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Effects of Feed Intake Variation on Acidosis and Performance of Finishing Steers

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Intake variation of 4 lb/day did not increase acidosis or decrease performance of finishing steers fed at ad libitum levels of intake. However, intake variation may increase acidosis of limit-fed steers.

Summary

Four metabolism and two finishing trials were conducted to determine the effects of imposed feed intake variation on acidosis and performance of finishing steers. In metabolism trials, intake variation of 3 lb DM/day increased acidosis of limit-fed steers as measured by ruminal pH. However, when steers were fed at ad libitum levels of intake, intake variation of up to 4 lb DM/day did not increase acidosis. In finishing trials, imposed intake variation of 4 lb DM/day neither decreased daily gain nor feed efficiency of steers fed at ad libitum levels of intake.

Introduction

Feed intake variation by cattle fed high-concentrate diets is presumed by most nutritionists and feedlot managers to either predispose or cause digestive disturbances such as acidosis. Despite this commonly held belief, relatively few data are available to evaluate effects of feed intake variation on acidosis and cattle performance. Feed intake variation has also been described as a sign, not necessarily a cause, of subacute acidosis. However, intake variation does not always have a strong negative correlation to cattle performance. Therefore, the cause and effect nature of intake variation and acidosis is unclear. Objectives of these trials were to evaluate the effects of imposed feed intake variation on acidosis and performance of finishing steers.

Materials and Methods

Metabolism Trials.

Four metabolism trials were conducted to determine the effects of

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imposed feed intake variation on acidosis of finishing steers. In Metabolism Trials 1 and 2, four ruminally fistulated steers were used in switchback designs with three 6-day periods. Steers were paired by previous ad libitum intake level and assigned an intake level, within pair, so that the steers averaged approximately 80% of ad libitum intake. In Metabolism Trial 1, treatments consisted of: constant amount of feed given per day (C); and daily feed intake variation of 1.5 lb/day (LV). In Metabolism Trial 2, treatments consisted of: constant amount of feed given per day (C), and daily feed intake variation of 3 lb/day (HV). In Metabolism Trial 3, the same four ruminally fistulated steers from Trials 1 and 2 were fed at ad libitum levels and subjected to three levels of feed intake variation: ad libitum intake with no imposed feed intake variation (AL); daily feed intake variation of 1.5 lb/day (LV); and daily feed intake variation of 3 lb/day (HV). Treatments LV and HV were based on each steer's individual AL intake. Treatments AL, LV and HV were applied to all steers in the 6-day periods of 1, 2 and 3, respectively. In Metabolism Trials 1, 2 and 3, steers were fed a 90% concentrate diet once daily consisting of (DM basis) 78.5% dry-rolled corn, 10% alfalfa hay, 7.8% molasses-urea supplement and 3.7% dry supplement. Rumensin was included in the diets at 25 g/ton.

In Metabolism Trial 4, six ruminally fistulated steers were utilized in a split-plot, crossover design with a 2x3 factorial treatment structure. Treatments consisted of three levels of imposed intake variation: ad libitum intake with no imposed intake variation (AL); daily feed intake variation of 2 lb/day (LV); and daily feed intake variation of 4 lb/day (HV). Treatments LV and HV were based on each individual steer's AL intake. Treatments AL, LV and HV were applied to all steers in periods 1, 2 and 3, respectively. During these periods, steers were assigned randomly to one of two dietary treatments, with or without Rumensin at 25 g/ton. Following period 3, Rumensin treatments were switched, with the three steers receiving Rumensin being assigned to the control diet and the three steers receiving the control diet being assigned to the Rumensin treatment. Following a 15-day wash-out period, treatments AL, LV and HV were then again applied to all steers in periods 4, 5 and 6, respectively. Steers were fed once daily a 92.5% concentrate diet consisting of (DM basis) 81.9% dry-rolled corn, 7.5% alfalfa hay, 6.4% molasses-urea supplement and 4.2% dry supplement.

