Corn Moisture, Protein Concentration and Rumensin and Digestion by Feedlot Steers

S. R. Rust, F. N. Owens
D. R. Gill and R. W. Fent

Story in Brief

Sixteen steers (650 lb) were used to determine the effects of corn moisture, protein concentration and monensin (Rumensin) on ration digestibility and nitrogen retention. The steers were placed in metabolism stalls and fed rations of high moisture corn (HMC) or dry rolled corn at two protein levels (9.3 and 12.3 percent) with two monensin levels (0 and 30 g per ton of feed).

Monensin addition decreased feed intake and increased digestibility of dry matter, organic matter, starch and nitrogen. The higher protein concentration increased nitrogen retention and digestibility of dry matter, organic matter, nitrogen, starch and ash. HMC had greater digestibility of dry matter, starch and organic matter than dry corn but produced lower dry matter intake and nitrogen retention. Although no monensin-protein interaction was apparent, addition of either protein or monensin to the low protein ration enhanced digestibility. Consequently, monensin may "spare" protein by this action. Responses to monensin supplementation were greater for dry rolled than high moisture corn suggesting that monensin benefits may be greater with less processing of the grain.

Introduction

Gill *et al.* (1977) reported monensin exhibited a protein sparing effect at a low protein level with whole shelled corn rations. Monensin addition improved feed efficiency more with dry corn diets (Gill *et al.*, 1977) than with HMC diets (Gill *et al.*, 1978). Conversely, Utley *et al.* (1977) reported no corn moisture by monensin interaction. This study was conducted to determine how monensin might "spare" protein and whether corn moisture level influenced this response. Ration digestibility and nitrogen retention were examined.

Table 1. Ration composition[1].

Corn moisture	11		23	
Protein level	9.3	12.3	9.3	12.3
Corn	85.6	76.8	86.2	77.8
Corn silage	12.1	12.1	11.6	11.6
Soybean meal	---	9.1	---	8.6
Alfalfa dehy	.51	.51	.51	.51
Dicalcium phosphate	.08	---	.07	---
Calcium carbonate	1.00	1.00	.95	.96
Potassium chloride	.43	.44	.14	.14
Salt, mineralized	.28	.28	.27	.27
Vitamin A	.0008	.0008	.0009	.0009

[1] Ingredients in a percentage of the dry matter.

Materials and Methods

Sixteen Hereford and Angus steers (650 lb) were alternated among rations so that each steer received four of the eight different rations. The steers were fed free choice. The steers were placed in concrete-slatted pens for seven days adaptation and moved to metabolism stalls the final seven days of each period. Urine and feces were collected the last five days of each period. The high concentrate ration (Table 1) was composed of dry rolled or HMC, and on a dry matter basis provided two protein levels (9.3 and 12.3 percent) and two levels of monensin (0 and 30 g/ton of feed).

Results and Discussion

The effects of monensin are shown in Table 3. Averaged across both corn types and protein levels, monensin addition decreased dry matter intake by 12.3 percent. This is commonly observed and has been suggested as a conditioned response to some intestinal discomfort produced by monensin and may be associated by the animal with some odor or flavor in Rumensin. Digestibilities of dry matter, organic matter, starch and nitrogen were increased with monensin feeding. Monensin increased fecal pH and

Table 2. Analysis of ration ingredients.[a]

	Dry matter	Starch	Ash	Crude protein	Soluble nitrogen[b]
	%	%	%	%	%
High moisture corn	77.0	80.8	1.65	9.34	50.2
Dry rolled corn	89.1	76.0	1.96	9.66	23.6
Corn silage	32.9	22.9	7.44	7.11	72.9

[a]Ingredient analyses on a dry matter basis.
[b]Percentage of total nitrogen.

Table 3. Influence of monensin on metabolism.

