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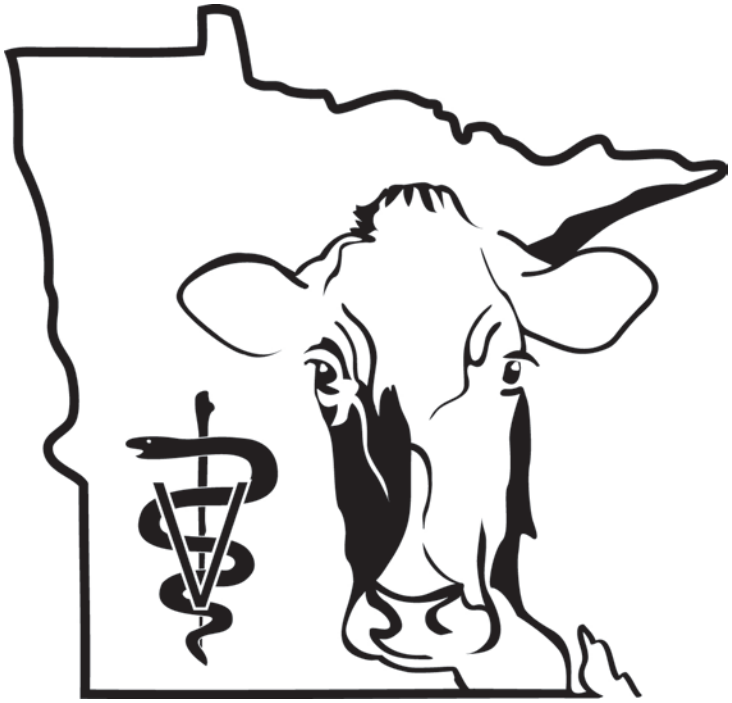

ST. PAUL, MINNESOTA
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Effect of Rumensin® (monensin sodium) on Performance and Health in Lactating Dairy Cows - Nine-trial North American Registration Summary

David G. McClary, DVM; Howard B. Green, MS; Elvin E. Thomas, PhD; John I. D. Wilkinson, PhD; R. Ken McGuffey, PhD; Angel A. Aguilar, PhD; Gerald D. Mechor, DVM, MVSc; and Zhanglin Cui, PhD - Elanco Animal Health

When Rumensin was fed to dairy cows:

- The efficiency of milk production was increased within the dose range of 11 g/ton to 22 g/ton (dry matter basis).
- Production of marketable solids-corrected milk (SCM) did not change when dry matter intake was reduced.
- Dry matter intake was not affected in early lactation, but was reduced at 15 g/ton and 22 g/ton during the second half of lactation.
- Milkfat percent was reduced at 15 g/ton and 22 g/ton but milkfat yield (lbs./day) was not affected.
- Milk protein percent was not affected at the 7 g/ton and 15 g/ton levels, but was reduced at the 22 g/ton dose. Milk protein yield (lbs/day) was not affected at any tested dose.
- Body weight was not different from controls during lactation but body condition score was higher at the end of lactation compared to controls.

Introduction

To remain competitive in the dairy industry, dairy producers must employ management practices and technology that are economically feasible. Income over feed costs must be optimized to maintain profitability of the dairy. Hutjens[1] defined the relationship between milk produced and dry matter consumed as dairy efficiency and suggested that the ratio between milk production (lbs/cow/day) and dry matter intake (lbs/cow/day) should be between 1.4 and 1.8:1.

One tool to increase milk-production efficiency is the use of Rumensin (monensin sodium:Elanco Animal Health, Greenfield, IN). Rumensin increases efficiency by altering the populations of rumen microbes so that the production of volatile fatty acids (VFA) is changed to decrease the acetate and propionate ratio. Rumensin has been used to improve feed efficiency in feedlot and mature beef cows since the mid 70s. It is now the first feed ingredient approved by the U.S. Food and Drug Administration (FDA) for increased milk-production efficiency (production of marketable solids-corrected milk per unit of feed intake) when fed to dairy cows.

Rumensin North American Dairy Trials

A series of nine trials was conducted with six trial sites in the United States (Indiana, North Carolina, Michigan, New York, Florida and California) and three trial sites in Canada (Ontario, Quebec and Alberta). The trials were initiated in 1994. Nine hundred sixty-six Holstein dairy cows, including 357 primiparous and 609 multiparous cows,

were initially assigned to treatment. Rumensin was fed beginning 21 ± 3 days before expected calving and continued through the full lactation cycle to 7 days in milk (DIM) of the second lactation at all trial sites. In addition, at the California, Florida and New York trial sites, cows continued through 200 DIM ± 3 days into their second lactation.

