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ALTERNATE DAY SUPPLEMENTATION OF CORN STALK DIETS FOR RUMINANTS WITH HIGH OR LOW RUMINAL ESCAPE PROTEIN SUPPLEMENTS

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Summary

Two experiments were conducted to determine the effects of feeding soybean meal (SBM) and corn gluten meal (CGM) based, isonitrogenous supplements at 24- or 48-hour intervals on corn stalk utilization. Exp. 1. Yearling rams were fed either protein supplement as 100 g daily or 200 g on alternate days. DMI was lower (P<.10) for the CGM than SBM based supplements. Protein source and interval of feeding did not affect (P>.10) digestible dry matter intake (DDMI) or disappearance of dry matter (DMD), but an interaction was observed (P<.05) between protein source and interval of feeding. Nitrogen retention was greater for CGM (P<.10) and 48-hour supplementation (P<.01). However, an interaction between protein source and interval of feeding occurred (P<.10) for N retention. Exp. 2. Angus and Hereford x Anugs steers (119 head; 620 $\pm$ 1.9 lb) allotted to 8-head pens were fed similar diets except supplements (46% crude protein) also provided 0 (0M) or 200 (200M) mg per head per day monensin. CGM supported higher (P<.05) ADG and gain/feed (G/F) than SBM, but a protein by monensin interaction occurred (P<.10) for ADG and G/F. There was an interval by monensin interaction for ADG (P<.10) and DMI (P<.05). An interaction between protein and interval occurred for plasma urea N on day 1 (P<.01) and day 2 (P<.10) of the sampling period. CGM was an effective isonitrogenous substitute for SBM based supplements in these applications. Supplementation at 48-hour intervals supported higher N utilization. High intermittent dosages of monensin appeared detrimental to calf performance.

(Key Words: Escape Protein, Ruminants, Corn Stalks, Supplementation.)

Introduction

The use of low quality forages as a primary feed resource is important in beef cattle production. However, nutrient deficiencies, particularly protein, in low quality forages limit effective utilization by the animal. A protein supplementation program is usually necessary to meet the ruminal and animal requirements. Protein supplementation on alternate days does not adversely affect dry matter intake and digestibility, daily gain and N retention. However, supplementation programs using high protein supplements may be over supplying protein above that which can be assimilated by rumen microorganisms. The use of high escape protein sources may reduce N loss associated with rumen degradable protein sources and improve daily gain and feed efficiency when low quality forages are fed.

Practical use of high escape protein supplements depends on palatability, animal performance and cost effectiveness. In recent years, monensin has been incorporated into range protein supplements. Monensin improves daily gain and feed efficiency but also reduces palatability.

This research was conducted to determine (1) the effect of protein source (soybean meal vs corn gluten meal) and interval (24 vs 48 hours) of supplementation of corn stalk diets on dry matter disappearance and N balance of lambs and (2) the effect of these supplement regimes with and without supplemental monensin on corn stalk utilization by growing steers.

Materials and Methods

Exp. 1. Twenty yearling Hampshire rams (128 $\pm$ 1.7 lb) were blocked by weight and randomly allotted to treatments in a N balance study. Treatments consisted of (1) soybean meal (SBM) fed daily (SBM24), (2) SBM fed on alternate days (SBM48), (3) corn gluten meal (CGM) fed daily (CGM24) and (4) CGM fed alternate days (CGM48). Supplements (Table 1) were top dressed on a basal diet of ground corn stalks. Diets were formulated to contain 8% crude protein. The 45% crude protein supplements were fed at 100 g/head daily (24 hours) or 200 g/head on alternate days (48 hours). Rams were housed under constant lighting

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TABLE 1. FORMULATION OF SOYBEAN MEAL AND CORN GLUTEN MEAL SUPPLEMENTS (EXP. 1)

Ingredients[a]	SBM[b]	CGM[b]
Corn gluten meal	--	66.70
Soybean meal	92.01	--
Dicalcium phosphate	3.37	3.37
Trace mineral salt[c]	3.37	3.37
Vitamins A, D, E premix[d]	.22	.22
Vegetable oil	.51	.51
Lasalocid[e]	.51	.51
Corn starch	--	25.31

[a] Percent, dry matter basis.
[b] Supplements differ only by interval of feeding (24 vs 48 hours).
[c] Contained 96% NaCl, .350% Zn, .28% Mn, .175% Fe, .035% Cu, .007% I and .007% Co.
[d] Contained 1,200,000 IU/lb vitamin A, 50,000 IU/lb vitamin D and 1,000 IU/lb vitamin E.
[e] Added as a coccidiostat.

and temperature (72 °F). Two rams had to be removed from the experiment because of problems unrelated to treatment.

