EFFECT OF CORN GLUTEN FEED, SOYBEAN MEAL, AND COTTONSEED MEAL ON INTAKE AND UTILIZATION OF PRAIRIE HAY BY BEEF HEIFERS

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Story in Brief

Twelve 704 lb crossbred beef heifers were used in three simultaneous 4 x 4 Latin squares to determine the effect of supplemental protein source on intake and digestibility of medium quality prairie hay (5.2% crude protein) fed free choice. Treatments included: 1) control, prairie hay; 2) soybean meal; 3) cottonseed meal; and 4) corn gluten feed. Daily dry matter intakes for these protein supplements were 1.67, 1.87, and 3.83 lb, respectively, to provide equal amounts of supplemental protein at the level of .80 lb per day. Daily hay intakes (dry matter basis) were 15.0, 20.9, 19.6 and 18.7 lb or 2.1, 2.9, 2.7 and 2.6% of body weight on the control, soybean meal, cottonseed meal and corn gluten feed treatments, respectively, with total daily dry matter intakes of hay plus supplement and minerals of 15.1, 22.7, 21.6 and 22.6 lb on the same treatments. Ration dry matter digestibilities were 44.3, 55.0, 54.6 and 54.1%, and total daily digestible dry matter intakes were 6.7, 12.5, 11.8 and 12.2 lb on the control, soybean meal, cottonseed meal and corn gluten feed treatments, respectively. Supplementation increased digestibility of the total diet above expected or calculated values (55.0 vs 47.7% for soybean meal; 54.6 vs 48.3% for cottonseed meal; 54.1 vs 51.1% for corn gluten feed). Forage intake was decreased slightly (7%) on the corn gluten feed treatment probably because of slightly more energy being fed in the supplement. Supplementation increased forage intake and digestibility for all supplements with little difference among supplements.

(Key Words: Prairie Hay, Protein Supplement.)

Introduction

Corn gluten feed (CGF) is a byproduct of wet-milling corn to produce corn syrup. It includes the corn bran and condensed steepwater solubles. Corn gluten feed contains about 22 to 23% CP, 2% ether extract, 9% crude fiber and

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is high in phosphorus and potassium. As the corn refining industry has grown, CGF has found wider use in the United States as a protein supplement and has become more widely available in recent years.

Some studies have been conducted with CGF, primarily in beef finishing or dairy rations, but only limited work has been done to investigate the use of CGF in range supplements for beef cattle or to compare the effects of CGF with more traditional protein supplements like soybean meal (SBM) or cottonseed meal (CSM) on the intake and digestibility of medium quality range forages similar to those grazed by cattle during summer months. Therefore, this study was conducted to investigate the effects of providing equal amounts of supplemental protein from SBM, CSM or CGF on forage intake, digestibility, ruminal pH, ruminal NH_3-N and rate of passage when fed with medium quality prairie hay to beef heifers.

Materials and Methods

Twelve crossbred beef heifers (704 lb) were used in three simultaneous 4 x 4 Latin squares. All animals were fed medium quality prairie hay ad libitum. Prairie hay was cut during the first half of July from a meadow harvested annually. The treatments included: 1) Control, consisting of hay (C); 2) SBM supplement (SBM); 3) CSM supplement (CSM), and 4) CGF supplement (CGF).

All heifers were housed individually in slatted-floor pens. The SBM, CSM, and CGF supplements were fed once daily at rates of 1.67, 1.87, and 3.82 lb, respectively (Table 1) to provide equal amounts of supplemental crude protein (.8 lb/day). A mineral and vitamin A mixture was fed to all animals at a level of .11 lb/day on all treatments (Table 1). Nutrient composition of the hay and supplements is denoted in Table 2.

Each period in the Latin square lasted 14 days, with days 1 through 8 for adaptation. Hay, fed and rejected, and supplements were weighed and sampled daily. Chromic oxide was fed as an indigestible marker to estimate digestibilities. Fecal grab samples were collected twice daily on days 10 through 13 in each collection period. Fecal samples from each animal for each period were refrigerated until the end of each period, composited, subsampled and dried at 60° C for 96 h. Hay, supplement and fecal samples were analyzed for moisture and chemical determinations.

Rate of particulate passage values for hay were determined using ytterbium (Yb). Hay was labeled with Yb and fed as a single pulse dose according to the procedure of Teeter et al. (1984). The rumen of each animal was sampled via stomach tube on the last day of each period within 2 to 4 h of feeding supplement. The pH of the ruminal fluid was measured immediately; then fluid was acidified and frozen for later NH_3-N analysis.

Table 1. Intake of the supplements (DM basis) and composition of mineral-vitamin A mixture.

Ingredient	Supplement[a]			
	C	SBM	CSM	CGF
	lb/day			
SBM	---	1.67	---	---
CSM	---	---	1.87	---
CGF	---	---	---	3.83
Mineral and vitamin mixture[b]	.11	.11	.11	.11
Total supplement	.11	1.78	1.98	3.94

[a] C is control; SBM is soybean meal; CSM is cottonseed meal; CGF is corn gluten feed.

