (SBM); or 4) cottonseed hull-based control (CONT). Requirements for DIP were determined using the 1996 NRC level 1 model software with estimated forage intake (1.8% BW) and estimated forage nutrients; OM (93%), CP (7.36%), DIP (70% of CP), NDF (75%) and TDN (60%, estimated from IVOMD) from historical masticate samples (1993 to 1998) collected from the experimental pastures. Other model inputs included steer BW, supplemental corn intake and 10.25% microbial efficiency of TDN. Soybean meal was added to the CRSBM diet until DIP requirements were met. Pelleted soybean hulls (SBH) were added to the CORN supplement to achieve equal TDN intake to CRSBM. Supplements that were based on BW (CRSBM, CORN and SBM) were fed using the mean BW of all steers on each treatment. Supplements (CRSBM, CORN, SBM, CONT) were fed at a rate of 1.3, 1.3, 0.4, or 0.06% BW/feeding, respectively. Steers were individually fed supplements 5 d per week in individual stalls at 8:00 a.m. Supplement intake was calculated on a per (steer·d) basis, multiplied by seven to determine weekly intake, and divided by five to determine the amount offered at each feeding. Cattle were adapted over 6 d to supplements at the initiation of the trial. Steers had ad libitum access to water and mineral mix with chlortetracycline (Aureomycin). Eight ruminally cannulated steers (496 ± 14 kg) were also individually fed supplements based on the mean initial BW of the two cannulated steers on each treatment. From d 50 to 60, supplements were top-dressed with 100 g of a 7.5% chromic oxide, 92.5% dried molasses supplement (7.5 g of chromic oxide/(steer·d)).

Sample Collection and Preparation. Feed ingredients were sampled once weekly during the trial. Masticate samples were collected from two unsupplemented ruminally cannulated steers at the initiation and completion of the trial and from eight ruminally cannulated steers on d 32 and 64. Fecal grab samples were collected monthly, dried, ground and stored for later analysis. Ruminal fluid samples were collected from cannulated steers on d 32 and 64 (fifth of five consecutive days of feeding) prior to feeding of supplement. Blood samples were taken by tail venipuncture within 1 h of supplement feeding.

Statistical Analyses. All response variables were analyzed using the MIXED procedures of SAS (1996). Supplemental dietary treatment was the effect included in the model. Since steers grazed a common pasture and were individually fed, individual steer was considered the experimental unit. Means were calculated using LSMEANS and were separated using the PDIFF option.

Results and Discussion

Animal Performance. All cattle had similar (P>.60) summer ADG (.51 kg/(steer·d)) prior to the experiment and similar (P>.60) initial BW (287 ± 7 kg). Steers fed CRSBM had greater (P<.01) ADG (Table 2) than either CORN- or SBM-fed cattle, which were similar (P>.14). The greater ADG for CRSBM- vs CORN-fed cattle may be a result of improved forage digestibility (Bodine et al., 2000). Steers supplemented with corn (CORN) had greater (P<.07) ADG than those fed CONT. Cattle fed supplemental soybean meal (SBM) had greater (P<.01) ADG than CONT-fed steers. It would appear that both energy and protein were deficient since animal performance was improved by the addition of either nutrient. However, the greatest response in animal performance was a result of supplementing to balance total diet TDN:DIP.

Blood Measures. Steers fed CORN, CRSBM, or SBM, had increased (P<.01) serum insulin (Table 2) vs CONT-fed animals. Feeding corn plus soybean meal resulted in greater (P<.01) serum insulin than either steers fed similar supplemental TDN (CORN) or DIP (SBM). The improvement in insulin levels for CRSBM vs CORN supplemented cattle may have been a result of greater forage digestion as a result of the added DIP in the CRSBM diets. The increased insulin for CRSBM-fed steers indicates that balancing DIP and TDN in the supplement resulted in improved energy utilization by cattle. Steers fed soybean meal (CRSBM, SBM) had greater (P<.01) serum urea nitrogen (Table 2) than steers not receiving adequate DIP (CORN, CONT). Serum urea nitrogen levels of cattle fed low DIP supplements (CORN, CONT) were below levels (7 mg/dL) suggested to respond to protein supplementation (Moore, 1992).

Fecal Measures. Feeding either supplemental energy or protein resulted in greater (P<.01) fecal nitrogen (Table 2) than CONT-fed cattle. Feeding corn with added DIP (CRSBM) resulted in greater (P<.01) fecal N than either similar levels of TDN (CORN) or DIP (SBM) alone. Feeding corn resulted in decreased (P<.01) fecal pH (Table 2) vs supplements without grain. This reduction in pH coupled with the increase in fecal N appears to indicate an increase in large intestinal fermentation. Fecal ADF concentration was also decreased (P<.01) for steers supplemented with either CORN or CRSBM, which may be due to the large amount of low ADF supplement, or as a result of decreased forage intake (Bodine et al., 2000).