The four treatments included Rumensin at 0 g/ton (control), 7 g/ton, 15 g/ton and 22 g/ton (100 percent dry matter basis). Rumensin was fed continually throughout the entire trial. The primary objective of these trials was to determine the effects of Rumensin on milk production, dry matter intake and milk composition. Secondarily, various reproduction and health parameters were also determined.

Rations and Feed Ingredients

Rations were typical of the regions where the trials were conducted, and met or exceeded nutrient requirements (1989 National Research Council, Sixth Edition)[2]. Nutrient specifications of the diets fed are summarized in Table 1. All rations were designed to contain a minimum of 19 percent acid detergent fiber (ADF) or 25 percent neutral detergent fiber (NDF) on a dry matter basis. Cows were offered fresh feed once or twice daily with weights of refused feed recorded daily. Feed intake was measured on an individual cow basis.

Table 1. Nutrient Specifications of Total Mixed Rations

Ration	NE_L Mcal/lb	Crude Protein %	Calcium %	Phosphorus %
Far-Off Dry	0.50-0.67	12.0-18.0	0.40-0.75	0.24-0.50
Close-Up Dry	0.68-0.76	13.0-16.5	0.40-0.75	0.35-0.50
TMR 1	0.76-0.80	17.5-19.0	0.70-1.20	0.48-0.66
TMR 2	0.70-0.76	15.0-17.5	0.60-1.20	0.40-0.50
TMR 3	0.64-0.70	13.0-16.5	0.60-1.20	0.35-0.50

Milk Yield and Composition

Cows were milked two times daily at all sites except at the Florida and Michigan locations where cows were milked three times daily. Individual cow milk weights were recorded at each milking for daily yield. Milk composition was determined weekly (excluding the first week following calving) and represented each milking from each cow during a 24-hour period. Components determined included percent fat, protein, lactose and total solids.

Feeding Management

Cows were fed TMR-1 (Table 1) from calving to at least 84 ± 3 days into lactation. The primary criteria for changing cows to TMR-2 was when body condition score (BCS) was ≥3.0 and daily milk production was <69 lbs/day (multiparous cows) or <54 lbs/day

(primiparous cows). Cows were fed TMR-2 for a minimum of 28 days (unless dry-off was indicated due to low milk production). Cows were changed from TMR-2 to TMR-3 when BCS was >3.5. The TMR-3 was fed until the end of lactation. Rations were offered to achieve a 5 percent to 10 percent feed refusal.

Body Weight and Body Condition Score

Both body weight and body condition score were determined according to the following schedule: at calving 1, at 28-day intervals until dry-off, at the change from far-off to close-up TMR, at calving 2 and at the end of treatment. In addition, body weights were collected at 14 ± 3 days in milk and at 14-day intervals to 112 ± 3 days in milk. In addition cows were weighed on consecutive days at Calving 1, Dry-off and the at completion of the study for each animal.

Statistical Analysis

Data from all the trial sites were pooled for statistical analysis. The minimum effective concentration was determined using a non-overlapping confidence interval technique from the dose-response relationship between Rumensin and SCM production efficiency during lactation 1.

Performance Results and Discussion

Milk Production and Composition

Average daily production of milk, SCM, and milk composition, are summarized for Lactation 1 in Table 2. Adjusting milk yield to a SCM basis allowed comparison of milk containing different percentages of components on an equal energy basis.
The equation used to calculate SCM was:

SCM = Milk, lbs x [(12.24 x Fat %) +
(7.10 x Protein %) + (6.35 x Lactose %) - 0.0761]

Table 2. Marketable Milk Yield and Composition Lactation 1[1]

	Rumensin Dose g/Ton DM TMR				
Variable	**0**	**7**	**15**	**22**	**SE**
Marketable Milk (lbs/day)	63.1	64.6	64.6	65.5[b]	1.80
Milkfat %[c]	3.65	3.59	3.49[a]	3.38[a]	0.08
Milkfat Yield (lbs/day)	2.34	2.38	2.29	2.27	0.04
Protein %[c]	3.15	3.16	3.13	3.10[b]	0.02
Protein Yield (lbs/day)	2.04	2.10[b]	2.08	2.09	0.03
Total Solids %[c]	12.38	12.29	12.17[b]	12.04[a]	0.09
Marketable SCM (lbs/day)	58.1	58.9	58.0	58.0	1.32

