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Effects of supplemental energy and Degradable Intake Protein on grazing behavior, forage intake, digestion and performance of steers grazing winter range

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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, .4, or .06% BW/feeding, respectively. Grazing behavior was measured for 5 d with grazing collars. Fecal output was determined by feeding chromic oxide and collecting fecal grab samples each morning for 5 d and adjusting for calculated chromium recovery determined from cannulated steers fitted with fecal bags. Forage intake was estimated from the acid insoluble ash in feces and feeds. Steers fed supplements with corn or soybean meal had increased gains 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. Supplemented steers grazing dormant native range had improved performance. Corn-based supplements fed with soybean meal will allow 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

Animals. Steers grazed common pastures without supplementation 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.

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/d) 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 supplement 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 in individual stalls at 8:00 a.m. Steers had ad libitum access to water and mineral mix with chlortetracycline (Aureomycin). From d 50 to 60, 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)).

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 (d 55 to 59), dried, ground and stored for later analysis. Cannulated steers were fitted with fecal collection bags (d 55 to 60) that were changed twice daily (8:00 a.m. and 5:00 p.m.). Grazing time was estimated from d 55 to 59 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 AIA by AIA concentration of masticate samples. Apparent total tract forage OMD was calculated as 100 minus masticate AIA concentration divided by fecal forage AIA concentration. Harvesting efficiency of forage was calculated by dividing forage intake by minutes spent grazing.

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 were individually fed and grazed a common pasture, individual steer was considered the experimental unit. Contrast statements were used to separate 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).

Forage Mass, Allowance and Diet Quality. Forage mass and diet quality (Table 2) appeared to decrease over time. Observed forage allowance (Table 2) was always sufficient to not be considered a limiting factor and diet quality suggested that steers would respond to supplementation. Masticate samples collected by steers on different treatments were not different (P>.62) in any of the measured nutrients, so diet quality is reported by time.

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). Forage OMI for CRSBM-fed cattle was not different (P>.74) 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). Protein supplementation (CRSBM, SBM) did not increase (P>.67) forage OMI vs CORN- and CONT-fed cattle, as would be expected (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<.04) forage OMD than those cattle that were DIP-deficient (CORN, CONT). This was due to the greater (P<.05) OM digestibility of the forage for CRSBM animals than for the CORN-fed steers. Other researchers (Hibberd et al., 1987 and Bodine et al., 1999) have noted this increase in forage digestion when DIP has been added to grain supplements. Yet, while the increased OMD for CRSBM vs CORN did support the observations in increased ADG, the increased forage OMD did not result in differences in forage OMI, or increased grazing time, intensity, or harvesting efficiency.

Animal Performance. Cattle had similar (P>.60) initial BW (Table 3) and summer ADG (.51 kg/(steer·d)) prior to 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 between CRSBM- vs CORN-fed steers may help explain the greater ADG of CRSBM steers since intake and grazing time were equal 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 with adequate DIP for the total diet TDN.

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

Supplement	Supplement[a]			
ingredient, (%)	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

[a]CRSBM=10.5 g/(kg BW·feeding) dry-rolled corn plus soybean meal to meet NRC (1996) DIP requirements; CORN=10.5 g/(kg BW·feeding) dry-rolled corn plus soybean hull pellets, equal TDN to CRSBM; SBM=soybean meal with equal g DIP/(kg BW·feeding) as CRSBM; CONT=.56 g/(kg BW·feeding) control supplement.

Table 2. Forage mass, allowance and masticate sample chemical composition for each period of the trial.

	Time		
Item	Early 1/3 (d1-32)	Middle 1/3 (d33-64)	Late 1/3 (d65-96)
Forage mass (kg DM/ha)	4249	4353	3654
Forage allowance (kg DM/kg BW)	36.4	36.8	29.5
Chemical analysis (% of DM)			
Organic matter	86.1	87.2	87.2
Crude protein	13.7	7.1	5.3
Degradable intake protein (%CP)	53.6	48.0	50.0
In vitro organic matter digestibility	71.0	60.8	58.4
Neutral detergent fiber	63.2	67.6	72.0
Acid detergent fiber	38.7	47.1	47.2

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	407	421	490	493	16.24	2,3
Grazing bouts	13.7	12.5	8.4	9.8	.95	2,3
Grazing intensity, min/bout	32.1	35.2	63.3	54.4	4.9	2,3
Harvest efficiency	.027	.025	.039	.034	.003	2,3

g/(kg BW·min grazing)					
Forage OMI, g/kg BW	11.91	12.40	18.23	17.56	1.10	2,3
Forage OMD, %	37.99	22.44	58.51	59.59	3.33	1,2,3,4
Initial BW, kg	279	296	284	287	6.64	NS
Final BW, kg	353	323	330	292	7.19	1,2,3,4
Trial ADG, kg/d	.77	.29	.48	.05	.09	1,2,3,4

[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.

[1]SEM=Standard error of the means, n=13.

[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.