1989

Alternate Day Supplementation of High Escape Compared to Low Escape Protein Fed with Corn Stalks

R. M. Collins
South Dakota State University

R. H. Pritchard
South Dakota State University

ALTERNATE DAY SUPPLEMENTATION OF HIGH ESCAPE COMPARED TO LOW ESCAPE PROTEIN FED WITH CORN STALKS

R. M. Collins[1] and R. H. Pritchard[2]
Department of Animal and Range Sciences

CATTLE 89-7

Summary

A study was conducted using four ruminally fistulated wethers to compare ruminal fermentation characteristics of corn gluten meal (high escape) and soybean meal (low escape) supplements to corn stalks. Supplements were fed at 24 or 48-hour intervals. Ruminal ammonia nitrogen (RNH_3-N) concentrations were affected ($P<.05$) by treatment and treatment by hour interactions occurred. Soybean meal fed at 48-hour intervals (SBM48) resulted in the highest mean and peak RNH_3-N concentrations, as expected due to the quantity of rumen degradable protein fed. Soybean meal fed at 24-hour intervals (SBM24) caused higher ($P<.05$) RNH_3-N concentration than corn gluten meal fed at 24-hour intervals (CGM24) but not CGM48. Total VFA concentrations averaged over time were not affected ($P>.10$) by type of protein supplement. Treatment by hour interactions were observed ($P<.05$) for total VFA, because SBM24 resulted in higher VFA concentrations at several points in the 48-hour sampling period. The ratios of acetate:propionate: butyrate were similar, 74:18:7, 74:18:7, 74:18:8 and 74:18:8 for SBM24, SBM48, CGM24 and CGM48, respectively. Ruminal fluid pH values were within the range of 6.2 to 7.0 normally associated with predominantly roughage diets. Alternate day supplementation with CGM48 allows for adequate ruminal fermentation and a more constant RNH_3-N concentration than SBM48.

(Key Words: Soybean Meal, Corn Gluten Meal, Corn Stalks, Rumen Fermentation, Ammonia, Volatile Fatty Acids.)

Introduction

Alternate day protein supplementation is a common practice of livestock production. Frequency of supplementation gives rise to concerns of appropriate protein source and feeding levels. There have been satisfactory responses to protein supplementation every other day, every third day, twice weekly or even once weekly, but the response depends on the protein type.

Feeding a readily rumen degradable protein source (low escape) can lead to increased urinary nitrogen excretion and therefore less efficient use of the protein supplement when frequency of supplementation is less than daily. A low rumen degradable protein source may increase nitrogen retention and therefore efficiency of supplement utilization by reducing the ruminal NH_3-N surge postfeeding and increasing amino acids absorbed postruminally for use in nitrogen recycling.

Several studies have shown that urinary nitrogen loss is lower and nitrogen retention is higher when high escape protein supplements are fed with low quality forages. Most of these studies added urea to the high escape protein supplements to allow for adequate rumen ammonia levels.

The objective of this study was to determine if high escape protein (corn gluten meal) without added urea would sustain ruminal fermentation comparable to soybean meal when fed at 24-hour and 48-hour intervals.

Materials and Methods

Four ruminally fistulated crossbred wether lambs (75 kg) were used in a Latin square designed experiment. Treatments consisted of corn stalk diets supplemented with corn gluten meal (CGM) and soybean meal (SBM) at 24-hour (SBM24 and CGM24) and 48-hour (SBM48 and CGM48) intervals. Supplements were formulated to be isonitrogenous (Table 1) and fed at 8.89% DMI to supply 50% of the 8.0% crude protein for maintenance requirement. Corn stalks, 4.6% crude protein and 71% NDF, were ground

[1]Graduate Research Assistant.
[2]Associate Professor.

through a 1.5 in. screen. Stalks were fed ad libitum at 7:00 a.m. and 5:00 p.m. daily. Lambs were housed in individual slotted floor pens under constant illumination and temperature (70 °F). Feed and feed refusals were weighed daily and recorded.

