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Observations Concerning the Effects of Ruminal Evacuation on Intake and Ruminal Recovery of Dry Matter

M.J. Goetz
South Dakota State University

J.J. Wagner
South Dakota State University

P.S. Johnson
South Dakota State University

OBSERVATIONS CONCERNING THE EFFECTS OF RUMINAL EVACUATION ON INTAKE AND RUMINAL RECOVERY OF DRY MATTER

M. J. Goetz[1], J. J. Wagner[2] and P. S. Johnson[2]
Department of Animal and Range Sciences

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Summary

The effect of repeated total ruminal evacuations on feed intake and animal behavior and rate of ruminal recovery expressed as percentage of feed bunk dry matter disappearance were observed in an observation trial with six Angus crossbred steers. Evacuation stimulated meal size and daily intake in comparison to that of a previous feeding. Feed intake decreased with consecutive evacuations. Two evacuation cycles at a 2-day interval may be the practical limit to frequency of evacuations without a 1 to 2-week recovery period. Rate of recovery of dry matter from the rumen over a 4-hour period was extremely variable and not correlated with feed intake during the same period.

(Key Words: Rumen Sampling, Rumen Evacuation.)

Introduction

Ruminally fistulated animals have been used in nutritional research for a variety of purposes. The cannulated fistula has commonly provided convenient access to the rumen for in situ (nylon bag) disappearance techniques and rate of passage studies as well as for a source of microbial inoculant for in vitro digestibility studies. Recently, there has been renewed interest in using ruminally fistulated cattle to identify and sample forages actually consumed in grazing situations. Under extensive range conditions, sampling via the rumen fistula offers several advantages over sampling via the esophageal fistula. These include the ease of maintenance of the rumen fistula and the minimal level of special handling required for the ruminally fistulated animals. Further, since salivary contamination is diluted in the rumen, there may be less bias of the chemical analyses of nitrogen and minerals in samples taken from the rumen comparison to esophageal samples.

The sampling of freshly grazed forage via the rumen involves a complete evacuation of the reticulo-rumen contents and then turning the animal on to the pasture to graze for a period of time after which the reticulo-rumen is again evacuated to obtain the sample. This technique presents several questions with regard to intake. How does the evacuation affect appetite and consequently selectivity and intake? What effects can be expected with repeated periodic evacuations? What intervals of time between evacuations minimize disruption of normal intake patterns? How does the quantity of rumen contents correlate with forage disappearance?

To anticipate the responses in several of these situations, an observation trial was conducted to study the effects of repeated rumen evacuations on dry matter intake of a forage-based diet fed to confined steers and to observe the relationship of the quantity of evacuated rumen contents to the quantity of feed missing from the feed bunk.

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[1]Graduate Research Assistant.
[2]Assistant Professor.

Materials and Methods

Six crossbred Angus steers (656 lb) were ruminally fistulated and fitted with 4-in plastic cannulas[3]. Four weeks following surgery, four steers were selected on the basis of typical and stable feed intake for the demonstration. The diet is presented on Table 1 and was the same for all animals. The supplement, also presented on Table 1, was designed to ensure adequate protein for the recovering animal consuming a limited amount of diet and to stimulate intake of the forage.

TABLE 1. COMPOSITION OF DIET[a]

Item	%
Alfalfa-brome hay	75.00
Supplement	(25.00)
Rolled corn grain	20.56
Soybean meal	2.08
Dicalcium phosphate	.38
Calcium cabronate	.28
Vitamin A	.16
Molasses	1.29
Composition	
Crude protein	15.00
NEm[b]	.643
NEg[c]	.364
Calcium	.42
Phosphorus	.36
Vitamin A[d]	1454

[a] Dry matter basis.
[b] Net energy, maintenance, kcal/lb.
[c] Net energy, gain, kcal/lb.
[d] IU per lb.

Three consecutive total rumen evacuation cycles were performed on each steer during each of two periods. An evacuation cycle included the removal of the reticulo-rumen contents immediately prior to the morning feeding followed by a second total evacuation approximately 4 hours later. Free access to both feed and water was provided between the two evacuations.