Rams were adapted to diets for 23 days in individual slotted floor metabolism stalls and 3 days in elevated metabolism crates. Two consecutive 8-day periods followed in which urine and feces were collected, subsampled and frozen for later analysis. Feed refusals were weighed daily and refed. Orts were collected at the end of the 16-day period and frozen for later analysis. Corn stalks were fed at 85% of previously established ad libitum intake. All feed, refusals and fecal samples were analyzed for dry matter (DM), Kjeldahl N, ADF and NDF (Table 2). Urine samples were analyzed for Kjeldahl N.

Data were analyzed as a 2 x 2 factorial arrangement in a randomized complete block design using GLM procedures in SAS and least square means for unequal cell sizes. Main effects were protein source, interval of feeding and replication. Interactions were calculated with dry matter intake as a covariate.

Exp. 2. One hundred twenty Angus and Hereford x Angus steer calves (620 $\pm$ 1.9 lb) were utilized in a 56-day steer performance study from December 12, 1989, to February 6, 1990. Steers were stratified by weight and allotted to treatments (1) soybean meal (SBM) fed daily without monensin (SBM24-0M), (2) SBM fed daily with monensin (SBM24-200M), (3) SBM fed alternate days without monensin (SBM48-0M), (4) SBM fed alternate days with monensin (SBM48-200M), (5) corn gluten meal (CGM) fed daily without monensin (CGM24-0M),(6) CGM fed daily with monensin (CGM24-200M), (7) CGM fed alternate days without monensin (CGM48-0M) and (8) CGM fed alternate days with monensin (CGM48-200M). Diets were formulated to contain 10% crude protein but, because of low intakes during the adaptation period, were adjusted to 14.47% crude protein. The 46% crude protein supplements (Table 3) were fed at 24.2% of the diet and top dressed on a basal diet of ground corn stalks. During the period of feed refusals, average temperatures were below 0 °F. One steer was removed from the study after developing polio encephalomalacia. One pen was deleted from the data set because of low feed intakes.

Initial and final weights were obtained on 2 consecutive days. Blood samples were taken prior to feeding on day 34 (day 1) and 35 (day 2) for all steers. Supplementation at 48-hour intervals was offered on day 1. Plasma was separated and frozen for urea-N analysis. Feed samples were analyzed for Kjeldahl N, NDF and ADF (Table 4).

TABLE 2. COMPOSITION OF FEED INGREDIENTS (EXP. 1)

		Supplements	
Item[a]	Corn stalks	SBM	CGM
Dry matter	85.64	89.04	91.02
Crude protein	3.74	44.02	46.23
Neutral detergent fiber	69.47	14.42	12.78
Acid detergent fiber	47.12	8.26	8.40

[a]Expressed as percent dry matter, except dry matter.

TABLE 3. FORMULATION OF SOYBEAN MEAL AND CORN GLUTEN MEAL SUPPLEMENTS (EXP. 2)

Ingredients[a]	SBM[b]	CGM[b]
Corn gluten meal	--	68.49
Soybean meal	94.03	--
Cracked corn	--	25.55
Trace mineral salt[d]	2.52	2.52
Dicalcium phosphate	2.52	2.52
Animal fat	.92	.92

[a] Percent, dry matter basis.
[b] Supplements differ by frequency (24 vs 48 hours) and monensin (0 vs 200 mg per head per day).
[c] Contained 920 IU/lb vitamin A and 8.37 IU/lb vitamin E.
[d] Contained 96% NaCl, .350% Zn, .28% Mn, .175% Fe, .035% Cu, .007% I and .007% Co.

