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Summary

Nine ruminally fistulated steers were used in a metabolism experiment to evaluate the effect of a new direct-fed microbial (DFM) on acidosis. No statistical differences were observed in dry matter intake (DMI). Minimum pH was significantly lower in steers fed the DFM during grain adaptation, resulting in a greater change in ruminal pH and pH variance for steers fed DFM during grain adaptation. However, once steers were on the finishing diet, no differences were detected due to treatment.

Introduction

Roughages such as alfalfa and corn silage have traditionally been utilized to aid in the control of acidosis; however, direct-fed microbial products have been utilized more recently. By definition, direct-fed microbial products must contain a viable microorganism commonly used during periods of high stress when acidosis is frequent. In addition, it has been shown that acidosis is reduced when wet corn gluten is fed, but acidosis still remains an issue when wet distillers grains are fed.

Methodology that combined simultaneous measurement of feed consumption and ruminal pH (via probes placed through the fistula) has enhanced acidosis research. However, cattle are required to be restrained throughout this process and measured for short windows of time (i.e., periods of 5 days); therefore, pH probes that allow for free movement of animals would be advantageous.

The objectives of this research were to: 1) determine the efficacy of a DFM specifically selected to reduce acidosis in diets containing wet distillers grains, and 2) validate the accuracy of self-contained pH probes.

Procedure

Nine ruminally fistulated crossbred steer calves (initial BW = 810 lb) were assigned randomly to one of two treatments in a simple two period cross-over design. Cattle were fed the same diet with the exception of the dietary treatments. Steers received either the DFM (5×10^9 colony-forming units in 0.5 g /day of maltodextrin carrier; +DFM) or a placebo (0.5 g of maltodextrin carrier; CON) in a powder form, which were top-dressed to the diet daily. The active microorganism in this DFM is *Bacillus pumilus* strain 8G134. The grain adaptation phase of the experiment was composed of four 7-day steps (days 1 to 28) and the finishing phase was from day 29 to day 120. Treatments were applied during grain adaptation and through day 75 of the experiment. At that time, dietary treatments were switched for the remaining 45 days of the trial. Table 1 provides diet composition fed throughout the trial.

Steers were individually housed in free box stalls from day 1 to 44, day 50 to 98, and day 104 to 120. Diets were fed in individual feed bunks suspended from load cells. Constant data acquisition of feed disappearance was obtained through use of computer software connected to the feed bunks. Feed weight in each bunk was recorded once every minute and continuously stored for each steer throughout the day. Bunks were read once daily at 0700 and feed offerings were adjusted accordingly for feeding at 0730. All feed refusals were weighed to accurately measure DMI. Measurements included DMI, number of meals per day, time spent eating per day and average meal size.

Self-contained (wireless) pH probes were placed into the rumen of each steer throughout the entire trial. Each probe contained a data logger, 9-volt battery, and an electrode cable housed in a watertight capsule constructed out of PVC material. Each pH electrode was enclosed in a weighted, PVC material cover that maintained the electrode in the ventral sac of the rumen. Ruminal pH was recorded once every minute continuously for seven days. At that time each probe

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Table 1. Diet composition of metabolism steers fed DFM (% of diet DM).

Ingredient	Step 1	Step 2	Step 3	Step 4	Finisher
High-moisture corn	20	30	40	50	57.5
WDGS	30	30	30	30	30
Alfalfa hay	45	35	25	15	7.5
Supplement	5	5	5	5	5

Table 2. Effect of DFM and placebo on feed intake and intake behavior.

	Grain Adaptation Phase[1]			Finishing Phase[2]		
Item	+ DFM	CON	*P*-value	+ DFM	CON	*P*-value
DMI, lb	20.2	19.6	0.85	24.7	24.5	0.92
Meals/day, n	4.61	4.94	0.56	6.00	5.68	0.41
Time eating/day, min	602.6	708.8	0.27	785.2	776.7	0.89
DMI/meals, lb	5.47	5.27	0.84	4.44	4.87	0.38

[1]Grain adaptation phase: days 1-28.
[2]Finishing phase: days 29-120.

Table 3. Effect of DFM and placebo on ruminal pH.

	Grain Adaptation Phase[1]			Finishing Phase[2]		
Item	+ DFM	CON	*P*-value	+ DFM	CON	*P*-value
Average pH	5.49	5.61	0.47	5.49	5.49	0.92
Minimum pH	4.98	5.18	0.15	4.99	4.99	0.99
Maximum pH	6.29	6.21	0.59	6.41	6.36	0.65
pH change	1.37	1.07	0.02	1.42	1.36	0.61
pH variance	0.139	0.066	0.01	0.117	0.111	0.80
Time < 5.6, min	842.0	768.1	0.67	926.7	944.4	0.87
Area < 5.6	395.8	272.7	0.35	349.9	332.8	0.81
Time < 5.3, min	648.6	503.6	0.52	581.5	542.7	0.74
Area < 5.3	209.7	108.4	0.29	121.5	109.1	0.73
Time < 5.0, min	387.6	242.4	0.43	188.7	176.4	0.84
Area < 5.0	91.2	28.8	0.29	19.3	17.7	0.88

[1]Grain adaptation phase: days 1-28.
[2]Finishing phase: days 29-120.

Table 4. Comparison of two pH measurement methods.