Rumen contents from the first evacuation were placed in a double plastic sack and the air expressed before sealing each sack with a twist tie. The sack was then placed in a warm water (100 °F) bath. These contents were then replaced in the rumen following the second evacuation of each cycle.

The evacuation technique included the removal of the fibrous mat and large particles by hand. A shop vac was used to remove the fluid portion and the smaller particles. The rumen and reticulum walls were scraped with the side of the hand and then rinsed with clear water and again evacuated with suction. To prevent bruising of the rumen wall, suction in the vacuum was controlled by opening or closing a small split in the 2.5-in wire-reinforced vacuum hose.

[3] Appreciation is expressed to Dr. John U. Thomson, Extension Veterinarian, for doing the surgery.

The fluid fraction was strained through a 1-mm sieve and the residue weighed and sampled for dry matter determination. The particulate fraction was hand squeezed to remove excess moisture, manually mixed, weighed and sampled.

Disappearance of feed from the feed bunk between the two evacuations was measured, as was total feed intake during and following the evacuation periods.

Evacuation treatment included three total reticulo-rumen evacuation cycles. Evacuation cycle treatment intervals were (1) every 3 days, (2) every 2 days, (3) every day and (4) two evacuations on consecutive days followed by a 1-day interval before the third evacuation cycle. Two steers were used on each treatment. Each steer was used on two treatments separated by a period of time to allow feed intake to recover to normal levels.

Results and Discussion

Daily dry matter intakes over the evacuation and recovery periods are shown graphically for treatment 1 in Figure 1. One steer was removed from the trial during the second evacuation cycle for reasons unrelated to the demonstration procedures. Consequently, only one steer was evacuated at 3-day intervals. Dry matter intake the day of the first evacuation was at about the same level as the intake during the previous 2 days. Feed intake decreased abruptly over the 2 days following the evacuation with daily intake the second day about 50% of the intake the day of the first evacuation. Intake the day of the second evacuation was equal to that before the evacuations began but again dropped sharply during the 2 days following the evacuation. The steer did not eat as much the day of the third evacuation in comparison to the relatively normal intakes on the days of the first and second evacuations. Also, although feed intake was depressed over the next 2 days, the depression was not as severe as it had been following the first two evacuation cycles. Feed intake began to improve 3 days after the last evacuation and approached pre-evacuation levels by the fifth day after the last evacuation.