	Monensin concentration	
Item	0	30 g/ton
Dry matter intake, g/day	4994[ab]	4381[c]
Digestibility, %		
Dry matter	81.2[b]	83.5[c]
Organic matter	82.2[b]	84.6[c]
Starch	96.5[f]	97.7[g]
Nitrogen	70.2[f]	72.6[g]
Ash	59.6	61.9
Nitrogen retention, g/day	32.6	29.6
Fecal		
pH	5.51[d]	5.77[e]
Starch, %	10.5	8.6
Ash, %	10.0	10.5
Urine output, g/day	4860	4293

[a]Each figure is the mean of 32 observations.
[bc]Means in a row with different superscripts differ statistically ($P<.025$).
[de]Means in a row with different superscripts differ statistically ($P<.05$).
[fg]Means in a row with different superscripts differ statistically ($P<.10$).

slightly decreased fecal starch content. Lower protein and energy intake with monesin feeding may explain the slightly lower nitrogen retention values observed with monensin. The increased dry matter and organic matter digestibilities can be explained totally by enhanced starch digestion. Higher fecal pH may be the result of less starch to ferment to acids in the large intestine.

Influence of corn moisture on digestion parameters is shown in Table 4. Consumption of HMC caused lower dry matter intake. This phenomenon has been associated with higher soluble nitrogen levels (Prigge, 1976). The soluble nitrogen for HMC was much greater than for dry rolled corn (Table 2.) Digestibility of dry matter, starch and organic matter was greater with HMC while ash digestibility was greater with dry

Table 4. Influence of corn moisture on metabolism.

Item	Corn moisture, %	
	11	23
Dry matter intake, g/day	5143[ab]	4234[c]
Digestibility, %		
Dry matter	81.18[b]	83.56[c]
Organic matter	82.01[d]	84.75[e]
Starch	95.48[b]	98.72[c]
Nitrogen	71.83	71.06
Ash	64.19[b]	57.28[c]
Nitrogen retention, g/day	34.20[b]	27.91[c]
Fecal		
pH	5.48[d]	5.80[e]
Starch, %	14.31[b]	4.86[c]
Ash, %	9.22[f]	11.29[g]
Urine output, g/day	4786	4367

[a]Each figure is the mean of 32 observations
[bc]Means in a row with different superscripts differ statistically (P<.05).
[de]Means in a row with different superscripts differ statistically (P<.025).
[fg]Means in a row with different superscripts differ statistically (P<.005).

Table 5. Influence of protein level on metabolism.

Item	Protein level, %	
	9.3	12.3
Dry matter intake, g/day	4523[a]	4852
Digestibility, %		
Dry matter	80.39[d]	84.35[e]
Organic matter	81.41[d]	85.34[e]
Starch	96.49[b]	97.71[c]
Nitrogen	66.35[d]	76.55[e]
Ash	58.74[b]	62.74[c]
Nitrogen retention, g/day	22.55[d]	39.57[e]
Fecal		
pH	5.69	5.59
Starch, %	10.30	8.87
Ash, %	9.86	10.65
Urine output, g/day	4329	4824

[a]Each figure is the mean of 32 observations.
[bc]Means in a row with different superscripts differ statistically (P<.10).
[de]Means in a row with different superscripts differ statistically (<.005).

corn. The increased dry matter and organic matter digestibility for HMC can be explained by higher digestibility of starch. Nitrogen retention was lower for steers fed HMC diet as compared to those fed dry corn. Fecal pH was higher when HMC was fed than when dry corn was fed.

Effects of additional protein are depicted in Table 5. The higher protein level produced greater digestibility of dry matter, organic matter, nitrogen, starch and ash. The increased nitrogen digestibility is probably the result of replacing ground corn by soybean meal in the diet. As protein from soybean meal is more digestible than that from corn, the ration change automatically increases protein digestibility.

Table 6. Influence of protein level and monensin on metabolism.

