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ALTERNATE DAY PROTEIN SUPPLEMENTATION OF CORN STALK BASED DIETS WITH HIGH AND LOW RUMINAL ESCAPE PROTEIN SOURCES

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Summary

Twenty-four crossbred wethers (88 $\pm$ .44 lb) were utilized to determine optimal level of dietary CP when corn gluten meal (CGM) and soybean meal (SBM) based supplements were fed alternate days. Diets were arranged in a 2 x 3 factorial design with SBM and CGM fed at 8, 9 or 10% dietary CP. Supplements were top dressed on ground corn stalks at a rate of two times the daily required amount (19.78% DM basis). The collection term consisted of an 8-day total feces and urine collection.

DMI and DDMI were improved ($P<.01$) when CGM was fed and as dietary CP was increased by either supplement. Dry matter digestibility (DMD) decreased ($P<.05$) as dietary CP level increased. Neutral detergent fiber digestibility (NDFD) did not differ ($P>.05$) for protein source or dietary CP level.

Nitrogen digestibility (ND) increased ($P<.05$) with increasing dietary CP level. Nitrogen retention (NR) was improved by CGM and increasing dietary CP level and an interaction occurred ($P<.10$) between protein source and dietary CP level.

Increased NR on CGM diets suggests providing ruminal escape N sources is beneficial when feeding CP supplements on alternate days.

(Key Words: Protein, Forage, Sheep.)

Introduction

Protein is the first limiting nutrient in low quality forages affecting animal performance. Supplemental protein is fed to improve dry matter intake and/or digestibility of the diet. The high cost of protein requires that the protein source be efficiently and effectively utilized by rumen microbes as well as by the host animal. In previous studies by the authors, it was shown that high ruminal escape corn gluten meal fed at 48-hour intervals improved animal performance compared to lower ruminal escape SBM. These data suggested that the gut supply of protein was more limiting than ruminally degradable N supply. If this were true, CGM may help meet the animal's CP requirement at a lower N intake.

The objective of this study was to determine optimal dietary CP levels of SBM and CGM based supplements fed alternate days with corn stalk based diets to sheep.

Materials and Methods

Twenty-four crossbred, 8 month old wethers (88 $\pm$ .44 lb) were stratified by weight and randomly allotted in a 2 x 3 factorially arranged N balance study. Dietary treatments consisted of soybean meal (SBM) and corn gluten meal (CGM) based supplements fed to provide dietary crude protein (CP) levels of 7.64% (SBM-8 and CGM-8), 9.09% (SBM-9 and CGM-9) or 10.5% (SBM-10 and CGM-10). Supplements (Table 1) were formulated to contain 28.54, 35.76 or 42.91% CP (DM basis) for the low, medium and high crude protein levels, respectively. Supplements were fed top dressed on corn stalks previously ground through a 1.5 in. screen at two times the daily feeding level (19.78% DM basis) at 48-hour intervals.

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TABLE 1. COMPOSITION OF SOYBEAN MEAL AND CORN GLUTEN MEAL BASED SUPPLEMENTS[a]

	SBM			CGM		
Ingredients	8	9	10	8	9	10
SBM, 44%	50.77	68.26	85.81			
CGM, 60%				37.12	50.06	62.80
Dical[b]	1.95	1.95	1.95	1.95	1.95	1.95
Trace mineral salt[c]	1.95	1.95	1.95	1.95	1.95	1.95
Na_2SO_4	4.55	4.55	4.55	4.55	4.55	4.55
Vegetable oil	.40	.40	.40	.40	.40	.40
Lasalocid[d]	.40	.40	.40	.40	.40	.40
A, D, E premix[e]	4.94	4.94	4.94	4.94	4.94	4.94
Corn, cracked	35.04	17.55		48.69	35.76	23.01

[a] Percent DM basis.

[b] A mixture of mono- and dicalcium phosphate to equal 26.30% Ca and 18.70% P.

[c] Contained salt (NaCl) 98%, zinc .035%, manganese .280%, iron .175%, copper .035%, iodine .007% and cobalt .007%.

[d] Added as a coccidiostat.

[e] Premix contained 1,000,000 USP units vitamin A, 500,000 USP units vitamin D and 1,000 IU vitamin E per .45 kg.

Lambs were adapted to corn stalks for 6 days. The experimental term consisted of a 21-day adaptation to dietary treatment followed by 8-days total feces and urine collection subsampled as two periods (4 days). Diets were fixed at 90% of previously established ad libitum intake. Total feed consumption was recorded and feed refusals were recorded and refed daily during the collection period.

Total feces output was recorded, subsampled (10% of daily output) and pooled over 4-day periods and subsequently frozen at -18° C until later analysis. Urine was collected into vessels containing 100 ml of 30% HCl (vol:vol). Daily urine volume was recorded. When urine output was <1000 ml, the sample was diluted with distilled water to 1 liter to avoid salts precipitation. Pooled subsamples (20% of daily output) were stored at 20° C during the collection term and subsequently at -18° C until later analysis.