[1]Values Least-square means
[a]Different from control P<0.01
[b]Different from control P<0.05
[c]Linear decrease with increasing dose of monensin (P<0.05)

During Lactation 1, there were no significant differences among treatment groups for production of SCM. During early lactation, milk production was increased above controls in the Rumensin groups, while dry matter intake was unchanged. Milkfat percentage was not different at 7 g/ton compared to controls, but was reduced (P≤.01) in the 15 g/ton and 22 g/ton treatments. Daily yield of milkfat was not different from controls for any group.

Milk protein percentage was not different from controls for the 7 g/ton and 15 g/ton treatments, but was reduced (P<.05) in the 22 g/ton treatment. Average daily milk protein yield was increased at the 7 g/ton dose (P<.05) compared to controls, but was unchanged at the 15 g/ton dose and the 22 g/ton dose. During lactation 2 (200 ± 3 DIM), no statistical differences existed for milk yield or any of the milk components compared to controls.

Dry Matter and Net Energy Intake

Average daily dry matter and NE_L intake are presented in Table 3. Dry matter intake for the 7 g/ton treatment group was not different from controls. Dry matter intake compared to control was reduced (P<.05) from treatment start to calving 1 (22 g/ton), during lactation 1 (15 g/ton and 22 g/ton) and from dry-off to calving 2 (22 g/ton). During lactation 1, intake was reduced 1.1 lbs/day (2.5 percent) and 1.6 lbs/day (3.5 percent) for both the 15 g/ton and 22 g/ton doses, respectively, compared to controls. During both dry periods, intake was reduced (1.1 lbs/day in dry period 1 and 1.7 lbs/day in dry period 2) at the 22 g/ton level (P<.05), but equaled controls at 7 g/ton and 15 g/ton. No differences in dry matter intake or NE_L intake were observed between treatments during lactation 2 (200 ± 3 DIM). Dry matter intake during the first 14 weeks of lactation 1 was not different for any Rumensin dose compared to controls.

Table 3. Dry Matter (lbs/day)[1] and Net Energy of Lactation Intake (Mcal/day)[1]

	Rumensin Dose g/Ton DM TMR				
	0	**7**	**15**	**22**	**SE**
Precalving Lactation 1					
DM Intake	24.2	24.2	24.0	23.1[b]	0.4
NE_L Intake	17.2	17.1	17.0	16.3	0.7
Lactation 1					
DM Intake[c]	43.9	44.1	42.8[b]	42.3[a]	0.9
NE_L Intake[c]	33.8	33.9	32.9[b]	32.6[a]	0.9
Dry-off to Calving 2					
DM Intake[c]	28.2	27.6	27.6	26.5[a]	0.9
NE_L Intake[c]	18.7	18.1	18.2	17.5[a]	0.7

[1]Values Least-square means
[a]Different from control P<0.01
[b]Different from control P<0.05
[c]Linear decrease with increasing dose of monensin (P<0.01)

Body Weight and Body Condition Score

Body weight (BW) and body condition score (BCS) data are presented in Table 4. There were no differences in body weight or body weight change among dose groups during any part of lactation or the dry period. During Lactation 1, the change in BCS from calving to the lowest measured score during the first 203 days of lactation was lower (P<.05) in controls compared to any Rumensin treatment. The results demonstrated that cows fed Rumensin maintained higher body condition throughout lactation compared to non-treated cows. Average BCS was not different between treated and control cows at Calving 2

Table 4. Body Weight[1] and Body Condition Score (1 to 5 scale)[1]

	Rumensin Dose g/Ton DM TMR			
	0	**7**	**15**	**22**
Ave. BW Change Calving 1 to 308 DIM (lbs)	134	157	143	154
BW at Calving 2	1487	1472	1486	1488
Ave. BCS at Calving	3.29	3.25[b]	3.26	3.27
Ave. Change in BCS to Min	-0.57	-0.55	-0.51[b]	-0.52[b]
Ave. Change in BCS Calving to 308 DIM	-0.16	-0.06[b]	-0.05[b]	-0.07[b]
Ave. Calving 2 BCS	3.32	3.28	3.33	3.32