Protein level, %	9.3		12.3	
Monensin, g/ton	0	30	0	30
Dry matter intake				
g/day	4828[a]	4220	5162	4542
Digestibility, %				
Dry matter	78.99	81.80	83.42	85.50
Organic matter	79.98	82.05	82.86	86.25
Starch	95.59	97.41	97.39	98.03
Nitrogen	65.85	66.85	74.65	78.45
Ash	58.14	59.34	61.03	64.45
Nitrogen retention,				
g/day	27.31	17.79	37.81	41.32
Fecal				
pH	5.60	5.78	5.43	5.75
Starch, %	11.41	9.14	9.62	8.13
Ash, %	9.63	10.09	10.32	10.98
Urine output, g/day	4830	4890	3834	4758

[a]Each figure is the mean of 32 observations.

Table 7. Starch digestibility relationships.

Equation	R^2[a]
Starch digestibility = 82.6 + 2.57 (fecal pH)	.15
Starch digestibility = 101.0 - 0.41 (fecal starch)	.87

[a]Degree of relationship with no relationship being 0, and a perfect relationship being 1.00.

Table 8. Monensin responses.

Protein level, %	9.3		12.3	
Corn type	DRC	HMC	DRC	HMC
	---- Digestibility change, % ----			
Dry matter	+3.68[a]	+1.94	+3.66	-0.08
Organic matter	+5.04	+0.72	+2.24	+1.36
Starch	+3.28	+0.37	+1.45	-0.18
Nitrogen	+3.77	-1.78	+4.34	+3.27

[a]Digestibility with monensin was 79.54 and without was 75.86 for an increase of digestibility by 3.68. Similar calculations were used for other values.

Nitrogen retention was greater for the higher crude protein diet. Greater nitrogen retention may be the result of more available energy for growth due to slightly higher intakes and greater digestibility of the high protein diet. The influence of monensin at the two protein levels is shown in Table 6. Addition of either monensin or protein to the low protein ration enhanced digestibility of dry matter and starch. This increased energy availability may explain part of the "protein sparing" action of monensin.

Fecal pH proved to be a poor indicator of starch digestibility while fecal starch closely reflected starch digestibility (Table 7). This suggests that fecal starch may be one measurement which might be used to measure energy availability and predict feed efficiency under feedlot conditions.

Digestibility responses to monensin at the two protein levels for dry and HMC are shown in Table 8. Starch is the primary nutrient of interest from the grain being fed. The greater response to monensin with the low protein level and the dry grain in starch digestibility diets confirms earlier suggestions from feedlot trials (Gill *et all*., 1977, 1978). This indicateshat productivity response to monensin may be greater when grain has received less processing and ration protein is low.

Literature Cited

Gill, D. R., F. N. Owens, J. J. Martin, D. E. Williams and J. H. Thornton. 1977. Okla. Agr. Exper. Sta. Res. Rep. MP-101:42.

Gill, D. R., F. N. Owens, J. J. Martin, J. H. Thornton and D. E. Williams. 1978. 70th Annual Meeting Amer. Soc. Anim. Sci. Abstr., p. 419.

Prigge, E. C. 1976. High Moisture Grain Symposium Proc. Okla. State Univ., p. 76.

Utley, P. R., G. L. Newton, D. M. Wilson and W. C. McCormick. 1977. J. Anim. Sci. 45:154.

High Moisture Corn Additives

F. N. Owens, J. H. Thornton and K. B. Poling

Story in Brief

Six commercial additives plus propionate, monensin, formaldehyde, bentonite and NH_4OH were added to high moisture corn (26.9 percent moisture) as it was ensiled. Material fermented in double-lined plastic bags for 10 months prior to feeding to sheep and to chemical analysis. Two materials, Chemstor III and propionic acid, inhibited fermentation and also inhibited mold growth when fermented material was exposed to air. These materials also tended to reduce ruminal fermentation. Other additives had little effect on characteristics of the grain or acceptability by growing lambs.

Introduction

Last year, a group of commercial additives for corn silage were examined (Rust *et al*., 1978) and one material was tested further as reported elsewhere in this publication by Zinn. Scientific information is limited regarding many of the commercial additives for ensiling with good quality high moisture corn. Some are added as mold inhibitors,