TABLE 1. COMPOSITION OF SOYBEAN MEAL AND CORN GLUTEN MEAL SUPPLEMENTS

Ingredient, %	SBM[a]	CGM[a]
Corn gluten meal		66.70
Soybean meal	92.01	
Dicalcium phosphate	3.37	3.37
Trace mineral salt	3.37	3.37
Vitamin A/D/E premix[b]	.22	.22
Vegetable oil	.51	.51
Bovatec[c]	.51	.51
Corn starch	.25	.31

[a] Supplements differ only by frequency (24 hours vs 48 hours) of feeding.

[b] Premix contained 1,000,000 IU/lb vitamin A, 500,000 IU/lb vitamin D and 1,000 IU/lb vitamin E.

[c] Added to prevent coccidiosis.

Lambs were adapted to corn stalk diets during a 7-day preliminary phase. Periods consisted of a 14-day adaptation followed by a 2-day collection. At the beginning of each period feed offered was restricted and gradually increased to ad libitum intake to ensure acceptance of the supplements. Jugular venous blood samples were collected at 0, 24 and 48 hours and analyzed for plasma urea nitrogen. Ruminal fluid was collected prior to feeding (0 hours) and at 3, 6, 9, 12, 24, 27, 30, 33 and 36 hours after feeding on day 15 of each period. Ammonia nitrogen (NH_3-N) and volatile fatty acid (VFA's) concentrations and pH were determined on these samples. Feed samples collected during each period were dried in a forced air oven at 100 °C for 48 hours for dry matter determination and ground through a Wiley mill. Samples were analyzed for Kjeldahl-N, acid detergent fiber (ADF) and neutral detergent fiber (NDF) content.

Data were arranged and analyzed as a 4 x 4 Latin square split plot design. Main effects of diet, period and lamb were tested by treatment x period x lamb interaction. Hour was tested by the hour x lamb interaction. Mean separations within hour were completed using least significant differences by PDIFF in SAS.

Results and Discussion

Supplements were accepted with minimal problems. Total dry matter intake for 16-day periods was affected ($P<.05$) by diet. No differences ($P>.10$) in DMI occurred during the last 7 days of each period. Total period differences may have reflected carryover effects from the previous period or initial acceptability of supplements. Daily DMI for the last 7 days of each period were 1310, 1231, 1198 and 1330 g $\pm$ 48.5 for SBM24, SBM48, CGM24 and CGM48, respectively.

Ruminal NH_3-N was affected ($P<.05$) by diet and a diet by hour interaction existed. RNH_3-N concentrations were higher ($P<.05$) when SBM48 was fed, reflecting quantity of protein and degradability supplied to the rumen. The diet by hour interactions (Table 2) that were observed ($P<.05$) for RNH_3-N may be due to differing fermentation rates as a result of protein source and frequency of supplementation. RNH_3-N concentrations on CGM diets were relatively low but did not drop below the 2 mg/dl suggested as a fermentation requirement. The lower RNH_3-N concentrations may reflect efficient bacterial growth, although VFA concentrations were not increased. Plasma urea nitrogen (PUN) as a possible indicator of ruminal NH_3-N spillover was not affected ($P>.10$) by diet (Table 3).

Diet did not affect total VFA concentration (Table 3), but a diet by hour interaction was present ($P<.05$). SBM48 caused a quicker ($P<.05$) peak in total VFA concentrations than CGM48 (Table 4), probably because of different protein degradation rates. CGM48 caused lower ($P<.05$) total VFA concentrations than SBM24 at 27 hours and 30 hours.

The molar proportions of the major VFA, acetate:propionate:butyrate, were 74:18:7, 74:18:7, 74:18:8 and 74:18:8 for SBM24, SBM48, CGM24 and CGM48, respectively. This suggests protein source or frequency of supplementation did not affect the type of fermentation that occurred.

Treatment effects on individual VFA concentrations (Table 3) were observed ($P<.05$). Isobutyrate concentrations were lower on the CGM24 diet. Individual VFA concentrations were affected ($P<.05$) by diet and hour interactions, reflecting total VFA diet by hour interactions.