Item	Conventional probe	Wireless probe	*P*-value
Period 1[1]	5.49	5.30	0.09
Period 2[2]	5.43	5.51	0.45
Overall[3]	5.46	5.41	0.64

[1]Period 1: days 45 – 49 of finishing phase.
[2]Period 2: days 99 – 103 of finishing phase.
[3]Significant interaction between method and each 5-day period ($P < 0.01$).

Table 5. Effect of DFM on comparison of two pH measurement methods.

Method	+ DFM	CON	*P*-value
Conventional probe	5.45	5.47	0.11
Wireless probe	5.42	5.40	0.13
Overall[1]	5.43	5.43	0.97

[1]Significant interaction between method and diet treatment ($P < 0.03$).

was briefly removed from the rumen, pH data were downloaded, pH electrodes were recalibrated, and then each self-contained pH probe was reinserted into the rumen. Ruminal pH measurements included average, minimum and maximum pH; pH change and variance; and time and area below pH 5.6, 5.3 and 5.0.

Simultaneous ruminal pH collection was necessary to effectively evaluate pH measurement systems. Therefore, in the evening of day 44 and day 98, steers were moved and secured to individual metabolism stanchions and were allowed to adjust to stanchions overnight. Cattle were in stanchions for two 5-day periods (days 45- 49 and days 99-103). Feed intake measurements while steers were in stanchions were identical to those taken when steers were in box stalls. At day 45 and day 99, submersible (conventional) pH electrodes were placed through the fistula into the rumen of each steer and remained in place through the morning of day 49 and day 103, respectively. Each pH electrode was enclosed in a weighted, four-wire metal cover to keep the electrode in a fixed suspended position approximately 4-6 in above the ventral wall of the rumen. Electrodes were linked directly to a computer equipped with data acquisition software to record ruminal pH every six seconds and average ruminal pH every minute throughout the pH data collection phase. At day 49 and day 103, the ruminal pH electrodes were removed and steers were returned to their individual free box stalls. Ruminal pH measurements were the same as those recorded with the self-contained probes.

Data were analyzed by day within period as a repeated measure using the MIXED procedure of SAS. Fixed model effects were period, treatment and period x treatment interaction. Animal nested within treatment was considered a random effect. A protected F-test was used during analyses where numbers represent *P*-value for variation due to dietary treatment or pH measurement method.

Results

Two steers were removed from the trial for approximately three weeks during the finishing phase while on the DFM treatment due to severe acidosis (DMI < 15 lb). These intake data were removed from the analyses of the experiment; however, pH data remained in the analyses.

Intake Behavior

Effects of the DFM on DMI and feeding behavior are presented in Table 2. No significant effects due to the DFM were observed on either DMI or intake behavior. Numerically, however, DMI was greater during both the grain adaptation and finishing periods when steers were fed the DFM. Despite this, we would expect DMI to be lower during finishing without removal of the two acidotic steers. Interestingly, when steers were fed the DFM, meals per day were numerically lower during grain adaptation, but numerically higher during finishing. Likewise, time spent eating per day was numerically lower during grain adaptation and numerically higher during finishing when steers were fed the DFM. In addition, DMI per meal was numerically greater for steers fed DFM during grain adaptation, but numerically lower when they were on the finishing diet.

Ruminal pH

Effect of the DFM on ruminal pH is presented in Table 3. Minimum pH tended to be lower ($P = 0.15$) in steers fed the DFM during the adaptation phase, resulting in a greater change in ruminal pH ($P = 0.02$) and greater

pH variance ($P < 0.01$) for steers fed DFM during grain adaptation. No significant differences were observed between DFM and CON once the cattle were on the finishing diet. Despite this, both pH change and variance were numerically greater for steers fed DFM. Although no significant results were found for time and area below differing pH levels, numerically intriguing trends were observed. Time and area below pH 5.6, 5.3 and 5.0 were all numerically higher when steers were fed the DFM throughout the entire trial, with the exception of time below pH 5.6 during finishing. These data suggest that feeding this specific DFM did not positively impact ruminal pH as hypothesized.

Method Comparison

Table 4 provides a summary of the comparison between the conventional probes and the wireless probes. An interaction ($P < 0.01$) between method of pH measurement and each 5-day period in stanchions was observed. The average pH varied from 5.30 to 5.51 between method and period. Interestingly, pH measurement of the wireless probe was lower during the first 5-day period and numerically greater during the second 5-day period.

Effects of DFM using each method is presented in Table 5. A method × diet treatment interaction ($P < 0.03$) was found. The average pH variation was slightly less, ranging from 5.40 to 5.47 between method and diet treatment. However, pH tended to be higher ($P = 0.11$) for the conventional probe system while steers were fed the placebo (CON). Conversely, pH tended to be higher ($P = 0.13$) for the wireless probes when steers were fed the DFM. Due to the small differences, we conclude there is no difference between the methods for measuring pH continuously.

In summary, DMI and eating behavior were not impacted by the addition of the DFM to the diet. Minimum ruminal pH was lower, with greater change and variance in pH observed during grain adaptation for steers fed the DFM. Direct-fed microbials are occasionally added to feedlot rations to reduce acidosis and increase feed efficiency. These data indicate, however, that the inclusion of this new DFM does not aid in control of acidosis. Likewise, two steers were removed due to acidosis and both were on the DFM treatment at the time.

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