Implanting with DES or Synovex-H (bottom of Table 4) significantly increased heifer weight gains by about 30 percent ($P<.05$). Weight gains of Ralgro-implanted heifers were increased about 18 percent ($P>.05$).

At this date (January 17, 1978) monensin is *not* presently cleared by the FDA for use in stocker programs. However, the average daily gains of stockers grazed on low- to average-quality pastures (such as native bluestem and shortgrass pastures, and bermudagrass pastures throughout the summer) have been increased by about one-quarter of a pound/head/day by feeding monensin in experimental trials. Percentage increases in stocker weight gains on these types of pastures have ranged from 11 to 39 percent.

On the basis of the two field trials that we have conducted to date, the potential of monensin for increasing weight gains of wheat pasture stockers appears uncertain. Additional trials relative to the effect of monensin onweight gains of wheat pasture stockers are presently being conducted.

Literature Cited

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Effect of Monensin on Forage Intake and Ruman Turnover Rate

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Story in Brief

Two trials were conducted to evaluate the effect of monensin on forage intake, rumen turnover rates, 24 hr volatile fatty acid patterns and rumen nitrogen components of cattle consuming low quality dry native range grass. In Trial 1 cows were fed a 30 percent protein soybean meal supplement with 0, 50 or 200 mg of monensin per cow per day. In Trial 2, mature ruminally cannulated steers were fed the same supplement with 0 or 200 mg of monensin. A third trial was conducted to estimate rumen turnover rate and cellulose disappearance rate of steers fed a high concentrate diet at a rate to meet maintenance requirements with 0, 50, 100 or 200 mg of monensin per steer daily.

Cow weight change was similar when 200 mg of monensin was added to the control supplement in Trial 1. However, cows fed the 50 mg level lost more weight than either the control or 200 mg monensin treatments. Relative forage intake, in Trial 1, was reduced 13.6 and 19.6 percent when 50 and 200 mg of monensin were fed respectively and was reduced 16 percent, in Trial 2, when 200 mg of monensin was fed.

Liquid rumen turnover rates were reduced 31 percent in Trial 2 and 10 percent in Trial 3 when 200 mg of monensin was fed. Solid rumen turnover rates were 44 percent slower in Trial 2 with 200 mg. Monensin also shifted the volatile fatty acid patterns of steers in favor of propionic acid without affecting cellulose disappearance or rumen nitrogen components.

Introduction

Monensin increases the energy content of the diet by increasing the ratio of propionate to acetate and butyrate. Forage fed cattle generally eat to bulk fill; therefore, an increase in usable energy by shifting the VFA's should result in increased weight gain or reduced weight loss. Monensin has been shown to reduce feed intake of cattle consuming high quality forage and concentrate rations, but little attention has been given to forage intake of cows fed near maintenance rations.

The relationships between fermentation rate, turnover rate and extent of digestion indicate the importance of turnover rate in the economy of feed utilization by the ruminant. The most complete digestion of forages will be obtained with a long rumen retention time (slow turnover rate). However, in some cases a short rumen retention time and reduced digestibility may result in more total energy intake.

The effect of monensin on rumen turnover rate and its relationship with feed intake has not been examined; therefore, the purposes of this study were: 1) to evaluate the effect of monensin on forage intake of cattle consuming low quality dry winter range grass, 2) to evaluate the effect of monensin on ruminal turnover rate of steers fed low quality harvested dry winter range grass or an 80 percent concentrate diet fed to meet maintenance requirements and 3) to evaluate the effect of monensin on ruminal nitrogen components and cellulose disappearance.

Procedure

Trial 1

Sixty-nine mature open Hereford cows were employed in a 123 day trial from November 13 to March 15. Cows were randomly allotted by weight to 23 simultaneous 3 × 3 Latin squares. The three treatments were 0, 50 or 200 mg of additions of monensin per cow daily to 30 percent natural crude protein supplements. Ingredient make-up of the supplement is shown in Table 1. All

cows were allowed to graze native tallgrass range with climax vegetation of little bluestem, big bluestem, Indian grass and switch grass. Cows were corralled six days per week and individually stall fed 2.75 lb of their respective supplement once daily.

Cows were weighed at the beginning and end of each 41 day period. On the last day of each period, cows were fed their respective supplements and allowed to graze for approximately 3 hours, after which rumen samples were taken for VFA analysis.

