Blood and Fecal Measures of Steers Supplemented with Energy and(or) Protein while Grazing Dormant Native Range

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Story in Brief

A two-year experiment utilized 100 yearling steers individually fed one of four supplements 5 d per week while grazing dormant native tallgrass prairie to determine the effects of supplemental corn grain, soybean meal, or their combination. 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, .4, or .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 organic matter, 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, and fecal nitrogen compared to control cattle. Steers fed corn plus soybean meal had greater daily gain, insulin, and fecal nitrogen than those fed corn or soybean meal alone. Corn-fed cattle had reduced fecal pH and fecal acid detergent fiber concentration than steers not fed corn 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 (Hammond et al., 1994). 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 their 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 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 30 clipped .1m^2 quadrats at the initiation, mid-point, and completion of both trials.

Animals. Fall-born English x Continental calves from two herds were received at the OSU Bluestem Research Range after summer weaning. Steers grazed late summer native tallgrass prairie pastures without supplementation prior to study initiation in yr 1 and grazed dormant Old World bluestem pastures and were fed 2 kg/steer three times weekly of 38% CP range cubes prior to the start of the trial in yr 2. The winter grazing period was 96 and 70 d, respectively, in yr 1 and 2. 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. Cattle were weighed without removal of access to feed and water 1 d prior to the initiation of the trial and on an approximately monthly basis to allow for calculation of supplement intake based on body weight.

Diets and Feeding. Descriptions of the diets are provided in greater detail in Bodine et al., (2000, 2001). Briefly, treatments (Table 1) consisted of: 1) .75% BW/d of dry-rolled corn plus approximately .3 % BW soybean meal (CRSBM); 2) .75% BW/d of dry-rolled corn plus .3% BW soybean hulls (CORN), equal TDN to CRSBM; 3) soybean meal (SBM), equal DIP to CRSBM; or 4) cottonseed hull-based control (CONT). Supplements (CRSBM, CORN, SBM, CONT) were fed at a rate of 1.3, 1.3, .4, or .06% BW/feeding, respectively. Steers were individually fed supplements 5 d per week in individual stalls at 0800. Steers had ad libitum access to water and mineral mix.

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
Supplement intake, kg/feeding	4.24	4.14	1.28	0.18
Supplement conversion, kg fed/kg gain	4.66	9.86	2.29	0

[a]CRSBM=1.3% BW/feeding dry-rolled corn plus soybean meal; CORN=1.3% BW/feeding dry-rolled corn plus soybean hull pellets, equal TDN to CRSBM; SBM=soybean meal with equal DIP as CRSBM, .4% BW/feeding; CONT=.06% BW/feeding control supplement

Sample Collection and Preparation. Feed ingredients were sampled once weekly during the trial. Fecal grab samples were collected monthly, dried, ground and stored for later analysis. Blood samples were taken by tail venipuncture within 1 h of supplement feeding, placed on ice, stored at 4°C overnight, and serum was harvested by centrifugation.

Statistical Analyses. All response variables were analyzed using PROC MIXED (SAS Inst. Inc., Cary, NC). Supplemental dietary treatment, experiment (year), and their interaction were the fixed effects included in the model. Since steers grazed a common pasture and were individually fed, individual steer was considered the experimental unit and was included in the model as a random effect. Means were calculated using the LSMEANS option and contrast statements were used to separate the means. Pre-planned contrasts included CRSBM vs CORN, CRSBM vs SBM, corn-fed (CRSBM, CORN) vs not corn-fed corn (SBM, CONT), and soybean meal supplemented (CRSBM, SBM) vs those not receiving soybean meal (CORN, CONT). Interactions between dietary supplement treatment and experiment were only noted for average daily gain ($P<.05$), and this was due to a large amount of weight loss by the control steers in the second experiment, therefore all data was pooled across both experiments.

Results and Discussion

Animal Performance. Cattle had similar ($P>.88$) ADG for the month prior to the initiation of the trial (.51 kg/(steer·d)) as well as similar ($P>.47$) initial BW (Table 2) at the start of the experiment. Steers fed CRSBM had greater ($P<.01$) ADG (Table 2) than either CORN- or SBM-fed cattle, or than the average of CORN- and SBM-fed steers. Steers supplemented with corn grain (CRSBM, CORN) had greater ($P<.01$) ADG than those not receiving grain (SBM, CONT). Cattle fed supplemental soybean meal (CRSBM, SBM) had greater ($P<.01$) ADG than steers that were not given soybean meal (CORN, CONT). The increased forage OMD and greater protein intake between CRSBM- vs CORN-fed steers may help explain the greater ADG of CRSBM steers since total OM intake and grazing time were similar for cattle fed these two supplements (Bodine et al., 2001). It would appear that both energy and protein were deficient since improved animal performance was noted from the addition of either nutrient to the diets. However, the greatest response in animal performance occurred when soybean meal was fed with corn to adequately balance DIP for the total diet TDN. For the month after the completion of the trial, steers that had not previously received protein (CORN, CONT) had greater ($P<.04$) ADG than steers that had been fed soybean meal (CRSBM, SBM), possibly suggesting a form of compensatory gain. However, this did not change the effects of trial ADG, as rate of gain for the trial period and following month were similar to the trial ADG results.