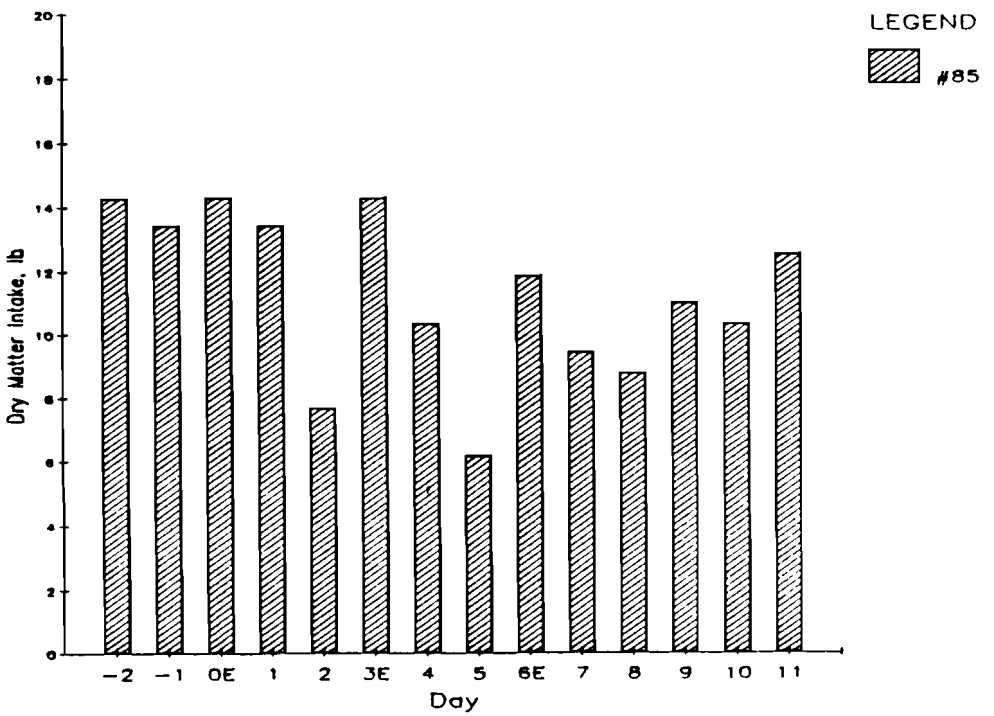

Figure 1. Daily dry matter intake, Treatment 1. (E = Evacuation)

Feed intake data for steers with an evacuation cycle interval of every other day is shown in Figure 2. Intake was substantially stimulated on the day of the first evacuation in comparison to the intake during the previous few days. Intake dropped substantially the day after the evacuation. This pattern of a high peak intake on the day of evacuation followed by a low intake the next was repeated during the second and third evacuation cycles, although it modulated downward with each additional evacuation.

Normal intakes are determined with a relatively stable flow into and out of the rumen. When the reticulo-rumen is completely empty, intake is stimulated and greater than normal consumption ensues. Intake was markedly depressed the day following the evacuation cycle and may be partially related to the the greater than normal intake on the previous day. The average of intakes on the first day of evacuation and the next day approximate normal intake. Intakes were stimulated by consecutive evacuations and the pattern was repeated, although not to the same degree as during the first evacuation. This is more apparent with more frequent evacuations (Figure 3). Recovery of intake to pre-evacuation levels followed an irregular pattern. Intake continued to decrease for 3 or 4 days and then increased to peak over the next 4 or 5 days before descending to normal levels 12 to 13 days after the last evacuation.

Figure 3 depicts daily intakes when the evacuation cycles were on consecutive days. Intake on the day of the first evacuation is increased over the normal intake. However, when the next evacuation cycles followed on consecutive days, intakes were depressed when compared to pre-evacuation levels and continued to decline to approximately 33% of normal intake by the second day after the last evacuation. Recovery to normal intakes followed a marked "roller-coaster" pattern and was not complete within 7 days of the last evacuation.

When the reticulo-rumen was evacuated on two consecutive days and then evacuated a third time after a 1-day interval, the same trend was apparent (Figure 4). One steer was inadvertently locked out of the feeder during the night and consequently had an atypically depressed intake the day of the first evacuation.

Intake was about 40% of normal the day after the second evacuation for both steers and remained low the day of the third evacuation cycle. The day after the last evacuation intakes were slightly improved but normal intakes were not achieved within 3 days of the third evacuation.

The consistent depression of feed intake and the sporadic intakes during the recovery period for all treatments may suggest that the microbial population of the rumen contents removed at the beginning of each evacuation cycle were not surviving the 4-hour period outside of the rumen. In spite of the warm water bath and anaerobic environment, the accumulation of waste products could have been toxic within the closed environment of the airtight sack. Adding only a portion of the evacuated contents back to the rumen as an inoculant source may possibly have moderated the sporadic recovery of intakes.

Feed bunk disappearance of the diet dry matter between the first and second evacuations in a cycle (about a 4-hour period) is presented as meal size in Figure 5. In general, meal size decreased from the first to the second and from the second to the third evacuation cycle. Average meal size across animal and treatment was 3.94, 3.04 and 2.22 lb in the first, second and third evacuation cycle, respectively. This decrease in meal size with increasing number of evacuations corresponds with total feed consumed during a 24-hour period.

Some general observations concerning the behavior of the steers following each evacuation may have have some value. After the morning evacuation, as the steers were returning to the feeders they would be looking for feed and trying to enter the feeder of each pen they would pass. Upon entering the pen they would stand with their heads in the stanchions waiting to be fed. They showed no interest in water and would immediately eat when feed was presented. Although they ate voraciously when feed was first presented, they appeared satiated after a normal sized meal since they seemed to consume no more during the 4-hour period than those cattle not evacuated during the same 4-hour period.

