RUMINAL DEGRADABILITY OF PROTEIN SUPPLEMENTS BY STOCKER CATTLE GRAZING WHEAT PASTURE

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Story in Brief

Two experiments were conducted to evaluate rate and extent of in situ ruminal nitrogen disappearance of soybean meal, cottonseed meal, meat and bone meal and fish meal by cattle grazing wheat pasture. In each of two years, 8 multi-cannulated steers were used in a split-plot design in which steers grazed wheat pasture during the immature and mature stages of wheat forage growth. Extent of ruminal degradability of the protein supplements was calculated by combining nitrogen disappearance estimates with rate of passage. Extent of ruminal nitrogen degradability (%) was greatest for soybean meal (62.5), while cottonseed meal (53.7) was intermediate and meat and bone meal (44.0) and fish meal (40.1) had the lowest values. Because of the rapid rate of wheat forage nitrogen degradation, differences in the rate and extent of nitrogen disappearance from protein feeds should be considered when formulating supplements for stocker cattle grazing wheat pasture.

(Key Words: Wheat Pasture, Protein Supplements, Ruminal Degradability.)

Introduction

Wheat and other small grain forages are high-quality forages, and commonly contain 24 to 30% crude protein (CP) on a dry matter basis. Recent studies by Zorrilla-Rios et al. (1985) and Vogel et al. (1988) have shown that wheat forage nitrogen (N) exists kinetically as two distinct N pools with different rates of N disappearance. Approximately 50 to 75% of wheat forage N disappears at rates of 13 to 28 %/hr. Because of the rapid rate of degradation of wheat forage N and loss of ammonia-N that is not incorporated into microbial protein, performance of rapidly growing stocker cattle on wheat pasture may be limited by inadequate amounts of non-ammonia nitrogen (NAN) flowing to the small intestine. Therefore, performance of wheat pasture stocker cattle may be improved by supplementation with protein. However, results from studies have been conflicting. Grigbsy (1982) did not observe any affect of increased protein intake on weight gains when stocker cattle grazing wheat pasture were fed soybean meal-based supplements. Conversely, Lee (1985) reported that weight gains of stocker cattle fed 1.50 lb/day of meat and bone meal-containing supplement were increased by .20 lb/day as compared with calves fed control, milo- or hominy-based supplements. Differences in these two trials may have been due to the amount of ruminal degradable protein fed. Therefore, the objective of this research was to determine the rate and extent of ruminal N disappearance of several high-protein feedstuffs by stocker cattle grazing wheat pasture.

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Experimental Procedure

In each of two years, 8 mature multi-cannulated Hereford and Hereford X Angus steers (1221 + 51 lb) were used in a split plot design with two grazing periods. Grazing periods occurred during rapid spring growth (immature, March 8 to March 20) and the "grazeout" (mature, April 18 to May 4) period on wheat pasture during 1986 and 1987. As part of another experiment, steers were randomly allotted to two treatments and received either a corn-based (control) or a 16 to 20% CP supplement containing 18 to 25% meat meal.

In each grazing period, duplicate dacron bags containing approximately 2.5 g of soybean meal (SBM), cottonseed meal (CSM, method of processing unknown), meat and bone meal (MBM) and fish meal (FSM) were incubated in situ in the rumen of each steer for 4, 8, 12, 24 and 36 hr in experiment 1 and also 48 hr in experiment 2. Residues from the bags were analyzed for nitrogen (N) content by the Kjeldahl procedure. Nitrogen disappearance estimates obtained in situ were fit using a nonlinear iterative procedure to estimate potential degradability (P) with the following equation: $P = a + b(1-e^{-ct})$ where

a = the highly soluble, rapidly disappearing fraction,
b = the fraction other than "a" that is potentially digestible,
c = the rate of disappearance of fraction "b",
t = time.

Using the estimated parameters (i.e., a, b and c) the extent of ruminal disappearance (RD) for each protein supplement was calculated using the equation of Ørskov and McDonald (1979) where RD = a + (b*c)/(c+k). The rate constant, k, represents rate of passage. Rate of passage in year 1 was assumed to be 5 %/hr while in year 2 rate of passage was estimated by mordanting meat and bone meal with chromium (Cr) and regressing Cr concentration of duodenal samples on time after a 200 g intraruminal dose of the mordanted meal.