Data were analyzed as a 2 x 2 x 2 factorial arrangement in a completely random block design using GLM procedures in SAS with least square means utilized because of uneven cell sizes. Main effects were protein source, interval of feeding and monensin and the calculated interactions. Initial weight was used as a covariate.

Results and Discussion

Exp. 1. Apparent digestible dry matter intake (DDMI) and disappearance of DM (DMD) are shown in Table 5. SBM and CGM intake supplied 39.20 and 42.08 g per day crude protein (dry matter basis) and 78.40 and 84.16 g per alternate day crude protein (dry matter basis) for SBM24, CGM24, SBM48 and CGM48, respectively. DMI was affected ($P<.10$) by protein source, 1010 vs 875 g/day for SBM and CGM diets, respectively. Some individual animal acceptance problems with the CGM supplements may partially explain the lower DMI of CGM24 and CGM48 diets. DMD, DDMI and ND were not affected ($P>.10$) by protein source or interval of feeding. An interaction between protein source and interval of feeding occurred for DMD and DDMI ($P<.05$) and ND ($P<.10$). The

TABLE 4. COMPOSITION OF FEED INGREDIENTS (EXP. 2)

Item[a]	Corn stalks	Supplements SBM	Supplements CGM
Dry matter	78.40	89.28	90.30
Crude protein	2.96	41.94	48.36
Neutral detergent fiber	75.73	13.63	12.29
Acid detergent fiber	56.19	7.52	7.10

[a] Expressed as percent dry matter, except dry matter.

TABLE 5. EFFECT OF PROTEIN SOURCE AND INTERVAL OF FEEDING ON APPARENT DIGESTIBLE DRY MATTER INTAKE, DISAPPEARANCE OF DRY MATTER AND NITROGEN (EXP. 1)

Item	Treatments[a] SBM24	SBM48	CGM24	CGM48	SEM
No. of animals	4	4	5	5	
Dry matter intake[b]	1004	1017	833	917	80.70
Digestible dry matter intake, g/day[c]	577	534	535	564	15.31
Disappearance, %					
Dry matter[c]	62.05	57.36	57.60	60.59	1.59

[a] Least square means.
[b] Protein ($P<.10$).
[c] Protein x interval effect ($P<.05$).

poorer utilization of SBM48 and CGM24 may be attributable to relative rates of ruminal protein degradation and escape. SBM48 appears to be causing a N deficit on day 2, wehre CGM24 may be limiting daily N availability. Urinary N output was affected (P<.10) by protein source on day 1 and interval of feeding (P<.01) on day 2 of the supplementation periods. An interaction occurred (P<.10) between protein source and interval of feeding on day 1 and were 6.91, 7.34, 6.90 and 6.12 g/day N for SBM24, SBM48, CGM24 and CGM48, respectively. Protein source affected (P<.10) N retention. However, there was an interaction (P<.10) between protein source and interval of feeding (Table 6).

Exp. 2. Crude protein content of corn stalks was lower than tabular values (Table 4), partially explaining the need to increase the amount of supplemental protein fed. DMI for treatments were different (P<.10) due to interval of feeding (Table 7), but an interval by monensin interaction (P<.05) occurred. DMI (1.72% of body weight) was within expected values for low quality forages, indicative of a slower rate of passage and increased gut fill. There was a protein source effect (P<.05) on ADG (.55 vs 1.00 lb/day) and gain/feed (4.97 vs 9.50 lb/cwt) for SBM vs CGM, respectively. Interval affected (P<.10) DMI which were 11.18 vs 10.24 lb/day for 24 and 48 hours, respectively. Monensin supplementation did not affect (P>.10) steer performance. An interaction occurred (P<.10) between protein source and monensin for ADG and G/F (Table 7). CGM with or without monensin caused increased feed efficiency over SBM, but the addition of monensin to CGM was detrimental. The increased intestinal supply of dietary protein from CGM may be supporting improved amino acid uptake and utilization. An interaction occurred for interval of feeding and monensin for ADG (P<.10) and DMI (P<.05) [Table 7]. ADG and DMI were lower when monensin was fed at 48-hour but not 24-hour intervals. At 48-hour intervals, monensin was offered at 400 mg on the day supplements were fed. This suggests dose related ruminal inhibition. A protein source effect on plasma urea nitrogen (PUN) occurred (P<.01) for day 1 (11.73 vs 13.47) and day 2 (17.89 vs 12.98) of the sampling period for SBM and CGM, respectively. Also, an interval effect on PUN occurred for day 1 (13.96 vs 11.25; P<.01) and day 2 (16.08 vs 14.79; P<.10) for 24 or 48-hour intervals, respectively. However, an interaction occurred for protein and interval on day 1 (P<.01) and day 2 (P<.10) of the sampling period (Table 7). Feeding at 48 hours resulted in lower PUN concentrations on day 1, suggesting a greater loss of N from the body, whereas CGM fed at 48 hours between days 1 and 2 remained relatively constant. No differences in PUN concentration were observed due to monensin, although an interaction occurred (P<.05) between interval and monensin for day 1 (Table 7). This may be due to a protein sparing effect from the presence of monensin.