In metabolism trials, steers were tethered in individual metabolism stalls. Individual feed bunks were suspended from load cells and monitored continuously. Ruminal pH also was monitored continuously with submersible pH electrodes suspended through the plug of the ruminal cannula of each steer. Each electrode was encased in a weighted four-wire metal shroud to keep the electrode in a stationary position approximately 5 inches above the ventral floor of the rumen, while allowing rumen contents to flow freely through it. Load cells and pH electrodes were linked directly to a computer, allowing data acquisition software to record both a feed weight and ruminal pH for each steer every minute during the six-day collection periods.

Finishing Trials.

Two finishing trials were conducted to evaluate the effect of imposed feed intake variation on performance of finishing steers. In Finishing Trial 1, 75 crossbred yearling steers (average initial weight = 620 lb) were blocked by weight and assigned randomly to one of two treatments (4 replications per treatment). Treatments consisted of two levels of imposed feed intake variation: ad libitum with no imposed feed intake variation (AL); or daily intake variation of 4 lb/day (HV). The finishing diet contained (DM basis) 51.7% dry-rolled corn, 35% high moisture corn, 5% alfalfa hay, 3.3 % corn silage and 5% dry supplement. Rumensin was included in the diet at 25 g/ton and Tylan at 10 g/ton. Steers were implanted with Revalor-S and fed for 140 days.

In Finishing Trial 2, 94 crossbred yearling steers (average initial weight = 656 lb) were assigned randomly to one of 12 pens. Pens were allotted randomly to one of two dietary treatments and to one of two levels of intake variation. Dietary treatments consisted of either control diet balanced for typical commercial feedlot CP and P levels or a diet balanced to match MP and P requirements using the NRC model (1996). The control diet contained (DM basis) 81.3% dry-rolled corn, 7.5% alfalfa hay, 6.7% molasses-urea supplement and 5% dry supplement. The balanced diet contained (DM basis) 64.5% high moisture corn, 20.1% corn bran, 7.5% alfalfa hay, 5% dry supplement and 2.9% tallow. In both diets, Rumensin was included at 25 g/ton and Tylan at 10 g/ton. Steers were fed for 147 days and were implanted with Revalor-S at the beginning, and again after 80 days on feed. Levels of intake variation consisted of ad libitum intake with no imposed feed intake variation (AL) or daily feed intake variation of 4 lb/day (HV). Dietary treatments were part of a separate trial with different objectives. Therefore, the only level of intake variation means presented are those which did not have a significant interaction ($P > .10$).

In both finishing trials, steers on the HV treatment were fed ad libitum from day 1 through day 34. Then, based on each pen's average DMI from day 28 through day 34, each pen was subjected to imposed feed intake variation of 4 lb/day from day 35 through slaughter (140 and 147 days on feed for Finishing Trials 1 and 2, respectively). This was accomplished by first decreasing the feed offered by 2 lb from each pen's average DMI on day 36. Feed offered was increased by 4 lb on day 37, decreased by 4 lb on day 38, increased by 4 lb on day 39 and so on. In order to maintain the average amount of feed offered at ad libitum levels, a 1 lb/day adjustment factor was used. For example, if feed remained in the bunk on the morning following a low-level offering day (-4 lb), only 3 lbs was offered, decreasing the average feed offered to the steers by 1 lb. On the other hand, if a bunk was slick on the morning following a high-level offering day,

Table 1. Effects of imposed low intake variation on limit-fed steers in Metabolism Trial 1.

	Treatment		
Item	Constant[a]	Low intake variation[b]	SEM
Daily DMI, lb	17.9	17.4	2.2
Rate of intake, %/h	53.4	67.0	31.2
Average ruminal pH	5.95	5.85	.26
Area of ruminal pH below 5.6[c]	97.7	151.7	63.7

[a]Constant amount of feed offered per day at approximately 80% of ad libitum intake.
[b]Daily intake variation of 1.5 lb/day based on the level of feed offered in the Constant treatment.
[c]Area = magnitude of ruminal pH below 5.6 by min.