All protein supplements were characterized chemically by total N analysis, solubility of N in .15 normal NaCl, pepsin insoluble N (PIN) and organic matter (OM). The composition of the wheat forage grazed is reported in the previous paper in this research report (Vogel et al., 1988).

Results and Discussion

The composition of the protein supplements is shown in table 1. Total CP content ranged from 39.8 to 60.6%. Soluble N comprised 14.5 to 21.0% of total N while PIN ranged from 6.3 to 18.5% of total N.

Parameters describing N disappearance in situ and extent of ruminal N degradability are presented in table 2. Treatment and grazing period did not influence ($P>.20$) the kinetics of N disappearance. Although the year x protein supplement interaction was significant ($P<.05$), the data were pooled across years because the rank order of protein supplements in each year was similar.

Of the N present in the protein supplements, virtually all was potentially degradable for SBM (97.4%) while approximately 77.3% was potentially degradable for CSM. The animal protein supplements (i.e., MBM and FSM) were more ($P<.05$) resistant to ruminal degradation with roughly 57% of total N being potentially degradable. Most likely, the heat applied during the drying of MBM and FSM makes the meals more resistant to ruminal degradation. When the potentially degradable N was partitioned into soluble N (i.e., fraction a) and insoluble but

Table 1. Composition (DM basis) of protein supplements.

Item	Protein supplement[a]				SEM[b] (n=6)
	SBM	CSM	MBM	FSM	
Organic matter, %	93.02	93.02	68.49	79.04	2.27
Crude protein, %	49.94	39.81	47.44	60.56	1.75
Nitrogen					
Total, %	7.51	6.37	7.59	9.69	.28
Soluble, % of total N	14.90	14.59	14.50	20.95	1.24
PIN[c], % of total N	8.62	18.52	11.51	6.28	.92

[a]SBM = soybean meal, CSM = cottonseed meal, MBM = meat and bone meal, FSM = fish meal.
[b]Standard error of the mean.
[c]Pepsin insoluble nitrogen.

Table 2. Parameters from the exponential equation describing nitrogen disappearance and extent of ruminal nitrogen degradability of SBM, CSM MBM and FSM for steers grazing wheat pasture.

Item	Protein supplement[a]				SEM[b]
	SBM	CSM	MBM	FSM	
Fraction a, %	17.62[f]	33.05[c]	23.66[e]	28.77[d]	.96
Fraction b, %	79.78[c]	44.26[d]	35.18[e]	26.25[f]	1.63
Potentially degradable, %	97.40[c]	77.31[d]	58.84[e]	55.02[e]	1.51
Rate of N disappearance, %/hr	6.57[d]	4.75[e]	8.03[c]	5.06[e]	.49
Ruminal degradability, %	62.53[c]	53.68[d]	43.99[e]	40.09[f]	.52

[a]SBM = soybean meal, CSM = cottonseed meal, MBM = meat and bone meal, FSM = fish meal.
[b]Standard error of the mean.
c,d,e,f Means in the same row with different superscripts are different (P<.05).

degradable N (i.e., fraction b), SBM contained the smallest (P<.05) proportion of soluble N (17.6%) and the largest (P<.05) proportion of insoluble but potentially degradable N (79.8%). Cottonseed meal (33.0), MBM (23.7%) and FSM (28.8%) each had substantial quantities of N present in fraction "a" which is assumed to be rapidly degraded within the rumen. It is interesting to note that fraction "a" for FSM was greater than 52% of the total potentially degradable N indicating that after the initial loss of soluble N, little was degraded in the rumen. Ørskov et al. (1983) fed sheep and cattle grass hay and reported similar fraction "a" values for CSM (32.2%), FSM (30.4%) and MBM (23.7%).