TABLE 2. LEAST SQUARES MEANS FOR RUMINAL AMMONIA-N BY TREATMENT AND HOUR

Hour	Treatments[a]			
	SBM24	SBM48	CGM24	CGM48
	mg/dl			
0	5.56	6.74	7.31	6.67
3	12.24^{b}	16.99^{c}	8.17^{d}	12.54^{b}
6	6.71^{b}	14.76^{c}	2.82^{de}	4.93^{be}
9	5.60^{b}	13.05^{c}	2.48^{de}	3.11^{be}
12	7.14^{b}	12.38^{c}	2.73^{d}	3.52^{d}
24	5.64^{b}	11.07^{c}	5.63^{b}	6.60^{b}
27	13.84^{b}	9.70^{c}	7.42^{cd}	6.52^{d}
30	8.11^{b}	6.55^{bc}	3.70^{d}	5.14^{cd}
33	6.82^{b}	6.13^{b}	2.54^{c}	4.80^{bc}
36	7.16^{b}	7.00^{b}	3.60^{c}	4.72^{bc}

[a] Error mean square = 22.0.
[b,c,d,e] Means within a row with unlike superscripts differ (P<.05).

TABLE 3. LEAST SQUARES MEANS FOR RUMINAL pH, NH_3-N, PLASMA UREA NITROGEN (PUN), TOTAL VFA AND INDIVIDUAL VFA

Item	Treatment				SEM
	SBM24	SBM48	CGM24	CGM48	
pH	6.45	6.43	6.38	6.44	.03
NH_3-N (mg/dl)	7.88^{ac}	10.43^{a}	4.64^{b}	5.86^{bc}	.74
PUN (mg/dl)	7.72	7.23	5.72	7.74	.64
	μmoles/ml				
Total VFA	49.99	47.08	43.70	47.27	1.49
Acetate	36.33	34.13	31.68	34.53	1.04
Propionate	9.12	8.44	7.68	8.14	.29
Isobutyrate	.35^{a}	.36^{a}	.26^{b}	.28^{a}	.02
Butyrate	3.47	3.42	3.43	3.68	.19
Isovalerate	.48	.51	.44	.43	.05
Valerate	.24	.23	.21	.21	.01

[a,b,c] Means within a row with unlike superscripts differ (P<.05).

TABLE 4. LEAST SQUARES MEANS FOR TOTAL VFA BY TREATMENT AND HOUR

Hour	Treatments			
	SBM24	SBM48	CGM24	CGM48
	μmoles/ml			
0	41.09	35.61	38.05	39.67
3	54.51^{bd}	55.66^{b}	44.47^{c}	47.44^{cd}
6	52.64^{be}	46.80^{bd}	40.23^{cd}	54.88^{e}
9	52.50^{b}	51.80^{b}	44.22^{cd}	49.76^{bd}
12	47.36	51.86	45.14	51.63
24	42.30^{bc}	45.89^{c}	36.02^{b}	44.81^{c}
27	56.83^{b}	46.20^{c}	46.79^{c}	43.90^{c}
30	55.37^{b}	46.52^{c}	47.29^{c}	47.41^{c}
33	54.14^{b}	45.29^{c}	48.14^{bc}	50.15^{bc}
36	43.19	45.22	46.63	43.02

[a] Error mean square = 88.81.
[b,c,d,e] Means within a row with unlike superscripts differ ($P<.05$).

Treatment did not affect ruminal fluid pH, but a diet by hour interaction was observed ($P<.05$). Values for pH were well within the 6.2 to 7.0 range normally associated with high roughage diets.

In summary, CGM48 performed comparably to SBM24, suggesting it will support adequate ruminal fermentation, although some differences in fermentation did occur. SBM48 and CGM48 had similar total VFA concentrations, even though SBM48 had a higher RNH_3-N peak. It is unclear why feeding CGM at 48-hour intervals provided more constant RNH_3-N concentrations over time than feeding at 24-hour intervals. Alternative day supplementation did not result in any adverse ruminal fermentation effects, suggesting the possible use of this regimen with low quality forages.