Relative forage intake of cows grazing dry native winter range grass was estimated in December, February and March using chromic oxide (20 gm/head/day). The chromic oxide was administered with one-half the daily allocation of supplement at 8 am and 4 pm during the six day preliminary and five day fecal collection periods. Fecal grab samples were dried at 140 F and analyzed for chromium content, lignin, cellulose and acid detergent fiber. Representative forage samples were also obtained, using three esophageally cannulated cows, to estimate forage digestibility.

Trial 2

Eight mature, ruminally cannulated steers weighing approximately 1,375 lb were randomly allotted to two treatments in a cross-over design. A 30 percent protein soybean meal supplement (Table 1) was fed with or without 200 mg of monensin added per steer daily. Steers were individually housed in slatted floor pens and *ad libitum* fed low quality winter range grass harvested in late December. Grass was chopped to a maximum length of five inches. Grass intake was recorded daily.

Steers were adapted to their respective supplements for a period of 13 days prior to measuring turnover rate. Liquid and solid rumen turnover rates were estimated by using polyethylene glycol and chromic oxide respectively. On day 13 of each period 50 gm PEG and 20 gm chromix oxide were mixed and fed at 8 am the daily allocation of supplement. Rumen samples were obtained at 4, 10, 16 and 22 hr post-supplement feeding and centrifuged to separate solid and liquid fractions. The liquid fraction was analyzed for PEG and for volatile fatty acids while the solid fraction was dried at 212 F for 48 hr and analyzed for chromium. Peptide nitrogen was determined on the 4 and 22 hr liquid fraction while alpha-amino nitrogen was estimated on the 22 hr liquid fraction only.

Trial 3

Four mature, ruminally cannulated Holstein steers were randomly assigned to four treatments in a Latin square design with 0, 50, 100 and 200 mg of monensin per steer per day. A high concentrate diet was limit-fed to meet maintenance requirements. The ration (Table 2) was fed twice daily at 8 am and 4 pm at a rate of 5.98 lb per feeding.

Steers were adapted to their respective supplements for two weeks. On day 9 and 13 of each period, steers were dosed intraruminally with 50 gm of

Table 1. Ingredient makeup of protein supplement

Item	International reference number	% in supplement
Corn, yellow	4-02-915	22.77
Soybean meal	5-04-604	58.25
Alfalfa hay, grd	1-99-118	10.00
Molasses, cane	4-04-696	5.00
Sodium phosphate, monobasic	6-04-287	2.50
Calcium phosphate, dibasic	6-01-080	.75
Sodium sulfate	6-04-292	.68
Trace mineral mix		.05
Vitamin A palmitate	7-05-143	22,000 IU/kg

Table 2. Ingredient makeup of ration in Trial 2

Item	International Reference No.	5 in Supplement
Corn, yellow	4-02-935	62.75
Soybean meal	5-04-604	10.00
Alfalfa, dehy	1-00-022	6.00
Molasses, cane	4-04-696	5.00
Cotton seed hulls	1-01-599	14.00
Urea		.10
Ammonium chloride		.50
Limestone		.50
Calcium phosphate, dibasic	6-01-080	.50
Trace mineralized salt		.50
Aurafac - 10		.15

chromium EDTA, to measure liquid rumen turnover rates and sampled at 4 and 24 hr after dosing. Samples were centrifuged and the liquid fraction analyzed for chromium content.

Cellulose disappearance rate was estimated using unwashed, unsized cotton fiber strips. On day 9 and 13 of each period these cotton fiber strips were suspended in the rumen for 24 hr, recovered, washed, dried and weighed to determine cellulose degradation.

Results and Discussion

Trial 1

Performance of cows grazing dry winter range grass is shown in Table 3. Average daily supplement intakes were equal among treatments. Weight loss of cows fed the 0 and 200 mg monensin supplements were similar. Cows fed the 50 mg of monensin lost significantly more weight than cows on the other treatments. These results would suggest that 50 mg is less useful than 0 or 200 mg of monensin per day for cows grazing poor quality winter range.

Table 3. Performance and relative forage intake of cows during winter supplementation in Trial 1

Item	Monensin, mg/cow/day		
	0	50	200
Cows, number	69	69	69
Daily supplement, lb	2.75	2.75	2.75
Initial cow wt, lb	901.52	898.50	899.60
Cow wt change, lb	$+14.87^{a}$	-21.47^{b}	-14.15^{a}
Forage intake, lb	21.14^{a}	18.26^{b}	17.01^{c}

^{a,b,c}Means with different superscripts are significantly different ($P<.05$).