The insoluble but degradable N (i.e., fraction b) ranged from 26.3 (FSM) to 79.9% (SBM) of total N. Rate of N disappearance of this fraction (%/hr) was greatest for MBM (8.03%), while rate of N disappearance for SBM (6.6%) was intermediate. Cottonseed meal (4.75%) and FSM (5.1%) had the lowest (P<.05) rates of N disappearance. However, because fraction "b" for MBM and FSM was small (35.2 and 26.3%, respectively) ruminal digestion of these protein supplements was almost complete within 20 hours (figure 1). Nevertheless, the rates of N disappearance (%/hr) are comparable to those reported by Ørskov et al. (1983) where rates of N disappearance for SBM, CSM, MBM and FSM were 5.48, 8.25, 7.74 and 1.90 %/hr, respectively.

Extent of ruminal N degradability for the protein supplements was calculated assuming a passage rate of 5 %/hr in year 1 and by obtaining rate of passage estimates using Cr-mordanted MBM in year 2. Meat and bone meal was assumed to represent rate of passage for all protein supplements since different protein sources fed at the same level should not change passage rates to a large degree. Rate of passage of the mordanted MBM averaged 4.85 %/hr. Ruminal N degradation was greatest (P<.05) for SBM (62.5%) which was approximately 8.9, 18.5 and 22.4 percentage units greater than CSM, MBM and FSM, respectively. Consequently, greater amounts of N from supplemental MBM and FSM would be expected to pass to the small intestine. The differences in ruminal degradability of the protein supplements may partially explain the discrepancies in animal performance in the studies reported by Grigsby (1982) and Lee (1984).

In conclusion, these data indicate that rate and extent of ruminal N degradation of SBM, CSM, MBM and FSM differ when fed to cattle grazing wheat pasture. These results should be considered in formulation of supplements for growing cattle on wheat pasture.

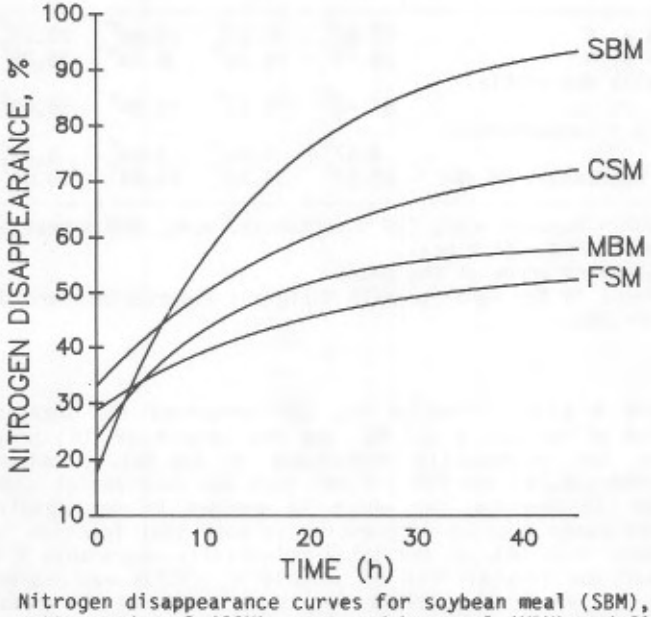

Figure 1. Nitrogen disappearance curves for soybean meal (SBM), cottonseed meal (CSM), meat and bonemeal (MBM) and fishmeal (FSM).

Literature Cited

Lee, R.W. 1985. Bypass protein supplementation for cattle grazing wheat pasture. Kansas Cattle Feeders Day Report of Progress 474, p. 7.

Grigsby, M.E. 1982. Supplements for stockers on winter wheat pasture. Proc. Clayton Livestock Research Center. New Mexico Agr. Rep. Sta. p. 17.

Ørskov, E.R. et al. 1983. Studies on the degradation and outflow rate of protein supplements in the rumen of sheep and cattle. Livestock Prod. Sci. 10:17.

Ørskov, E.R. and I. McDonald. 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J. Agric. Sci. Camb. 92:499.

Vogel, G.J. et al. 1988. Kinetics of ruminal disappearance of wheat forage nitrogen in steers grazing wheat pasture at two stages of forage maturity. Oklahoma Agr. Exp. Sta. Res. Rep. MP-125:41.

Zorrilla-Rios, J. et al. 1985. In situ disappearance of dry matter and nitrogen of wheat forage, corn gluten meal, cottonseed meal and soybean meal in steers grazing wheat pasture at two stages of maturity. Oklahoma Agr. Exp. Sta. Res. Rep. MP-117:169.