ADDED COTTONSEED MEAL FOR BEEF HEIFERS CONSUMING CORN-SUPPLEMENTED LOW-QUALITY NATIVE GRASS HAY DIETS

C.A. Hibberd[1], C.C. Chase, Jr.[2] and L.D. Bourquin[3]

Story in Brief

Four supplements supplying 3.9 lb of ground corn plus 0, .6, 1.2 or 1.8 lb of cottonseed meal per day were fed to mature, ruminally cannulated Hereford X Angus heifers consuming low-quality native grass hay. Added cottonseed meal increased organic matter digestibility from 40.7% (no cottonseed meal) to 47.2% (1.8 lb added cottonseed meal). Neutral detergent fiber digestibility increased from 24.1% to 35.3% with added cottonseed meal. Hay intake was 15.2, 17.1, 17.8 and 18.7 lb/day for 0, .6, 1.2 and 1.8 lb of added cottonseed meal, respectively. Adding 1.8 lb cottonseed meal to the diet increased digestible organic matter intake by 3.5 lb (49%) compared to the control. Supplementation of low-quality native grass hay diets with large quantities of corn may result in a ruminal protein deficiency which can be alleviated with the addition of cottonseed meal.

(Key Words: Supplement, Corn, Cottonseed Meal, Native Grass, Beef Cattle.)

Introduction

Beef cows grazing dormant native range require energy supplementation when environmental stress or production demands increase. Many commercial energy supplements contain large quantities (60-70%) of high-starch cereal grains. Corn supplements fed in excess of 4 lb/day decrease forage digestibility and intake to the extent that total energy intake is not improved (Chase and Hibberd, 1985).

Cereal grain supplements may decrease ruminal fiber digestion via decreased ruminal pH or inadequate ruminal ammonia concentrations. A previous study illustrated that ammonia addition was more effective than buffers in overcoming detrimental starch effects on fiber utilization (Chase et al., 1986). In practical supplements, however, ammonia is added in the form of protein in feeds such as cottonseed meal. The following study was performed to determine the effect of adding graded levels of cottonseed meal to a corn supplement on the digestibility and intake of low-quality native grass hay fed to beef heifers.

Materials and Methods

Four mature, ruminally cannulated Hereford X Angus heifers (850 lb) were individually penned and fed coarsely chopped (1 inch) native grass hay (4.70% crude protein) free choice. At 0800 hours each day, heifers were fed supplements (table 1) that provided 3.9 lb of ground corn plus 0, .6, .12 or .18 lb of cottonseed meal (CSM). As the amount

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[1]Assistant Professor [2]Former Graduate Assistant [3]Undergraduate Student

Table 1. Feed and chemical composition of corn supplements with added cottonseed meal[a].

	Hay	Treatment 1	2	3	4
Feed composition, lb/day					
Corn		3.9	3.9	3.9	3.9
Cottonseed meal		.0	.6	1.2	1.8
Mineral[b]		.26	.26	.26	.26
Total, lb/day		4.16	4.76	5.36	5.96
Supplemental nutrient supply, lb/day					
Crude protein[c]		.33	.57	.83	1.06
Ruminal degradable protein[d]		.12	.26	.40	.55
Total digestible nutrients[d]		3.51	3.97	4.42	4.88
Chemical composition, %					
Crude protein[c]	4.70	8.03	11.86	15.49	17.75
Total digestible nutrients[d]	---	84.2	83.2	82.3	81.7
Neutral detergent fiber[c]	68.3	13.6	14.5	18.5	22.4

[a]Dry matter basis.
[b]Mineral mix contained 63.4% dicalcium phosphate, 15.1% potassium chloride, 20.9% trace mineralized salt and .6% Vitamin A (20,000 IU/d).
[c]Actual analysis.
[d]Estimated.

of CSM in the supplement increased, total crude protein and ruminal degradable protein also increased.