Table 2. Effects of imposed high intake variation on limit-fed steers in Metabolism Trial 2.

	Treatment		
Item	Constant[a]	High intake variation[b]	SEM
Daily DMI, lb	18.1	18.1	2.0
Rate of intake, %/h	46.0	70.7	22.6
Average ruminal pH	5.84	5.82	.23
Area of ruminal pH below 5.6[cd]	106.2	180.9	83.7

[a]Constant amount of feed offered per day at approximately 80% of ad libitum intake.
[b]Daily intake variation of 3 lb/day based on the level of feed offered in the Constant treatment.
[c]Area = magnitude of ruminal pH below 5.6 by min.
[d]Means differ (P<.05).

Table 3. Effects of imposed intake variation on steers fed at ad libitum levels in Metabolism Trial 3.

	Treatment			
Item	Ad libitum[a]	Low variation[b]	High variation[c]	SEM
Daily DMI, lb	21.8	21.6	21.9	4.2
Rate of intake, %/h	22.2	25.6	24.5	4.1
Average ruminal pH	5.63	5.63	5.67	.17
Area of ruminal pH below 5.6[d]	227.4	187.0	180.0	87.0

[a]Ad libitum intake with no imposed intake variation.
[b]Daily intake variation of 1.5 lb/day based on the level of feed offered in the Ad libitum treatment.
[c]Daily intake variation of 3 lb/day based on the level of feed offered in the Ad libitum treatment.
[d]Area = magnitude of ruminal pH below 5.6 by min.

Table 4. Effects of imposed intake variation on steers fed at ad libitum levels in Metabolism Trial 4.

	Treatment			
Item	Ad libitum[a]	Low variation[b]	High variation[c]	SEM
Daily DMI, lb	28.8	27.9	27.9	2.2
Rate of intake, %/h	31.4	37.9	35.9	6.3
Average ruminal pH[d]	5.55	5.68	5.76	.07
Area of ruminal pH below 5.6[de]	215.8	154.1	94.7	52.6

[a]Ad libitum intake with no imposed intake variation.
[b]Daily intake variation of 2 lb/day based on the level of feed offered in the Ad libitum treatment.
[c]Daily intake variation of 4 lb/day based on the level of feed offered in the Ad libitum treatment.
[d]Linear (P<.05).
[e]Area = magnitude of ruminal pH below 5.6 by min.

(+4 lb), the amount offered only decreased by 3 lb, increasing the average feed offered to the steers by 1 lb. By using this system, feed intake variation could be imposed on individual pens based on individual ad libitum intakes.

Results

Metabolism Trials.

In Metabolism Trial 1, no significant differences in DMI, rate of intake, average ruminal pH or area of ruminal pH below 5.6 (P>.10) were noted between treatments of C or LV of 1.5 lb/day (Table 1). In Metabolism Trial 2, no significant differences in DMI, rate of intake and average ruminal pH (P>.10) were noted between treatments of C and HV of 3 lb/day (Table 2). However, area of ruminal pH below 5.6 was increased (P<.05) by 75 units (magnitude of pH below 5.6 by min) in the HV treatment compared with C.

Results of Metabolism Trial 1 indicate daily intake variation of 1.5 lb/day does not significantly alter measures of intake or acidosis within a limit-feeding system. However, there were numerical trends for increased rate of intake and area of ruminal pH below 5.6 and decreased average ruminal pH with the LV treatment compared with C. Results of Metabolism Trial 2 indicate intake variation of 3 lb/day increased acidosis in steers as measured by the area of ruminal pH below 5.6, within a limit-feeding system. In addition, rate of intake numerically increased with the HV treatment, although not significantly. Although Metabolism Trials 1 and 2 were separate, they were consecutive and utilized the same steers. Therefore, these two trials indicate that there may be a linear response of increased acidosis with increasing levels of imposed feed intake variation within a limit-feeding system. Note, though, that average ruminal pH would not have provided the same conclusions as it was not significantly affected in either trial. Because area of ruminal pH below 5.6 should provide a more accurate measure of acidosis, conclusions were based on this parameter.