[b] Contained: Dicalcium phosphate 42.2%, KCl 18.1%, trace minerals 27.4% (.25% Mn, .2% Fe, .033% Cu, .0025% Co, .007% I, .005% Zn), Na_2SO_4 11.8% and vitamin A .5% (220 USP units/g).

The statistical analysis included square, period, animal within period and square x treatment as variables. Treatments were compared using orthogonal contrasts of supplementation (all vs C), CGF vs the SBM plus CSM and, finally, SBM vs CSM.

Results and Discussion

Supplementation increased (P<.01) the daily intake of prairie hay from 15.0 lb (C) to 20.9, 19.6 and 18.7 lb on the SBM, CSM and CGF treatments, respectively (Table 3), representing increases in hay consumption of 39, 30 and 24% above the C. Total daily dry matter intakes (hay + protein supplement + mineral-vitamin A) also were increased (P<.01) by supplementation from 15.1 (C) to 22.7 (SBM), 21.6 (CSM) and 22.6 lb. While hay intake was about 7% lower (P<.01) on the CGF treatment compared to SBM + CSM, there was no difference in total daily dry matter intake (hay + supplement). Slightly lower forage intake on the CGF treatment can likely be attributed to the larger quantity

Table 2. Chemical composition (%) of hay and supplements[a].

Item[a]	Prairie hay	SBM[b]	CSM	CGF
Dry matter	89.5	88.3	89.0	86.2
Organic matter	93.6	93.0	92.1	92.1
Crude protein	5.2	47.9	42.9	20.8
Acid detergent fiber	45.6	10.5	14.7	13.4
Neutral detergent fiber	72.5	15.3	29.0	45.4
Ash	6.4	6.9	7.9	7.9

[a] Dry matter basis.
[b] Contained: Dicalcium phosphate 42.2%, KCl 18.1%, trace minerals 27.4% (.25% Mn, .2% Fe, .033% Cu, .0025% Co, .007% I, .005% Zn), Na_2SO_4 11.8% and vitamin A .5% (220 USP units/g).

of supplement fed and thus the extra energy supplied by the CGF. Slightly lower forage consumption by heifers fed CGF agrees with results by Fleck and Lusby (1986) in which mature cows grazing native winter range lost similar amounts of weight when fed SBM or CGF as a supplement.

Total ration dry matter digestibility (%) was increased from 44.3 on the C to 55.0 (SBM), 54.6 (CSM) and 54.1 (CGF) (Table 3). Supplement should improve digestibility of the diet since supplement is more digestible than hay. Predicted digestibility values also were calculated based on the value obtained for prairie hay on the C treatment and using an assumed digestibility of 80% for the supplement. Improvements in digestibility noted above predicted values with the different supplementation programs are graphically noted in Figure 1. Supplementation improved digestibility above anticipated values on all treatments, although no significant differences were noted among the protein supplement treatments. In the case of SBM, for example, the observed digestibility of 55.0% exceeded the anticipated digestibility of 47.1%, demonstrating the positive effect of supplemental protein on digestibility of prairie hay.

Digestibility of acid detergent fiber was increased ($P<.01$) from a value of 35.4% on the C to a range of 44.4 to 47.5% on the supplemental protein treatments, with no difference among protein source (Table 3). As anticipated, supplementation resulted in increased ($P<.01$) protein digestibility, being 24.8%

Table 3. Influence of supplementation on daily intake and digestibility by heifers.

Item	Supplement[a]					Orthogonal comparisons[b]		
	C	SBM	CSM	CGF	SE	S	A	B
Prairie hay DM intake,								
lb	15.0	20.9	19.6	18.7	.44	.0001	.01	.04
% of BW	2.1	2.9	2.7	2.6	.06	.0001	.01	.04
Total DM intake,								
lb	15.1	22.7	21.6	22.6	.44	.0001	.28	.08
Dry matter dig, %	44.3	55.0	54.6	54.1	2.71	.003	.82	.92
Digestible DM intake,								
lb	6.76	12.5	11.8	12.2	.64	.0001	.72	.37
Indigestible DM intake,								
lb	8.5	10.2	9.8	10.4	.55	.01	.65	.71
% of BW	1.2	1.4	1.4	1.5	.07	.01	.65	.71
Apparent crude protein dig, %								
Observed	24.8	55.8	54.3	51.5	2.60	.0001	.01	.68
Expected	31.3	53.4	54.0	51.1	.35	.0001	.0001	.22
Acid detergent								
fiber dig, %	35.4	47.5	45.4	44.4	31.5	.009	.68	.64

[a] C is control; SBM is soybean meal; CSM is cottonseed meal; CGF is corn gluten feed.

b Comparison included: S for C vs all other treatments; A for CGF vs SBM plus CSM; B for SBM vs CSM.

