Grazing Behavior, Intake, Digestion, and Performance by Steers Grazing Dormant Native Range and Offered Supplemental Energy and(or) Protein

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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 energy, protein, 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. Grazing behavior was measured for 5 d. Fecal output was determined by feeding chromic oxide, collecting fecal grab samples for 5 d, and adjusting for chromium recovery determined from steers fitted with fecal bags. Forage intake was estimated from acid-detergent insoluble ash in feces and feeds. Supplemented steers grazing dormant native range had improved performance, while steers fed corn plus soybean meal had greater gains than other steers. Forage intake and digestibility were reduced for steers supplemented with corn vs those not fed corn while forage digestibility was greater for corn plus soybean meal than corn plus soybean hulls. Grazing time, intensity, and harvest efficiency were reduced by corn supplements, while grazing bouts increased. Corn-based supplements fed with soybean meal allowed a greater level of animal performance than corn or soybean meal supplements fed individually. Overall, high-starch supplements can be successfully utilized on low-quality forges as long as ruminally degradable protein is adequate for forage and supplement digestion.

Key Words: Intake, Digestion, Grazing Behavior, Beef Cattle

Introduction

Cattle grazing low-quality dormant native range in Oklahoma may encounter several nutrient deficiencies that result in decreased animal performance. Therefore, supplementation is necessary to optimize animal performance during this period. Protein is typically the primary limiting nutrient, however, increasing forage intake with protein supplements may not result in adequate energy intake for animal performance to achieve desired levels. The objective of this study was to determine the effects of energy, protein, or a combination of energy and protein supplements on animal performance, grazing behavior, forage intake, and forage digestion.

Materials and Methods

Animals. In both years, all steers grazed common pastures prior to the initiation of the trial and 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. The winter grazing period was 96 and 70 d, respectively, in yr 1 and 2. Fall-born, English x Continental steers from two herds were received at the OSU Bluestem Research Range after summer weaning.

Diets and Feeding. Treatments (Table 1) are described in detail in Bodine et al. (2000), but briefly consisted of: 1) .75% BW/d of dry-rolled corn plus adequate soybean meal (CRSBM) to balance total diet DIP:TDN; 2) .75% BW/d of dry-rolled corn plus soybean hulls (CORN), equal supplemental TDN to CRSBM; 3) soybean meal (SBM) with equal supplemental 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 in individual stalls at 0800. Steers had ad libitum access to water and mineral mix. For 10 d during the last third of the grazing period each year, all 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)) to estimate fecal output.

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 pellets	---	21.88	---	20
Soybean meal (49%CP)	21.48	---	100	---
Cottonseed hulls	---	---	---	55
Molasses	---	---	---	3
Salt	---	---	---	2
Nutrient, (% of DM)				
Dry matter	87.96	88.02	89.87	90.04
Organic matter	97.83	98.09	94.33	95.35
Crude protein	18.34	9.84	53.16	7.59
Degradable intake protein (%CP)	36.57	29.34	84.95	38.17
Acid detergent fiber	5.53	14.06	6.43	46.22
Neutral detergent fiber	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, 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. Masticate samples were collected from unsupplemented ruminally cannulated steers at the initiation and completion of the trial and supplemented ruminally cannulated steers monthly (2X/yr). Fecal grab samples were collected for the last 5 d of the 10-d chromic oxide feeding period, dried, ground and stored for later analysis. During the same time period, cannulated steers were fitted with fecal collection bags that were changed twice daily (0800 and 1700). Grazing time was estimated during the fecal collection period by the use of 12 grazing collars with vibracorders. Grazing collars were placed on three steers per treatment 1 d prior to the initiation of grazing time measurements.

Calculations. Forage allowance was calculated by dividing total forage DM by total steer BW. Fecal output was determined by dividing chromium intake by fecal chromium concentration. Fecal output was adjusted for calculated chromium recovery as determined from cannulated

steers fitted with fecal bags. Forage OMI was determined by dividing fecal forage ADIA by ADIA concentration of masticate samples. Apparent total tract forage OMD was calculated as 100 minus masticate ADIA concentration divided by fecal forage ADIA concentration. Harvesting efficiency of forage was calculated by dividing forage intake (g/kg BW) by total minutes spent grazing.