Table 4. Total and molar percentages of volatile fatty acids in rumen fluid of cows in Trial 1

Item	Monensin, mg/cow/day		
	0	50	200
Acetate, molar %	78.46^{a}	78.43^{a}	73.68^{b}
Propionate, molar %	15.86^{b}	16.85^{b}	21.92^{a}
Butyrate, molar %	5.71^{a}	4.70^{b}	4.12^{c}
Total mM/1	32.11	31.77	30.42

^{a,b,c}Means with different superscripts are significantly different ($P<.05$).

Relative forage dry matter intakes are shown in Table 3. Forage intake was significantly depressed 13.6 percent with 50 mg of monensin and 19.6 percent with 200 mg of monensin when compared to the control treatment. The estimated forage digestibilities were 41.7, 38.2 and 39.8 percent for December, February and March intake trials respectively.

Total and molar percentages of volatile fatty acids are shown in Table 4. Rumen fluid from cows fed the 200 mg supplement had less acetate and butyrate and more propionate than rumen fluid from cows fed the control supplement. Rumen fluid from cows fed the 50 mg supplement was intermediate in concentration of VFA's between the control and 200 mg treatments, but not consistently different from the control. The failure of the 50 mg level of monensin to consistently alter acetate, propionate and butyrate further indicates it is not the proper level of monensin for cows grazing dry native winter range. Total molar concentration of VFA's was not significantly affected by the addition of monensin.

Trial 2

When monensin was fed, average daily forage intakes (Table 5) were significantly depressed by 15.6 percent. These results closely agree with those of cows in Trial 1. A partial explanation for decreased feed intake with monensin feeding may be that rumen digestion, solid turnover and liquid turnover rates were decreased when monensin was fed. Steers fed monensin had a 30.8 percent slower liquid turnover rate and a 43.6 percent slower solid rumen turnover rate than control steers. Decreased turnover matches the reduction in feed intake with monensin supplementation of high roughage rations.

Table 5. Intake, rumen turnover and rumen volume of steers fed harvested dry winter range grass in Trial 1

Item	Monensin, mg/steer/day	
	0	200
Intake, lb	10.12[a]	8.54[b]
Liquid turnover, dilution %/hr	6.53[c]	4.52[d]
Solid turnover, dilution %/hr	2.73[c]	1.54[d]

[a,b]Means with different superscripts are statistically different (P<.02).
[c,d]Means with different superscripts are statistically different (P<.10).

Table 6. Twenty-four hour volatile fatty acid pattern of steer fed harvested dry winter range grass in Trial 1

Item	Monensin, mg/steer/day	
	0	200
4 hr sampling		
Acetate, molar %	68.50[a]	63.40[b]
Propionate, molar %	25.56[b]	30.48[a]
Butyrate, molar %	5.95	6.12
Total, mM/1	41.54	44.95
10 hr sampling		
Acetate	73.00[c]	64.14[d]
Propionate, molar %	20.20[c]	29.27[d]
Butyrate, molar %	6.80	6.59
Total, mM/1	46.45[e]	33.05[f]
16 hr sampling		
Acetate, molar %	76.09[c]	63.89[d]
Propionate, molar %	17.96[d]	30.02[c]
Butyrate, molar %	5.96	6.08
Total, mM/1	45.71	41.74
22 hr sampling		
Acetate, molar %	72.56[e]	66.54[f]
Propionate, molar %	21.10[f]	27.15[e]
Butyrate, molar %	6.33	6.31
Total, mM/1	45.78[a]	35.63[b]

[a,b]Means with different superscripts are significantly different (P<.10).
[c,d]Means with different superscripts are significantly different (P<.001).
[e,f]Means with different superscripts are significantly different (P<.05).

Twenty-four hour volatile fatty acid patterns of steers fed harvested dry winter range grass is shown in Table 6. Acetate was significantly decreased and propionate significantly increased when monensin was fed at the 4, 10, 16 and 22 hr samplings. Butyrate was not significantly affected by monensin at any sampling time. Total VFA concentration was lower at the 4 and 16 hr samplings when monensin was fed.