After the second evacuation (4 hours after the first) in the cycle, the empty rumen was manually filled with the contents removed in the morning and which had been aerobically stored in a warm water bath to attempt to maintain the microbial population. Although the rumen was filled to capacity, the steers exhibited the same anxious and hungry behavior as they had in the morning when the rumen was empty.

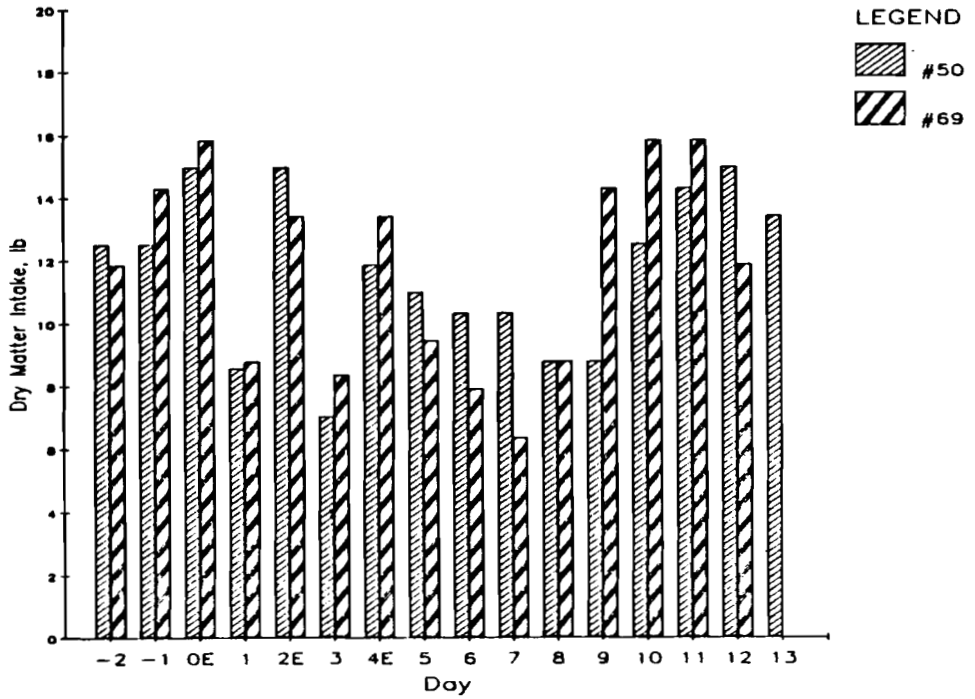

Figure 2. Daily dry matter intake, Treatment 2. (E = Evacuation)