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

	Supplement[a]					
Item	CRSBM	CORN	SBM	CONT	SEM[1]	Contrast[2]
Initial BW, kg	295.6	307.7	303.9	304.1	5.5	NS
Final BW, kg	356.8	328.3	337.6	292.9	5.4	1,2,3,4
Average daily gain[3], kg/d	0.74	0.25	0.39	-0.17	0.11	1,2,3,4

Post-Trial[3] ADG, kg/d	.11	.34	.08	.26	.07	1,4
Trial+Post[3] ADG, kg/d	.60	.31	.36	.03	.04	1,2,3,4
Serum						
Serum urea nitrogen (mg/dL)	10.4	4.2	15.8	5.6	.6	1,2,3,4
Serum insulin (ng/mL)	2.2	1.7	1.9	1.6	.06	1,2,3,4
Fecal						
OM, (%DM)	85.8	87.6	83.1	84.3	.6	1,2,3,4
Acid detergent fiber, (% DM)	26.1	27.1	37.6	39.9	.5	2,3,4
Nitrogen, (% OM)	2.5	2.1	2.1	1.7	.05	1,2,3,4
pH	5.97	5.74	6.88	6.81	.05	1,2,3,4
OM Output, g/kg BW	9.6	10.7	8.7	8.1	.3	1,2,3
ADF Output, g/kg BW	2.9	3.3	3.9	3.9	.1	1,2,3

[a]CRSBM=1.3% BW/feeding dry-rolled corn plus soybean meal; CORN=1.3% 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

[1]SEM=Standard error of the means, n=25

[2]Contrasts (P<.05): 1 = CRSBM vs CORN; 2 = CRSBM vs SBM; 3 = (CRSBM+CORN)/2 vs (SBM+CONT)/2; 4 = (CRSBM+SBM)/2 vs (CORN+CONT)/2

[3]Average trial period was 83 d; average Post-Trial period was 33 d ;and average Trial + Post period was 116 d

Blood Measures. Steers fed supplements with soybean meal (CRSBM, SBM) had increased (P<.01) serum insulin (Table 2) vs animals fed no soy (CORN, CONT). Feeding corn plus soybean meal resulted in greater (P<.01) serum insulin than either steers fed similar supplemental TDN (CORN) or DIP (SBM). The increased 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, or greater supply of gluconeogenic precursors. The increased insulin for CRSBM-fed steers may suggest that balancing DIP and TDN in the supplement resulted in improved availability of gluconeogenic substrates to cattle. Insulin levels were similar (P>.55) between all treatments prior to the initiation, and one month after the completion, of the trial. Following initiation of the trial, feeding supplements did not change serum insulin levels for CORN or CONT steers, while it increased (P<.01) for both CRSBM and SBM steers.

Steers fed soybean meal (CRSBM, SBM) had greater (P<.01) serum urea nitrogen (Table 2) than steers not receiving adequate DIP (CORN, CONT). Levels of serum urea nitrogen were similar (P>.49) among treatments before and after the study, and increased (P<.01) after the initiation of the study for all treatments, with soybean meal fed steers (CRSBM, SBM) having a greater increase (P<.01) than others (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 (Hammond et al., 1994). After the trial, serum urea nitrogen levels of CONT steers did not change (P>.56), while CORN-fed steers increased (P<.01), and steers that had been consuming soybean meal showed a decrease (P<.01).

Fecal Measures. Steers fed supplements with corn (CRSBM, CORN) or soy (CRSBM, SBM) had greater (P<.01) fecal nitrogen (Table 2) than cattle that did not receive those feeds. Feeding corn with added DIP (CRSBM) resulted in greater (P<.01) fecal N than either similar levels of TDN (CORN) or DIP (SBM) alone. Fecal N was similar between all diets prior to and after the completion of the study. All treatments had increased (P<.01) N concentration of feces after the start of the study and the diets fed with soy had the greatest increase (P<.01). As forage quality increased after the completion of the trial, fecal N also increased with steers previously fed CRSBM having similar (P>.38) fecal N as was observed during the study and all other treatments having greater (P<.02) fecal N than occurred during the study.

Feeding corn (CRSBM, CORN) resulted in decreased (P<.01) fecal pH (Table 2) vs supplements without grain (SBM, CONT). This reduction in pH coupled with the increase in fecal N appears to indicate an increase in large intestinal fermentation. Fecal pH was unchanged (P>.21) for CONT and SBM fed steers during the periods prior to, during, or after the trial. However, fecal pH of CRSBM and CORN cattle had decreased pH after the initiation and increased pH after the completion of the trial when compared to the values observed during the experiment.

Fecal ADF concentration (Table 2) 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 fed, or as a result of decreased forage intake (Bodine et al., 2000, 2001). Fecal ADF concentration tended (P<.10) to be reduced by the inclusion of soybean meal in the supplements containing corn.

Total OM fecal output (Table 2) was greater for diets with corn, which may be related to the decreased digestibility of forage, or the increased total OMI. Steers fed CORN had greater fecal OM output than either CRSBM or SBM cattle. This can be partially attributed to the low forage OMD of the CORN diets, since CORN and CRSBM had similar forage and total OMI, but CRSBM steers had reduced fecal OM output vs CORN-fed cattle. Supplementing with soybean meal (CRSBM, SBM) tended (P<.12) to decrease fecal ADF output, which may be due to the greater ADF digestibility of those diets. This may be supported by the increased forage and total diet OMD of steers supplemented with soybean meal (CRSBM, SBM). However, diets fed without corn had the greatest fecal ADF output, the lowest total OM fecal output, and the greatest ADF concentration, along with the highest forage OMD and OMI.

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