Ruminal Measures. Feeding supplemental corn, DIP, or both, resulted in increased (P<.01) ruminal ammonia vs CONT-fed cattle. Steers fed supplements with corn (CRSBM, CORN) had decreased (P<.01) ruminal pH, acetate:propionate ratios and acetate concentrations (Table 2), similar (P>.22) total VFA amounts and increased (P<.01) propionate concentrations vs those cattle not consuming corn-based supplements (SBM, CONT). These changes are consistent with increased digestible organic matter stimulating greater microbial fermentation, resulting in a decrease in pH, an increase in propionate and decreased acetate and acetate:propionate ratios. These changes in ruminal measures appear to indicate a greater supply of glucogenic precursors, which agrees with the increases in serum insulin. Decreased acetate:propionate ratios and greater total VFA amounts would suggest that feeding corn grain should result in greater energy available to the animal. However, performance was greater for CRSBM- than CORN-fed steers, indicating that measures of physiological effects, such as serum urea N, serum insulin, fecal pH, or fecal N may aid greatly in using the results of ruminal fermentation to adequately describe the effects of supplementation on whole body efficiency of energy utilization by beef cattle.

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Table 1. Ingredient and nutrient composition of supplements fed 5 d/wk to steers grazing dormant native tallgrass prairie.

Supplement ingredient, (%)	Supplement[a]			
	CRSBM	CORN	SBM	CONT
Corn (dry-rolled)	78.52	78.12	---	20
Soybean hull pellet	---	21.88	---	20
Soybean meal (49)	21.48	---	100	---
Cottonseed hulls	---	---	---	55
Molasses	---	---	---	3
Salt	---	---	---	2
Nutrient, (% of DM)				
DM	87.96	88.02	89.87	90.04
OM	97.83	98.09	94.33	95.35
CP	18.34	9.84	53.16	7.59
DIP	36.57	29.34	84.95	38.17
ADF	5.53	14.06	6.43	46.22
NDF	10.34	21.20	10.84	64.23

[a]CRSBM=1.1% BW/feeding dry-rolled corn plus soybean meal to meet NRC (1996) DIP requirements; CORN=1.1% BW/feeding dry-rolled corn plus soybean hull pellets, equal TDN to CRSBM; SBM=soybean meal with equal DIP as CRSBM; CONT=.06% BW/feeding control supplement.

Table 2. Performance, blood, fecal and ruminal measures of steers grazing dormant native tall grass prairie and fed one of four supplements 5 d/wk.

Item	Supplement[1]				SEM[2]
	CRSBM	CORN	SBM	CONT	
Average daily gain	.77[a]	.29[bc]	.48[b]	.05[c]	.2
Serum					
Serum urea nitrogen (mg/dL)	11.4[a]	4.9[b]	16.5[c]	5.6[b]	.7
Serum insulin (ng/mL)	3.0[a]	2.5[b]	2.5[b]	2.3[b]	.1
Fecal					
Nitrogen (% OM)	2.6[a]	2.4[b]	2.3[b]	2.0[c]	.07
pH	5.7[a]	5.8[a]	6.8[b]	6.8[b]	.05
Acid detergent fiber (% DM)	26[a]	27[a]	38[b]	40[b]	.8
Ruminal					
pH	6.1[a]	6.1[a]	6.4[b]	6.4[b]	.06
Ammonia-N (mg/dL)	5.2[a]	6.7[a]	9.0[a]	1.3[b]	2.4

Total VFA (mMol/L)	98.6	108.5	94.1	87.5	6.6
Acetate (%)	68[a]	68[a]	73[b]	76[b]	1.3
Propionate (%)	19[a]	18[ab]	15[b]	15[b]	1.2
Acetate:Propionate	3.6[a]	3.8[a]	4.8[b]	5.2[b]	.3

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Serum insulin (ng/mL)	3.0[a]	2.5[b]	2.5[b]	2.3[b]	.1
Fecal					
Nitrogen (% OM)	2.6[a]	2.4[b]	2.3[b]	2.0[c]	.07
pH	5.7[a]	5.8[a]	6.8[b]	6.8[b]	.05
Acid detergent fiber (% DM)	26[a]	27[a]	38[b]	40[b]	.8
Ruminal					
pH	6.1[a]	6.1[a]	6.4[b]	6.4[b]	.06
Ammonia-N (mg/dL)	5.2[a]	6.7[a]	9.0[a]	1.3[b]	2.4

Total VFA (mMol/L)	98.6	108.5	94.1	87.5	6.6
Acetate (%)	68[a]	68[a]	73[b]	76[b]	1.3
Propionate (%)	19[a]	18[ab]	15[b]	15[b]	1.2
Acetate:Propionate	3.6[a]	3.8[a]	4.8[b]	5.2[b]	.3

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