Statistical Analyses. Experimental design for both years was a completely randomized design. Experiment (year), supplemental dietary treatment, and their interaction were included in the model as fixed effects. Since steers were individually fed and grazed a common pasture, individual steer was considered the experimental unit and was included in the model as a random effect. All response variables were analyzed using PROC MIXED of SAS (SAS Inst. Inc., Cary, NC). Means were calculated with 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

Forage Mass, Allowance and Diet Quality. Forage mass was relatively constant during both trials while diet quality (Table 2) appeared to decrease over time for both years. Observed forage allowance (Table 2) was always sufficient, and was not considered a limiting factor. Additionally, diet quality of masticate samples representing forage available for consumption by cattle suggested that steers would respond to supplementation.

Table 2. Forage mass and allowance, and masticate sample chemical composition for each period pooled across both trials

	Portion of the winter grazing period		
Item	First 1/3	Middle 1/3	Last 1/3
Forage mass (kg DM/ha)	3684	4465	4025
Forage allowance (kg DM/kg BW)	31.1	36.9	31.3
Chemical analysis (% of DM)			
Organic matter	87.7	87.3	87.1
Crude protein	9.1	5.8	5.7
Degradable intake protein (%CP)	55.0	52.1	50.3
In vitro organic matter digestibility	66.1	60.6	58.9
Neutral detergent fiber	67.9	69.5	71.6
Acid detergent fiber	43.1	46.0	46.9

Grazing Behavior. Steers fed supplements with corn (CRSBM, CORN) had reduced ($P<.01$) grazing time and intensity and increased ($P<.01$) number of grazing bouts (Table 3) vs those not receiving supplemental grain (SBM, CONT). This agrees with the conclusions in the review of supplementation effects on grazing behavior by Krysl and Hess (1993). Time spent foraging was reduced by high levels of supplementation, which may result in decreased energy expenditure

from grazing. However, grain supplements decreased (P<.01) harvesting efficiency (Table 3) which does not agree with the general conclusion drawn by Krysl and Hess (1993).

Forage Intake. Cattle fed corn (CRSBM, CORN) had reduced (P<.01) forage intake (Table 3) vs those not supplemented with corn (SBM, CONT). This agrees with the results of the grazing behavior measurements. The decreased forage OMI is in agreement with the findings of Chase and Hibberd (1987). While forage OMI of steers fed soybean meal (CRSBM, SBM) tended to be greater (P=.12) than cattle receiving the low-protein supplements (CORN, CONT), forage OMI by CRSBM-fed cattle was not different (P=.18) vs CORN supplemented steers, which does not agree with our previous findings that adding soybean meal to grain supplements will increase forage intake of low-quality prairie hay (Bodine et al., 1999).

Forage Digestibility. Forage OMD was decreased (P<.01) for steers fed corn-based supplements (CRSBM, CORN) vs those not fed supplemental grain (SBM, CONT). This supports the similar findings in grazing behavior and forage intake. It is supported by previous research that has shown decreased digestion of low-quality forages when corn has been used as a supplement (Chase and Hibberd, 1987). However, steers that were adequate in DIP (CRSBM, SBM) had greater (P<.01) forage OMD than those cattle that were DIP-deficient (CORN, CONT). This was due to the greater (P<.01) OM digestibility of the forage consumed by CRSBM animals than for the CORN-fed steers. Other researchers (Hibberd et al., 1987; Bodine et al., 1999) have noted this increase in forage digestion when DIP has been added to grain supplements. The increased OMD for CRSBM vs CORN supports the observations in increased ADG, and agrees with a tendency for increased forage OMI, total diet OMD, and digestible OMI, while it is not supported by the similar grazing time, intensity, or harvesting efficiency of CRSBM- and CORN-fed steers.