[1]Values Least-square means
[a]Different from control P<0.01
[b]Different from control P<0.05

Milk-Production Efficiency

Milk-production efficiency (MPE) is expressed as lbs marketable SCM per Mcal NEL intake corrected for changes in body weight. Energetics of body-weight change were considered according to the following formula[2]:

MPE = SCM ÷ NEL – (k × Change in BW, lbs)
Where k = 2.32 if BW increases and
k = 2.23 if BW decreases

Milk production efficiency increased linearly with dose of Rumensin with MPE being greater ($P<0.05$) in the 15 g/ton and 22 g/ton doses compared to control.

What is the Effective Dose of Rumensin?

The minimum effective dose of Rumensin was defined as the lowest non-zero concentration for which the lower limit of the 95 percent confidence interval did not overlap with the upper limit of the 95 percent confidence interval for the 0 g/ton or control dose. This determination was made by using the non-overlapping confidence intervals around the 0 g/ton dose group and 15 g/ton dose group, which was the lowest tested effective dose that was used in the study. The minimum effective dose was determined to be 11 g/ton. Thus, Rumensin is expected to significantly increase milk-production efficiency within the dose range of 11 g/ton to 22 g/ton (dry matter basis).

Reproduction and Health

Studies[3,4] have demonstrated an association between energy balance and the incidence of a number of postpartum diseases in the dairy cow. Other studies[5-7] have demonstrated a negative relationship between reproductive efficiency and the level of negative energy balance as measured by loss in body condition. Hammon et al.[8] showed an inverse relationship in periparturient dry matter intake (DMI), and the incidence of retained fetal membranes (RFM), subclinical endometritis and fever. Furthermore, they showed that cows with subclinical endometritis and fever had significantly higher periparturient serum nonesterified fatty acid (NEFA) and ß-hydroxybutyrate (BHB) concentrations compared to cows without these conditions.

Improved reproductive performance associated with improved energy balance in early lactation could be anticipated in Rumensin-supplemented cows. However, four studies[9-12] evaluating reproductive performance showed no difference between control cows and Rumensin-supplemented cows in days to first service, pregnancy rate or days open.

A total of 966 Holstein dairy cows, including 357 primiparous and 609 multiparous, were initially assigned to treatment at the nine trial sites. Rumensin was fed beginning 21 ± 3 days before expected calving and continued through the full lactation to 7 to 9 days in milk (DIM) of the second lactation at all trial sites. Cows from three of the original nine

trial sites continued on the trial to approximately 200 days in the second lactation. Treatments included 0 (control), 7, 15 and 22 g/ton Rumensin (100 percent dry matter basis) as part of a total mixed ration. Rumensin was fed continuously throughout the entire trial.

The voluntary wait period prior to breeding was 50 days for all study animals. Cows were observed twice daily for 30 minutes for estrous activity. All breedings were by artificial insemination. All inseminations within a 2-day period were considered a single service in this report. Cows were eligible for breeding up to 200 DIM. No estrus-detection aids (e.g., tail chalking, pressure-sensitive heat-detectors) or hormonal interventions (e.g., prostaglandins) for timing of estrus were used on study animals prior to 135 DIM.

All cows were monitored daily for health and reproductive events during the entire first lactation, the subsequent dry period (for pregnant cows) and from calving to 7 to 9 DIM of the subsequent lactation for all trial sites. Cows from the three second-lactation sites were monitored for health and reproductive events until approximately 200 DIM in a second lactation. Cows were routinely observed or examined for common health and reproductive conditions by trained trial-site personnel. The attending veterinarian for the individual trial site confirmed any suspected reproductive or health conditions observed by trial-site personnel. All personnel at the individual sites were blinded to treatment.

Health and reproductive conditions were summarized and analyzed by the following:

- Animal Rate: Number of animals observed with the characteristic of interest relative to the number of animals at risk during the study period in question (an individual animal may contribute once per lactation)
- Observation Rate: Number of days observed with the characteristic of interest relative to the number of days at risk
- Incident Rate: Number of incidents for the characteristic of interest relative to the number of days at risk (individual animal may contribute a number of incidents)
- Average Case Duration: Mean number of days that incidents persisted for the characteristic of interest

Occurrence of clinical mastitis (CM) was monitored on all cows throughout the study. A CM case was defined as an observation of abnormal milk and/or an abnormal mammary gland by trial personnel at a scheduled milking, or during an examination or observation period. Clinical mastitis was expressed as quarter rates (quarters with at least one case of CM per quarters at risk) as well as animal rate, incident rate (number CM per 1,000 quarter-days at risk) and average case duration. Clinical mastitis was also monitored by observation rate (number of days observed with CM per quarter-days at risk).