Supplements (treatments) were fed to the heifers for 14-day periods in a latin square design. Each period consisted of 9 days of adaptation followed by 4 days of fecal sampling and 1 day of ruminal sampling. Hay and supplements were sampled during feeding on days 9 to 12 and hay refusals were weighed and subsampled on days 10 to 13. Fecal samples were collected on days 10 to 13 of each period at 0800 and 2000 hours. Samples of feces and hay refusals were composited for each animal within each period. Fecal composites were subsampled and dried for 4 days at 55 C followed by air equilibration. Fecal, hay, hay refusal and supplement samples were analyzed for dry matter (DM), ash, acid-insoluble ash (AIA) and neutral detergent fiber (NDF). Digestibility estimates were calculated with the marker ratio technique using AIA as the indigestible marker.

Ruminal samples were collected from each heifer at 0, 2, 4, 6, 9, 12, 18 and 24 hours post-supplement feeding on day 14. Ruminal pH was measured immediately after which samples were strained (4 layers cheesecloth), acidified (1 ml 20% H_2SO_4/50 ml fluid) and frozen. Ruminal fluid was later analyzed for ammonia.

Data were subjected to least squares analysis for period, animal and treatment effects. Response to cottonseed meal addition was evaluated by orthogonal contrasts for linear, quadratic and cubic effects.

Results and Discussion

When CSM was added to ground corn supplements for heifers consuming low-quality native grass hay (4.70% CP), a cubic increase ($P<.03$) in organic matter digestibility was observed (table 2). Much of

Table 2. Effect of added cottonseed meal on intake and digestibility of low-quality native grass hay.

Item	Treatment 1	2	3	4	SEM[a]
Digestibility, %					
Organic matter[b]	40.7	46.2	44.9	47.2	.81
NDF[c]	24.1	31.3	30.4	35.3	1.63
Intake, lb/day					
Hay[d]	15.2	17.1	17.8	18.7	.38
Digestible OM[d]	7.2	9.3	9.5	10.7	.32

[a]Standard error of the mean.
[b]Cubic response (P<.03).
[c]Linear response (P<.04).
[d]Linear response (P<.001).

the increase in OM digestion was observed with the first .6 lb increment of CSM added to the supplement. Cottonseed meal addition increased NDF digestibility linearly (P<.004) from 24.1% for the control (no CSM) to 35.3% for heifers receiving 1.8 lb/day of additional CSM. Protein supplementation increases forage digestion by meeting bacterial needs for ammonia. Although a starch-free control was not included in this study, NDF digestibility of the control (no CSM) was probably lower than would be expected with protein (no starch) supplementation. Thus, the addition of CSM to the supplement appeared to overcome some of the detrimental effects of grain supplementation.

Hay intake increased linearly (P<.001) as CSM was added to the diet (table 2). Increased forage digestion noted previously probably increased the rate of forage disappearance from the digestive tract allowing heifers to consume additional hay. Increased hay and supplement intake coupled with increased diet OM digestibility resulted in a linear increase (P<.001) in digestible OM intake with added CSM. Because digestible OM intake estimates TDN intake, heifers fed additional CSM would be expected to be in better energy balance than heifers supplemented with corn (no CSM).

Added CSM decreased ruminal pH, especially at 4 hours post-supplementation (figure 1). Grain supplementation may decrease fiber digestion via decreased ruminal pH. These data, however, suggest that the addition of CSM increases the fermentability of the diet to the extent that ruminal pH is markedly depressed compared to the control (no CSM). Ruminal ammonia concentrations were increased by CSM addition, primarily at 2 hours post-supplementation (figure 2). By 4 hours post-supplementation, ruminal ammonia concentrations declined to .5 mg/dl or less and remained low for the remainder of the day. Feeding grain with low-quality forage diets appears to create a large demand for ammonia in the rumen. Ammonia may be rapidly assimilated by starch-digesting bacteria leaving the fiber-digesting bacteria deficient. Adding 1.8 lb CSM to the diet increased ruminal ammonia supply (figure 2) and fiber digestion (table 2). Low ruminal ammonia concentrations from 4 to 24 hour after supplementation suggests that additional ammonia could be beneficial.