In Metabolism Trial 3, with the treatments of AL, LV of 1.5 lb/day and HV of 3 lb/day, no differences in DMI, rate of intake, average ruminal pH or area of ruminal pH below 5.6 (P>.10) were noted (Table 3). However, although not significant (P=.28, AL versus HV), area of ruminal pH below 5.6 numerically decreased as level of intake variation increased. The same steers, fed under the same general conditions, responded differently to imposed intake variation

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when fed at ad libitum levels of intake compared with being limit-fed.

In Metabolism Trial 4, with the treatments of AL, LV of 2 lb/day and HV of 4 lb/day, DMI was not affected by level of intake variation and averaged 28.2 lb/day (Table 4). Rate of intake tended (*P*=.13) to increase for both LV and HV compared with AL; but the LV and HV treatments did not differ. Average ruminal pH increased linearly (*P*<.01) across the treatments of AL (0), 2 and 4 lb/day of imposed intake variation, and area of ruminal pH below 5.6 decreased linearly (*P*<.05) as level of intake variation increased. Both measurements indicate a reduction in acidosis as the level of intake variation was increased.

The results of Metabolism Trials 3 and 4 suggest steers fed at ad libitum levels of intake do not experience increased acidosis with imposed intake variation of up to 4 lb/day. In fact, the results support a reduced incidence of acidosis with increased level of intake variation. This, however, is difficult to explain. One explanation might be that when the steers were subjected to intake variation, days of reduced feed allowed the steers to build buffer capacity or base-excess, so acidosis was not induced even with over-consumption the following day. However, this is speculation. Further work with rumen and blood metabolites is needed in this area. One thing is clear: steers fed at ad libitum levels under these trial conditions did not experience more acidosis with increased intake variation.

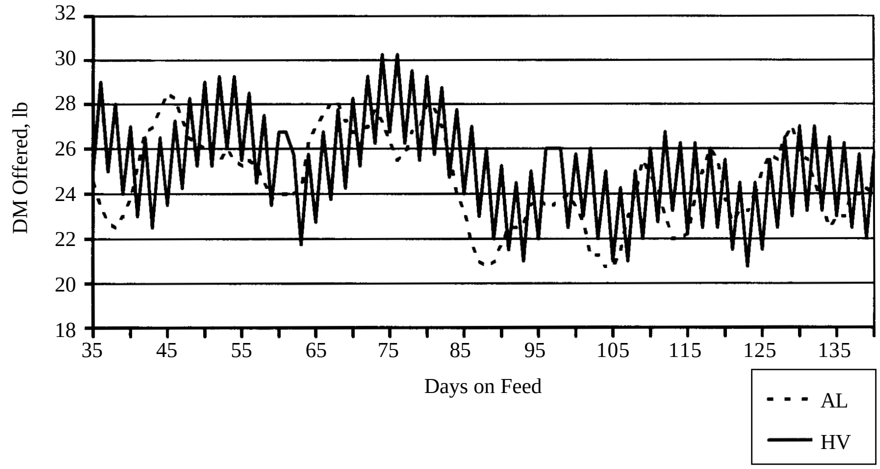

Figure 1. Dry matter offered during Feedlot Trial 1.