Feed and orts were dried at 100° C for 48 hours and feces at 60° C for 72 hours in a forced air oven for DM determination. Dried samples were ground through a 1 mm screen and stored. Nitrogen content of the feed, orts, feces and urine were determined by the Kjeldahl method. NDF content of feed, feces and orts was determined and feed samples were analyzed for ADF content.

These data were statistically analyzed as a 2 x 3 factorial design with the split plot factor of sampling period tested by period x protein source x dietary CP level. The whole plot of protein source and dietary CP level were tested by the nested term lamb within period x protein source x dietary CP level.

Results and Discussion

Corn stalks contained 3.19% CP, 75.1% NDF and 45.9% ADF. Supplements provided approximately 70% of the dietary CP.

Dry matter intake (DMI) and digestible DMI (DDMI) were increased ($P<.01$) when CGM was fed and when dietary CP level increased. An interaction occurred ($P<.01$) between protein source and dietary CP level for DMI and DDMI (Table 2). Increasing dietary CP level decreased ($P<.05$) dry matter digestibility

TABLE 2. EFFECT OF PROTEIN SOURCE AND DIETARY PROTEIN LEVEL ON DIET DIGESTIBILITY

	SBM			CGM			
Item	8	9	10	8	9	10	SEM
No. of animals	4	4	3	4	4	4	
DMI, g/day[a]	538	545	730	575	721	699	63.46
DMD, %[b]	62.68	62.91	60.26	63.53	62.51	60.70	2.27
DDMI, g/day[a]	337	340	441	366	452	425	41.69
NDF digestibility, %	56.51	58.14	55.81	62.84	62.98	59.52	3.35

[a] Source, level, source x level (P<.01).
[b] Level (P<.05).

(DMD), but no differences due to protein source were observed. This indicates that CGM provided sufficient rumen degradable N to support ruminal fermentation comparable to SBM.

The higher N intake and fecal N loss for CGM diets can be partially explained by the concurrent higher DMI compared to SBM diets. Nitrogen digestibility (ND) increased (P<.05) with incremental increases in dietary CP level. This is generally accepted to occur with increasing dietary protein and protein which is available to intestinal breakdown and absorption.

Corn gluten meal supported higher (P<.10) N retention (NR) compared to SBM. By increasing dietary CP, NR also increased (P<.05), indicating that the low protein level was suboptimal in meeting dietary requirements. The interaction observed (P<.10) between protein source and dietary CP level for NR (Table 3) indicates that less CGM was needed to meet dietary protein requirements compared to SBM.

The biological value (BV) of CGM was higher (P<.05) than SBM and increased as dietary CP level increased from 8 to 9%. However, the interaction (Table 4) that occurred (P<.05) between protein source and dietary CP level suggests that energy rather than CP was the first limiting nutrient for CGM-10. The optimal dietary CP level for SBM diets was not exceeded in this study, but it is likely the BV of 63 for SBM-10 is near optimum for these types of diets.

In conclusion, the intestinal protein (or amino acid) supply appears to be limiting animal performance more than the rumen degradable N supply under these feeding conditions. High ruminal escape CGM can meet the ruminal N requirement as well as the apparent absorbable amino acid requirement at lower dietary CP than SBM. This should be considered when least cost formulations are made for low quality forage diets.

TABLE 3. EFFECT OF PROTEIN SOURCE AND DIETARY PROTEIN LEVEL ON N UTILIZATION BY LAMBS

	SBM			CGM			
Item	8	9	10	8	9	10	SEM
No. of animals	4	4	3	4	4	4	
N intake, g/day[a]	10.28	12.29	16.69	11.81	17.39	19.04	1.14
Fecal N, g/day[b]	3.02	2.94	4.23	3.41	4.09	4.27	.39
N digestibility, %[c]	70.62	76.39	78.79	71.09	76.55	77.49	1.99
Urine N, g/day[c]	4.14	5.87	5.79	3.64	5.41	6.53	.50
N retention, g/day[d]	3.12	3.47	9.72	4.76	7.89	8.24	.85

[a] Source (P<.05), level (P<.01), source x level (P<.05).
[b] Source (P<.05), level (P=.05), source x level (P<.05).
[c] Level (P<.05).
[d] Source (P<.10), level (P<.05), source x level (P<.10).

TABLE 4. EFFECT OF PROTEIN SOURCE AND DIETARY PROTEIN LEVEL ON THE RELATIVE VALUE OF DIETARY N

	SBM			CGM			
Item	8	9	10	8	9	10	SEM
No. of animals	4	4	3	4	4	4	
NR/NI, g/day[a]	30.02	27.18	49.71	40.01	45.05	42.89	3.86
BV, %[b]	42.51	35.98	63.30	56.40	58.82	55.34	.05

[a] Source (P<.10), level (P<.10), source x level (P<.10).
[b] Source (P<.05), level (P=.05), source x level (P<.05).