Quarter milk samples were collected for bacteriological culture during both lactations at the three second-lactation sites. Quarter samples were collected at specific events (e.g., calving and dry-off or removal) and the end of study. A second set of samples was collected at 56-day intervals throughout the lactation periods. Milk samples were collected weekly and submitted for determination of milk composition and of somatic

cell count (SCC) during lactation 1 at all sites and to 200 DIM at the three second-lactation sites.

Statistical Analysis

This study was a randomized complete-block design. Each Rumensin treatment was compared to control in a pair-wise comparison with a statistical difference considered for health and reproductive parameters if $P \leq .10$. A parity-by-treatment interaction was considered significant if $P \leq .25$. If a significant parity-by-treatment interaction was determined, individual parity comparisons were examined. A dose-related linear trend was considered if a linear trend test was $P \leq .10$.

Reproduction and Health Results:

Reproductive performance

All measures of reproductive efficiency of cows in the four treatment groups compared favorably with industry standards[13].

Estrous activity was measured on 869 cows entering the breeding period (50 DIM) during Lactation 1. Days to first observed standing estrus and days to first service were not different between any of the Rumensin treatment groups and controls (Table 4).

Table 4. Estrous activity for cows in Lactation 1.

	Rumensin (g/ton)				
Variable	**0**	**7**	**15**	**22**	**Industry Goal[13]**
Number of cows (50 DIM*)	218	211	219	221	
Days to first observed standing estrus	74.5	73.8	68.6	73.0	
Days to first service	84.1	84.7	86.9	83.6	<80

*50 day voluntary wait period

Eight-hundred fifty-one cows were inseminated. First service conception rate was reduced and days open were increased ($P \leq 0.05$) relative to controls at the highest (22 g/ton) level of Rumensin in the first lactation. Furthermore services per conception (for all and pregnant cows) tended to be higher and overall conception rates tended to be lower in Rumensin supplemented cows. However, the rates at which eligible cows became pregnant (average 21-day pregnancy rates) ranged from 19.2 to 21.5% and were not different ($P > 0.10$) between treated and control cows. Pregnancy rates achieved in the study were considered to be good compared to industry standards (Table 5).

Table 5. Breeding efficiency in Lactation 1.

	Rumensin (g/ton)				
Variable	**0**	**7**	**15**	**22**	**Industry Goal[13]**
Cows inseminated	213	209	213	216	
Services per conception (all cows)	2.43	2.52	2.71	2.77	
Services per conception (pregnant cows)	1.79	1.90	1.75	1.97	≤ 2
First service conception rate (%)	49.1	41.6	44.5	36.4[a]	50
Overall conception rate (%)	42.8	41.4	40.0	37.6	50
Days open	99.8	104.6	100.4	107.7[a]	85 to115
Percent calving*	64.6	63.1	62.0	68.6	65 to 70
21-day pregnancy rate[1]	21.5	20.3	18.7	19.2	18-22

[a] P ≤0.05 compared to control

*Percent cows eligible for breeding that calved following a normal, full gestation

[1] Data on file.

There were no differences in the percentage of cows entering the breeding period that ultimately calved following a normal, full-length gestation (percent calving) or the multiple birth rate following Lactation 1. Gestation length was normal and not different between treated animals and controls.

Birth weights of calves were heavier (P ≤0.10) for calves born to Rumensin treated cows (Table 6). The difference in birth weight was observed in female but not male calves. Birth weights were within the anticipated range for Holstein calves. Differences in birth weights failed to produce any effect on calving ease scores between treated and control animals.

Table 6. Birth ratio and weights of calves born to cows at the completion of Lactation 1.