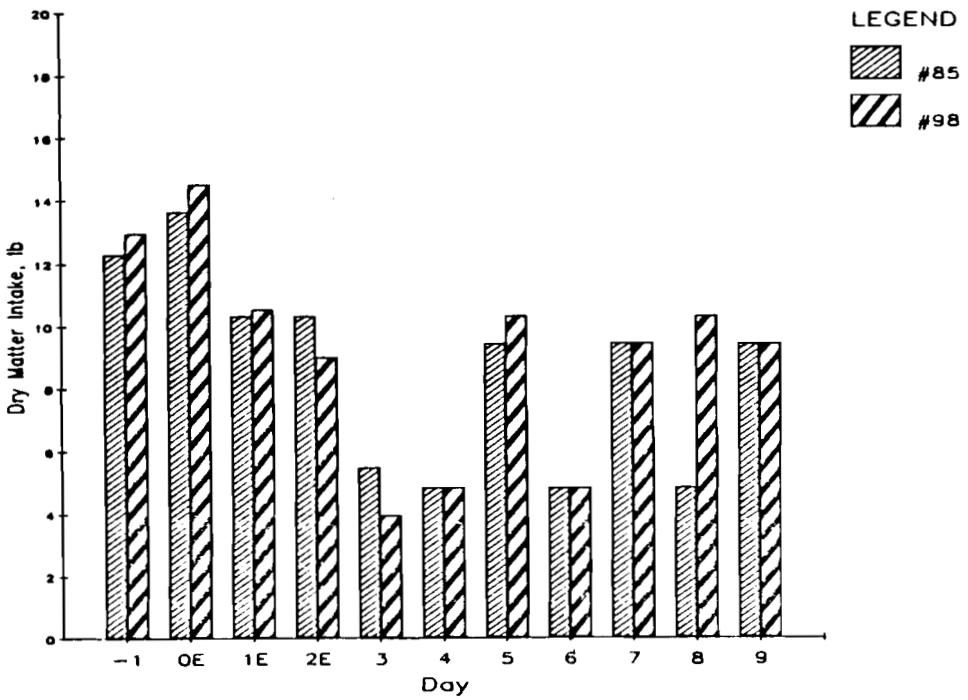

Figure 3. Daily dry matter intake, Treatment 3. (E = Evacuation)

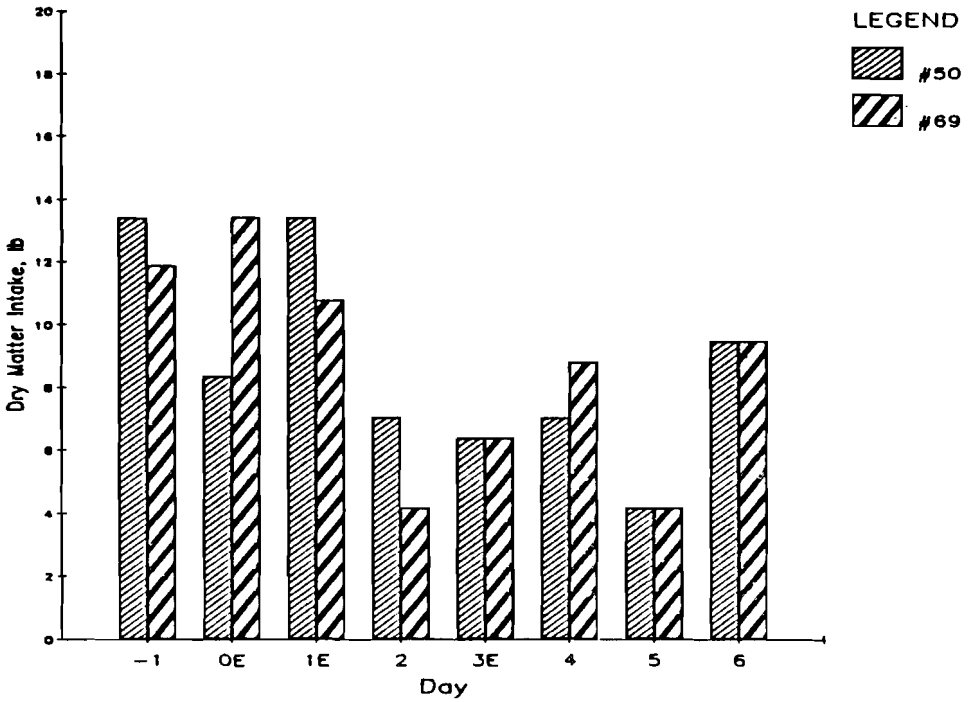

Figure 4. Daily dry matter intake, Treatment 4. (E = Evacuation)