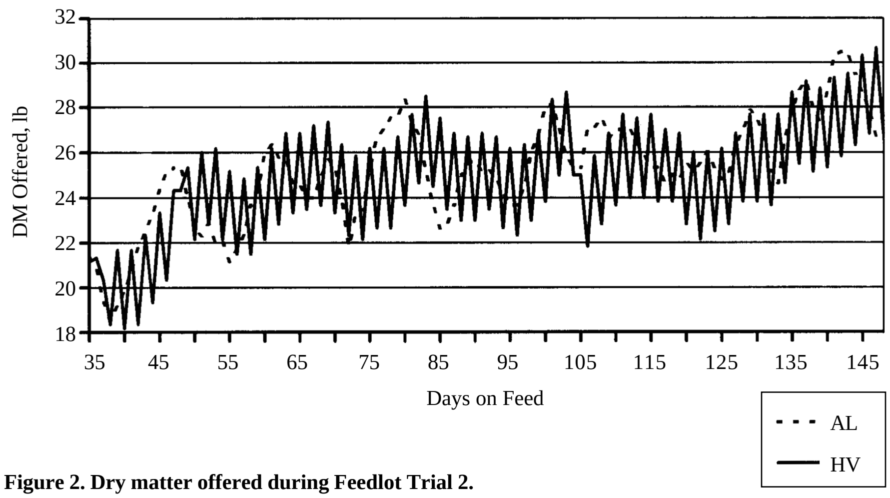

Figure 2. Dry matter offered during Feedlot Trial 2.

Finishing Trials.

Dry matter offered to pens of cattle in Finishing Trials 1 and 2 are shown in Figures 1 and 2, respectively. In these figures, DM offered is averaged by level of intake variation for day 35 through slaughter. Although these figures depict feed offered, actual DMI should be similar as the daily amount offered was adjusted so feed would not accumulate in the bunk. The overall pattern of DMI was very similar between levels of intake variation for both trials. However, there was a much higher degree of day-to-day intake variation in the pens on the HV treatments, predictable due to the imposed intake variation of 4 lb/day. In both finishing trials, the average absolute daily change in amount of DM offered was 1 lb/day for AL and 3 lb/day for HV. It is important to note DMI was not constant for pens on the AL treatment, where the daily amount of feed offered was adjusted in order to avoid both feed accumulation and an empty bunk.

In Finishing Trial 1, overall DMI was higher (*P*<.05) in the HV treatment compared with the AL treatment (Table 5). However, due to intake variation, no differences in daily gain or feed efficiency (*P*>.10) were noted.

In Finishing Trial 2, there were no interactions (*P*>.10) between dietary treatment and imposed intake variation. Therefore, only the overall means for intake variation are presented (Table 6). No differences in DMI, daily gain or feed efficiency were noted due to intake variation.

The results of Metabolism Trials 3 and 4 and Finishing Trials 1 and 2 indicate imposed intake variation of up to 4 lb/day neither increased acidosis nor decreased performance of finishing steers fed at ad libitum levels of intake. However, results of Metabolism Trials 1 and 2 indicate intake variation in a limit-feeding system may increase the incidence of subacute acidosis.

It is important to note the intake variation in these trials was imposed and "consistent". Steers may have

Table 5. Effects of imposed intake variation on performance of steers fed at ad libitum levels in Finishing Trial 1

	Treatment		
Item	Ad libitum[a]	Intake variation[b]	SEM
Daily DMI, lb[c]	23.7	24.1	.1
Daily gain, lb	3.75	3.84	.06
Gain/DMI	.159	.159	.003

[a]Ad libitum feed offered with no imposed intake variation.
[b]Daily intake variation of 4 lb/day from days 35 through slaughter.
[c]Means differ (P<.05).

Table 6. Effects of imposed intake variation on performance of steers fed at ad libitum levels in Finishing Trial 2

	Treatment		
Item	Ad libitum[a]	Intake variation[b]	SEM
Daily DMI, lb	24.5	24.3	.2
Daily gain, lb	4.06	3.96	.05
Gain/DMI	.165	.163	.003

[a]Ad libitum feed offered with no imposed intake variation.
[b]Daily intake variation of 4 lb/day from days 35 through slaughter.

adapted to the routine of imposed changes and therefore were less affected. On the other hand, random occurrences of intake variation, such as a weather change or mill breakdown, may increase the incidence of acidosis. These data suggest that finishing cattle can naturally vary their intake (up to 4 lb/day and maybe more) without creating acidosis or reduced performance.

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