	Rumensin (g/ton)			
Variable	**0**	**7**	**15**	**22**
Male:Female	52:48	47:53	52:48	53:47
All calves weight (lb)[b]	94.8	97.7[a]	97.2[a]	97.4[a]
Female calf weight (lb)[b]	88.8	92.6[a]	93.3[a]	94.8[a]
Male calf weight (lb)	100.5	102.7	101.2	99.9

[a] P ≤0.10 compared to control

[b] P ≤0.10 for linear dose trend

Reproduction Conditions

There was no difference between treated and control animals in retained fetal membrane (RFM) rate in Lactation 1 but cows receiving rations containing 7 and 15 g/ton Rumensin

had a higher (P ≤0.10) rate in Lactation 2. The RFM rate was not different from controls in the high (22 g/ton) Rumensin dose group so there was no dose related trend for this condition (Table 7). The incidence of other reproductive tract conditions was not different between treated cows and controls in Lactation 2.

Table 7. Animal Rate for Retained Fetal Membranes (RFM) in Lactations 1 and 2.

	Rumensin (g/ton)				
	0	**7**	**15**	**22**	**Industry Goal[13]**
Lactation 1					
Number Observed	32	36	37	25	
Animal Rate	11.1	13.3	12.3	8.7	<8
Lactation 2a*					
Number Observed	21	30	42	25	
Animal Rate	10.0	18.0[a]	22.6[a]	12.2	<8

* Lactation 2a – Calving 2 to 7-9 DIM (9 sites)
[a] P ≤0.10 compared to control

There was a linear trend (P≤0.10) for an increase in the animal rate for metritis during Lactation 1. This trend was not observed in Lactation 2 but the number of observations in Lactation 2 was low (8-12 per treatment) (Table 8).

Table 8. Animal Rate for Metritis in Lactations 1 and 2.

	Rumensin (g/ton)				
	0	**7**	**15**	**22**	**Industry Goal[13]**
Lactation 1					
Number Observed	38	50	60	57	
Animal Rate[b]	14.9	20.8	23.7[a]	22.6	<10
Lactation 2b**					
Number Observed	8	9	12	9	
Animal Rate	12.7	14.1	20.0	14.5	<10

** Lactation 2b – Calving 2 to ~200 DIM (3 sites)
[a] P ≤0.10 compared to control
[b] P ≤0.10 for linear dose trend

There was a dose related trend (P≤0.10) for a higher animal rate for cystic ovarian disease (COD) as determined by rectal palpation in Lactation 1. There was also a significant parity by treatment interaction for COD in Lactation 1. Individual parity analysis indicated no difference in the animal rate in multiparous animals but a significant linear trend for a higher animal rate in primiparous animals. The number of animals with COD in the primiparous group was 6, 8, 13, and 15 animals observed in the 0, 7, 15 and 22 g/ton treatment groups respectively (Table 9).

Table 9. Animal Rate for Cystic Ovarian Disease in Lactation 1.

	Rumensin (g/ton)				
	0	**7**	**15**	**22**	**Industry Goal[13]**
Number Primiparous Observed	6	8	13	15	
Animal Rate[b]	6.1	7.3	13.3[a]	14.7[a]	<10
Number Multiparous Observed	22	21	23	24	
Animal Rate	12.9	11.6	13.0	13.6	<10

[a] P ≤0.10 compared to control

[b] P ≤0.10 for linear dose trend

There was no difference in the animal rate for COD in Lactation 2 but the total number of animals diagnosed with COD in Lactation 2 was insufficient for an accurate evaluation of this condition (Table 10).

Table 10. Animal Rate for Cystic Ovarian Disease in Lactation 2*.

	Rumensin (g/ton)				
	0	**7**	**15**	**22**	**Industry Goal[10]**
Number Observed	12	5	10	9	
Animal Rate	19.0	7.8	16.7	14.5	<10

* Calving 2 to ~200 DIM (3 sites)

Udder Health

Clinical mastitis

There was no difference in the rates (animal, quarter, incidence, or observation) or the average duration of clinical mastitis cases during Lactation 1. The microorganisms cultured from clinical cases were classified as environmental pathogens (primarily coliforms and environmental streptococci), contagious pathogens (*Staphylococcus aureus* and *Streptococcus agalactiae*), coagulase negative staphylococci (CNS), others, and negative (no growth). Most clinical cases during Lactation 1 were caused by environmental pathogens. There was no difference in the pathogens isolated across treatment groups in Lactation 1.