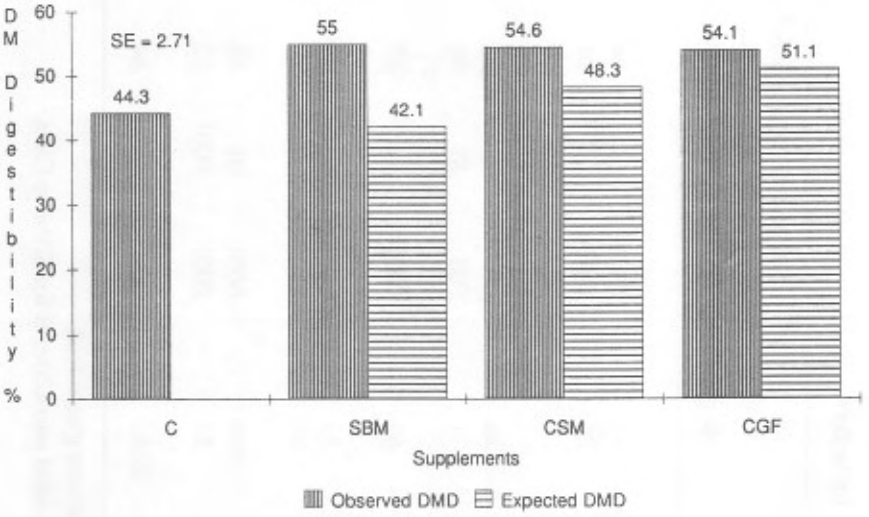

Figure 1. Comparison of observed vs expected diet dry matter digestibilities. Expected digestibilities are based upon values obtained for hay on the control treatment and an assumed 80% DM digestibility for supplements. C is control, SBM is soybean meal, CSM is cottonseed meal and CGF is corn gluten feed supplements.

on the C and from 51.5 to 55.8% on the three protein treatments. An increase in protein intake should result in an increase in apparent protein digestibility because of dilution of metabolic fecal nitrogen. Corrections for metabolic fecal nitrogen resulted in calculated (anticipated) digestibilities close to observed values. Although the differences were small, the average (55.0%) protein digestibility for SBM and CSM was higher ($P<.01$) than for CGF (51.5%).

Because of an increase in both forage intake and diet digestibility, daily digestible dry matter intake (DDMI) was increased ($P<.01$) from 6.6 lb (C) to 12.5 (SBM), 11.8 (CSM) and 12.2 (CGF), representing an average increase of about 84% on the three protein treatments (Table 3). No differences in DDMI were noted among protein sources.

Intake of indigestible dry matter was calculated to determine if improved intake could be attributed solely to increased digestibility of the diet. Ellis et al. (1983) reported indigestible daily dry matter intake tended to remain constant in cattle grazing ryegrass pastures of differing qualities and proposed that gut fill of indigestible material was responsible for restricting forage intake. In our study, however, daily intake of indigestible dry matter intake was increased

Table 4. Influence of protein supplement on ruminal measurements.

Item	Supplement[a]				SE	Orthogonal comparisons[b]		
	C	SBM	CSM	CGF		S	A	B
Ruminal fluid pH	7.0	7.0	6.4	6.8	.25	.89	.76	.15
Ruminal NH_3-N, mg/dl	.77	3.36	3.48	5.27	.213	.0001	.0001	.69
Particulate passage rate, %/hour	1.7	3.3 +94%[c]	2.9 +70%[c]	2.8 +64%[c]	.19	.001	.31	.19

[a] C is control; SBM is soybean meal; CSM is cottonseed meal; CGF is corn gluten feed.
[b] Contrasts included: S for C vs all other treatments; A, CGF vs SBM plus CSM; b, SBM vs CSM.
[c] Percentage change from control supplement.

(P<.01) by supplementation on all protein treatments by an average of 19.4% (Table 3). An increase (24 to 43%) in indigestible dry matter intake when prairie hay was supplemented with SBM also was noted by Guthrie and Wagner (1988).

Ruminal fluid pH (Table 4) was not significantly altered by supplementation, although there was a tendency for slightly lower values on the CSM and CGF treatments. Ruminal NH_3-N values were increased (P<.01) by supplementation, with values (mg/dl) ranging from .77 on the C to 3.36 (SBM), 3.48 (CSM) and 5.27 (CGF). Additionally, NH_3-N values were higher (P<.01) for the CGF treatment than for the average of the SBM and CSM. The higher NH_3-N values on CGF imply that protein in CGF was either degraded more rapidly or extensively in the rumen or that NH_3-N was less completely utilized for microbial synthesis on CGF than for SBM or CSM. Particulate passage rates ranged from 1.7 (C) to 3.3% per hour, being increased (P<.01) by supplementation by an average of 76% (Table 4), with no significant differences among the three protein sources.

Feeding of either SBM, CSM or CGF increased forage intake, digestibility of dry matter and acid detergent fiber, total digestible dry matter intake and rate of passage. Differences between protein sources were generally small, although there appeared to be a small, but consistant (usually nonsignificant) increase for SBM compared to CSM or CGF.

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