The low DMI in these studies are indicative of the high structural fiber content in corn stalks. These data suggest that CGM fed at 48-hour intervals supports improved N efficiency and disappearance of DM and N when compared to SBM fed at 48-hour intervals. CGM fed without monensin to steers supported higher feed efficiency and ADG. Regardless of the presence of monensin, CGM supported steer performance comparable to or better than that of SBM. The intermittent dosage of monensin in this study reduced DMI and ADG, which may be attributable to a reduction in palatability and inhibition of rumen microorganisms. The supplemental protein with monensin in this study provided 400 mg/head on alternate days in which reduced performance was observed. Further studies are needed to determine optimal dosage of monensin with alternate day supplemental protein regimens.

TABLE 6. EFFECT OF PROTEIN SOURCE AND INTERVAL OF FEEDING ON NITROGEN UTILIZATION (EXP. 1)

Item	Treatments[a]				SEM
	SBM24	SBM48	CGM24	CGM48	
No. of animals	4	4	5	5	
N digestion, %[b]	61.80	59.00	59.50	62.06	1.42
Nitrogen balance, g/day					
N intake	11.96	12.68	11.46	12.18	.50
Fecal N	4.84	5.50	4.37	4.58	.49
Urine N[c]	6.75	6.20	6.64	5.26	.37
N retained[bcd]	.37	.97	.45	2.34	.38
N retained/N intake, %[bcd]	2.96	7.38	3.62	19.32	3.25

[a] Least square means.
[b] Protein by interval effect (P<.10).
[c] Interval effect (P<.05).
[d] Protein effect (P<.10).
[e] Interval effect (P<.01).

TABLE 7. EFFECT OF TREATMENT ON STEER PERFORMANCE AND PLASMA UREA NITROGEN (EXP. 2)[a]

	SBM				CGM				
Item	24-0M	24-200M	48-0M	48-200M	24-0M	24-200M	48-0M	48-200M	SEM
Dry matter intake, lb/day[bc]	9.73	12.66	11.77	9.27	11.64	10.68	11.19	8.72	.81
Average daily gain, lb/day[def]	.02	.97	.78	.43	1.35	.94	1.11	.59	.23
Gain/feed, lb/cwt[de]	.25	7.86	6.92	4.86	12.17	8.72	10.13	6.98	.02
Plasma urea nitrogen, mg/dl									
Day 1[cghi]	15.58	14.44	8.11	8.80	13.16	12.66	12.73	15.37	1.11
Day 2[ghj]	17.65	18.17	17.61	18.14	14.97	13.51	11.96	11.46	1.30

[a] Least square means.
[b] Interval effect (P<.05).
[c] Interval by monensin interaction (P<.05).
[d] Protein effect (P<.05).
[e] Protein by monensin interaction (P<.10).
[f] Interval by monensin interaction (P<.10).
[g] Protein effect (P<.01).
[h] Interval effect (P<.01).
[i] Protein by interval interaction (P<.01).
[j] Protein by interval interaction (P<.10).