There was no difference in the clinical mastitis rates between Rumensin treated and control animals in Lactation 2. There was a linear dose trend for a shorter (P≤0.10) duration of clinical cases during Lactation 2 but this observation was not considered clinically relevant. During Lactation 2 CNS was the most common pathogen group isolated from clinical cases. The relative incidence of CNS was higher in Lactation 2 than in Lactation 1.

Subclinical mastitis

During the study 15,370 routine quarter milk samples were collected from cows at the three two-lactation sites. Results for samples were reported by animal and quarter

prevalence. Infection prevalence was higher in multiparous cows compared to primiparous cows in Lactation 1. There were no differences in animal rate, quarter rate, incident rate, or average case duration during Lactations 1 or 2 between any treatment level and control. During Lactation 2 the observation rate was lower ($P \leq 0.10$) in the 22 g/ton group compared to control.

Somatic Cell Count

Somatic cell counts (SCC) were low in all treatment groups averaging less than 100,000 cells/ml. During Lactation 1 SCC were similar for the control and 15 and 22 g/ton groups. Average SCC was higher ($P=0.08$) in the 7 g/ton Rumensin group than controls. There was no dose related trend for higher SCC with Rumensin levels.

During Lactation 2, SCC was similar for all groups. Cell counts tended to be lower in the 22 g/ton Rumensin group than other groups in the first 15 weeks of lactation but were similar to other groups later in lactation.

There was no indication of a relationship between the feeding of Rumensin and any of the udder health parameters monitored in the study.

Animal Survival

Animal survival or the rate of involuntary removal from the trial was measured for four time periods relative to treatment start. There was no difference between the animal survival rates for control and treated animals for all periods measured except for the treatment start to 7 DIM in Lactation 1. In this comparison, cows in the 15 and 22 g/ton treatment groups had higher ($P \leq 0.10$) survival compared to control (Table 11).

Table 11. Animal survival rates in Lactations 1 and 2.

	Rumensin (g/ton)			
Animal Surival at:	**0**	**7**	**15**	**22**
Treatment start to 7 DIM Lactation 1, %	96.7	98.1	99.0[a]	99.0[a]
Treatment start to Dry off Lactation 1, %	78.2	78.7	80.4	81.1
Treatment start to 7 DIM Lactation 2 (9 sites), %	64.1	62.1	61.0	68.0
Treatment start to 200 DIM Lactation 2 (3 sites), %	63.4	66.5	55.6	66.8

[a] $P \leq 0.10$ compared to control

Conclusion

Rumensin is effective and approved by the FDA for use in dairy cows to increase milk-production efficiency (production of marketable solids-corrected milk per unit of feed intake) at doses at or in between 11 g/ton and 22 g/ton on a 100 percent dry matter basis. The average improvement in milk production efficiency from the trials was 2-4%. During early lactation increased efficiency was primarily due to an increase in milk yield with no change in DMI. As lactation progressed through mid and into late lactation

efficiency was increased through a reduction in DMI with a smaller or no difference in milk yield. Overall SCM yield was not different between treatments due to dose related reduction in percent milkfat but production efficiency ie. lbs of SCM produced per unit of energy intake was increased.

Excessive negative energy balance has been shown to decrease reproductive performance and increase the incidence or severity of some disease conditions. Duffield et al.[14] suggested that improved energy balance prior to calving is important in preventing energy associated metabolic diseases such as clinical ketosis, retained placenta, and LDA. Rumensin provides additional energy from the ration by altering ruminal fermentation such that more propionate is produced relative to other VFA. This mechanism should be particularly beneficial in early lactation when the dairy cow is in negative energy balance.

The incidence of some reproductive health conditions such as metritis, cystic ovaries, and RFM were increased in Lactation 1 or 2 in some Rumensin treatment groups compared to controls. Additionally some reproductive parameters such as services per conception, days open, and calving interval were increased and first service conception rate was reduced in the 22 g/ton Rumensin group compared to controls in Lactation 1. However, pregnancy rates and calving rates were not different between any of the Rumensin treatments and controls indicating that even though additional services were needed in the 22 g/ton group these cows eventually became pregnant within the 50 to 200 DIM breeding window. Furthermore, the rate at which animals were removed (survival rate) was not different between treated and control cows. Other studies[9-12] showed no difference in reproductive performance in Rumensin treated compared to control cows.

Even though fertility appeared to be reduced in Rumensin-treated cows as reflected in services per conception, first service conception rate and days open, the overall pregnancy rate did not differ, indicating that any reduction in fertility is manageable.

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