Total Diet. Steers fed corn (CRSBM, CORN) had greater (P<.01) total diet OMI than those not (SBM, CONT), and CRSBM cattle consumed more (P<.01) total OM than did SBM steers. Digestibility of the total diet OM was greater (P<.03) for CRSBM-fed vs CORN and SBM supplemented steers, corn-fed (CRSBM, CORN) vs no corn (SBM, CONT), and soybean meal supplemented (CRSBM, SBM) vs not (CORN, CONT). This was due to greater forage digestion for CRSBM vs CORN, and greater intake of highly digestible supplement for CRSBM and CORN, as well as the high digestibility of the SBM supplement. As a result intake of digestible OM, a measure of energy intake, was greater (P<.03) for CRSBM- vs CORN- and SBM-supplemented steers, corn-fed (CRSBM, CORN) vs no corn (SBM, CONT), and soybean meal supplemented (CRSBM, SBM) vs not (CORN, CONT).

Table 3. Performance, intake, digestion and grazing behavior of steers grazing dormant native tallgrass prairie and fed one of four supplements 5 d/wk

	Supplement[a]					
Item	CRSBM	CORN	SBM	CONT	SEM[1]	Contrasts[2]
Grazing time, min	445	421	516	543	15.3	2,3
Grazing bouts	12.3	11.7	8.7	9.8	.6	2,3
Intensity, min/bout	39.6	38.2	63.5	59.7	3.1	2,3
Harvest efficiency g/(kg BW·min grazing)	.025	.022	.033	.030	.002	2,3
Forage OMI, g/kg BW	12.5	11.2	17.5	16.6	.7	2,3

Forage OMD, %	38	16	57	56	2.5	1,2,3,4
Total diet OMI, g/kg BW	26.1	24.8	21.5	17.2	.7	2,3,4
Total diet OMD, %	63	56	59	52	1.2	1,2,3,4
Digestible OMI, g/kg BW	16.9	14.4	13.5	9.9	.6	1,2,3,4
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
Pre-Trial[3] ADG, kg/d	.0	.13	.16	.19	.20	NS
Trial[3] ADG, kg/d	.74	.25	.39	-.17	.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

[a]CRSBM=13 g/kg of BW/feeding dry-rolled corn plus soybean; CORN=13 g/kg of BW/feeding dry-rolled corn plus soybean hull pellets, equal TDN to CRSBM; SBM=soybean meal, equal DIP as CRSBM; CONT=.6 g/kg of 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]Pre-Trial period was 21 d; average Trial period was 83 d; average Post-Trial period was 33 d ;and average Trial + Post period was 116 d

Animal Performance. Cattle had similar (P>.88) ADG for the month previous to the initiation of the trial (.51 kg/(steer·d)) as well as similar (P>.47) initial BW (Table 3) at the start of the experiment. Steers fed CRSBM had greater (P<.01) ADG (Table 3) 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. 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. Feeding either energy or protein supplements to steers consuming low-quality dormant native range resulted in similar observations as many previous researchers have noted. However, the combination of energy and protein in a single supplement resulted in greater than expected animal performance, primarily as a result of increased forage digestibility and digestible organic matter intake. Feeding a supplement that provided both energy and adequate DIP to digest not only the supplement, but also the basal forage diet, allowed us to achieve these significant rates of gain on dormant native range with excellent supplement conversions. This suggests that while cattle were deficient in

both energy and protein, the most efficient method of supplying these ingredients was in a balanced form.

Literature Cited

Bodine, T.N. et al. 1999. Okla. Agr. Exp. Sta. Res. Rep. P-973:229.

Bodine, T.N. et al. 2000. Okla. Agr. Exp. Sta. Res. Rep. P-980:33.

Chase, C.C., Jr. and C.A. Hibberd. 1987. J. Anim. Sci. 65:557.

Hibberd, C.A. et al. 1987. Okla. Agr. Exp. Sta. Res. Rep. MP-119:275.

Krysl, L.J. and B.W. Hess. 1993. J. Anim. Sci. 71:2546.