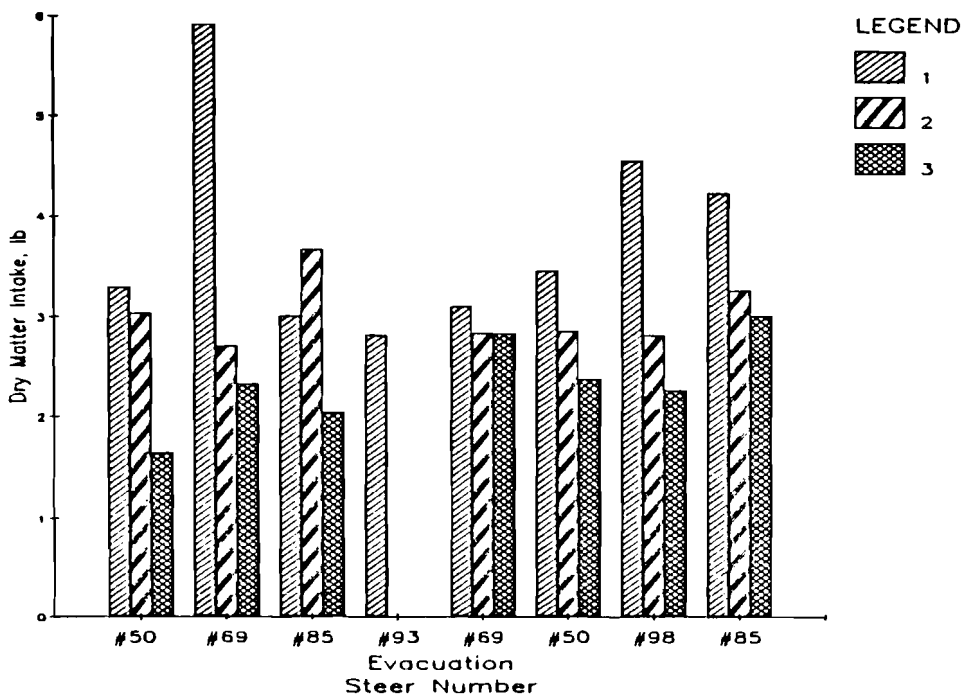

Figure 5. Meal size following rumen evacuation.

In these demonstrations, a single rumen evacuation appeared to result in anxious, hungry behavior and elevated feed intakes in yearling steers. This implies a possible loss in selectivity when this technique is applied in the sampling of mixed specie pastures. Further, there was a depression in intake following the third rumen evacuation cycle from which it may require at least 7 days to recover.

The comparison of the quantity of dry matter recovered from the rumen in relation to the dry matter missing from the feed bunk after the second evacuation of the cycle was highly variable. Ruminal dry matter recovery ranged from 55.76 to 92.75%. The overall mean of 70.50% (SE=10.01) was substantially lower than expected. The evacuation cycles were completed within 4 to 5 hours and it was anticipated that there would be virtually no flow of dry matter from the rumen during this period of time. The most obvious factor contributing to the discrepancy between amount missing from the feed bunk and that recovered in the rumen would be that which the animal spills from the feeder while eating. Two other factors may be involved as well. The hay was extremely dusty and both organic as well inorganic fines may have passed through the rumen with the liquid faction more rapidly than expected. In addition, the supplement was not pelleted and contained readily soluble and degradable constituents which may also have passed through the rumen rapidly. It seems reasonable that these three factors could account for the 25 to 30% loss in recovery rate under these circumstances. A shorter evacuation cycle and freeze-drying of the total rumen contents rather than straining the liquid faction of the rumen contents may have increased the rumen recovery rate. Recovery from the rumen was not correlated with feed bunk disappearance ($P>.88$). In a grazing situation, rate of recovery may be higher because the forage would be relatively free of fines and no supplements would be fed during the collection period. At this time, no explanations are apparent for either the extremely high or low recovery rates encountered.

Conclusions

Total rumen evacuation techniques have potential for the sampling of forage in grazing situations. Even under severe evacuation regimens, including repeated total evacuation and rinsing of the rumen, no detrimental effects were evident following a 1 to 2-week recovery period. Over the evacuation period, daily feed intake was depressed with consecutive evacuation, although any individual evacuation had a tendency to stimulate intake in comparison to previous (control) intake. The intake during the first and second evacuation cycles was normal or slightly above normal. Our observations suggest that the practical limit to frequency of evacuation is two evacuations, preferably separated by 1 day and followed by a 12-day recovery period. Animal behavior following evacuation may imply an initial loss of selectivity.

The highly variable rate of recovery from the rumen limits the value of the rumen evacuation technique in quantitative sampling, at least with the type of feedstuffs used in this trial. The potential for qualitative sampling (for example, the sampling of protein or fiber) still needs to be evaluated.