Nitrogen components of liquid rumen contents from steers fed harvested dry winter range grass are shown in Table 7. Peptide nitrogen was not significantly affected at either the 4 or 22 hr sampling by the addition of monensin. These data suggest that monensin did not cause free amino acid or

Table 7. Liquid rumen nitrogen components of steers fed harvested dry winter range grass in Trial 1

Item	Monensin, mg/steer/day		
	0	200	S.E.
4 hr sampling[1]			
Peptide nitrogen, mg/ml	2.72	3.04	.25
22 hr sampling[2]			
Peptide nitrogen, mg/ml	4.07	3.73	.56
α-amino nitrogen, mM	4.35	4.50	.46

[1]Sampled 4 hr post-supplement feeding.
[2]Sampled 22 hr post-supplement feeding

Table 8. Cellulose disappearance and liquid rumen turnover of steers limit fed a high concentrate ration in Trial 2

Item	Monensin, mg/steer/day			
	0	50	100	200
Cellulose disappearance rate, %	18.8	15.9	13.6	19.1
Liquid turnover, dilution %/hr	5.33[a]	4.82[ab]	4.78[ab]	4.16[b]
Rumen liquid volume, l	53.0	67.8	58.0	65.9

[a,b]Means with different superscripts are statistically different (P<.05).

peptide nitrogen accumulation in the rumen of cattle fed low quality dry winter range grass.

Trial 3

In vivo cellulose disappearance and liquid rumen turnover rates of steers limit-fed a high concentrate ration are shown in Table 8. *In vivo* cellulose disappearance rate was not significantly altered when monensin was added to the control supplement, however, it appears that the 50 and 100 mg levels of monensin may slightly depress cellulose digestibility on a high concentrate ration. Turnover rates of rumen liquid tended to be slower in the 50, 100 and 200 mg of monensin treatments than the control with an apparent linear depression as monensin level increased. These results agree with those obtained in Trial 1.

Several theories exist that may explain the relationship between reduced forage intake and rumen turnover rate when monensin is fed. First, rumen turnover rate may be decreased because intake is decreased. In Trial 2, with steers *ad libitum* fed harvested low quality range grass, rumen turnover rate was slower. This may be the result of reduced intake. However in Trial 3, with steers limit-fed a high concentrate diet, intake of feed was held constant while turnover rate declined. This suggests that the second theory may explain the forage intake and rumen turnover rate relationship; reduced rumen turnover rate causes a reduction in forage intake. It appears that monensin depresses rumen turnover rate independent of its effect on intake as shown in Trial 3. Consequently, the depression in rumen turnover appears independent, and therefore probably the cause and not simply a result of reduced forage intake.

Based on research finding to date, it seems that monensin decreases intake of low quality forages as well as rumen turnover rate. One explanation for reduced forage intake is decreased rate, but not necessarily extent of ruminal digestion. Decreasing the rate of digestion of particulate matter in the rumen would prolong rumen retention and slow rumen turnover. Reduced rumen turnover would decrease feed intake if bulk fill limits intake. The decreased energy intake of monensin fed cattle may not reduce performance however, due to compensating factors. These may include: 1) increased propionate production, 2) decreased methane production, 3) decreased heat loss, 4) decreased energy expenditure for grazing and 5) decreased metabolic fecal energy loss.

Slow Ammonia Release for Steers

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Story in Brief

Slow and rapid ruminal ammonia release rates were simulated by feeding urea intermittently. Steers were fed half a pound of prairie hay hourly with the following daily dietary supplements: Urea continuously (C) as 0.007 lb/hr; moderate (M) as 0.031 lb/hr for 6 hr; rapidly (R) as 0.19 lb of urea in 1 hr, or no supplemental urea (0). Ruminal ammonia remained stable with treatments C and O. Treatments R and M peaked at 1.5 and 6.5 hr after feeding began showing that slow release of ammonia was effectively achieved. Digestibility of dry matter was increased by 5 percent and retention of nitrogen was increased with the addition of urea regardless of the rate of urea administration. Simulated slow ammonia release rates enhanced neither dry matter digestibility nor nitrogen retention. Use of ammonia in the rumen was not improved by slowing its release rate.

Introduction

Cattle grazing low quality forage utilize supplemental urea poorly. This has been attributed to rapid breakdown of urea to ammonia with low availability of energy for bacteria to use the ammonia. Slowing the ammonia release rate might help balance ammonia and energy availability. The objective of this study was to determine if slow release of ammonia would prove beneficial for digestion and nitrogen retention of steers fed winter range grass.