The heifers used in this study require about 1.2 lb of supplemental crude protein per day for maintenance. When they received 1.8 lb of CSM, however, their total crude protein intake (hay plus supplement) was 1.94 lb/day. At this level of protein intake, hay

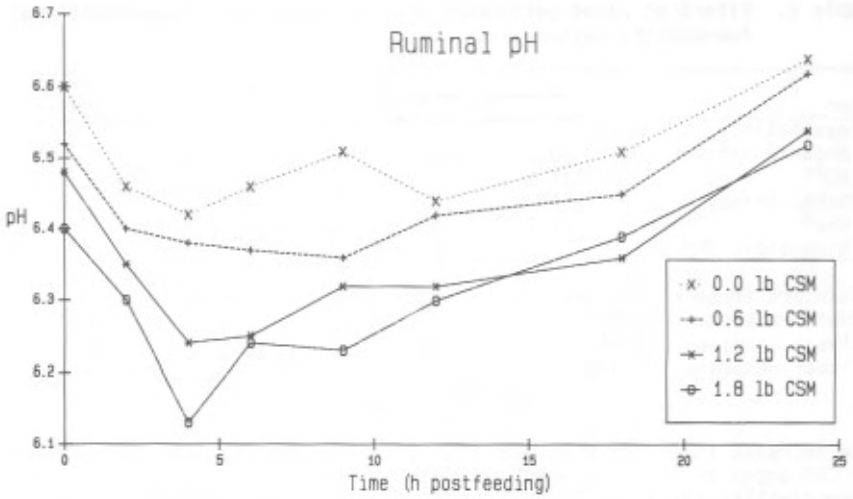

Figure 1. Diurnal variation in ruminal pH of heifers supplemented with ground corn and graded levels of cottonseed meal.

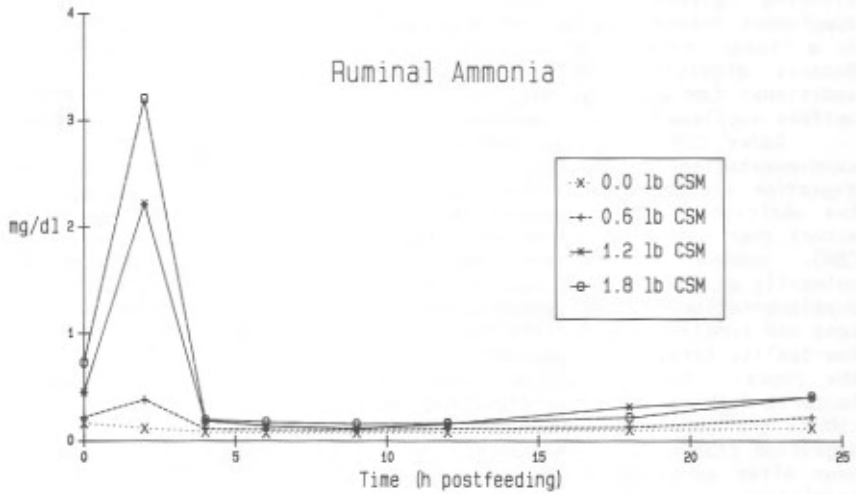

Figure 2. Diurnal variation in ruminal ammonia of heifers supplemented with ground corn and graded levels of cottonseed meal.

intake and forage digestibility had not reached a plateau suggesting that additional CSM could be useful. This response is probably attributable to increased ruminal degradable protein. Ruminants require ruminal degradable protein to supply adequate amounts of ammonia to fiber-digesting bacteria. The protein in corn and low-quality grass hay is poorly degraded in the rumen leaving cottonseed meal as the primary source of ruminal degradable protein in these diets. Thus, even though the highest level of CSM addition supplied 60% more protein than the cattle required, increased hay intake was observed because of increased ruminal degradable protein. This study illustrates that the ruminal degradable protein content of range supplements containing cereal grains should be considered during formulation.

Literature Cited

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