Evaluation of Encapsulated *Megasphaera Elsdenii* in an Accelerated Beef Step-Up Program and an Acidosis Challenge Event

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Summary with Implications

A 100-day metabolism study with 40 ruminally cannulated steers, individually fed, was conducted to determine the effects of daily feeding of encapsulated Megasphaera elsdenii along with a one-time dose of Lactipro NXT on dry matter intake, rumen organic acid concentration, lactate disappearance and native and specific strains of Megasphaera elsdenii concentration following an acidosis challenge. Steers fed Megasphaera elsdenii daily had greater intake after an acidosis event. Cattle fed daily Megasphaera elsdenii also had a faster rate of lactic acid disappearance after an acidosis event. Feeding Megasphaera elsdenii daily may result in a faster recovery time, after an acidosis event, compared to a one-time drench of Megasphaera elsdenii.

Introduction

Streptococcus bovis is a gram-positive bacterium that produces lactic acid, which causes a drop in ruminal pH below 4.8, the PKA of a volatile fatty acid (e.g. the pH at which a weak acid buffers). When cattle that are not adequately adapted to a high starch diet there can be an accumulation of lactic acid causing severe acidosis. In some animals, a single incident of ruminal acidosis has negative impacts throughout the entire finishing period, resulting in low feed intake and poor performance. Therefore, minimizing acidosis is important, especially during diet adaptation when acidosis is most prevalent. Traditionally, ruminants in the feedlot are stepped up gradually (3–4 weeks) from a high-forage to a high concentrate diet (HCD). A gradual increase of a HCD minimizes the accumulation of lactate in the rumen. In adequately adapted cattle the ruminal pH does not decrease below the ability of *Megasphaera elsdenii (M. elsdenii)* to convert lactic acid to volatile fatty acids. *Megasphaera elsdenii* is a lactate utilizing bacteria that has the potential to mitigate acidosis during the transition of feedlot cattle from a high-forage diet to HCD. The objective of this study was to evaluate the effects of a single LactiproNXT *(M. elsdenii)* drench or a LactiproNXT drench plus daily feeding of encapsulated *M. esldenii* at different rates during an accelerated step-up diet and following an acidosis challenge event.

Table 1. Dietary composition (% of DM) from step 1 diet through the finishing diet for all treatments

Ingredient	Step 1	Step 2	Step 3	Finisher
Steam-flaked Corn	37	52	62	70
MDGS	18	18	18	18
Alfalfa Hay	40	25	15	7
Supplement[1]				
Fine Ground Corn	2.202	2.202	2.202	2.202
Limestone	1.680	1.680	1.680	1.680
Urea	0.600	0.600	0.600	0.600
Salt	0.300	0.300	0.300	0.300
Tallow	0.125	0.125	0.125	0.125
Beef Trace Premix	0.050	0.050	0.050	0.050
Rumensin- 90 Premix[2]	0.165	0.165	0.165	0.165
Vitamin A-D-E	0.015	0.015	0.015	0.015
Tylan- 40 Premix[3]	0.011	0.011	0.011	0.011
Mcals,NEg/d	61.20	68.50	73.40	77.40

[1] Supplement fed at 5% of dietary DM for all treatments

[2] Supplement formulated to provide 30g/ton of Rumensin ® (Elanco Animal Health, DM Basis)

[3] Supplement formulated to provide 8.8g/ton of Tylan ® (Elanco Animal Health, DM Basis)

Procedure

A metabolism study conducted at the University of Nebraska—Lincoln Eastern Nebraska Research and Extension Center near Mead, NE, used 40 ruminally cannulated crossbred yearling steers [initial body weight (BW) = 958 ± 83.5 lb] Steers were sorted into two BW blocks, stratified by BW within block, and assigned randomly to one of five treatments (8 steers per treatment). Ground smooth bromegrass hay was offered at 2% of BW two weeks prior to experiment initiation to simulate steers received from pasture and to equilibrate gut fill to determine accurate initial BW.

Treatments consisted of control (Con) steers which were fed no *M. elsdenii* and stepped onto the finishing ration over 19 days. LactiproNXT (Drench) steers were drenched with the commercial dose of LactiproNXT on d 1 of the experiment and received no other *M. elsdenii*. LactiproNXT+10^6 (Low) steers were drenched with the commercial dose of LactiproNXT on d 1 of the experiment and received 1×10^6 CFU of encapsulated *M. elsdenii* daily throughout the experiment. LactiproNXT+10^7 (Medium) steers were

Table 2. Dry matter intake (as pounds)

	Treatments						*P*-value			
Item	Control	Drench	Low	Medium	High	SEM	Control vs Mega E	Drench vs Daily	Linear	Quadratic
Step-up DMI, lb[1]	21.1	20.8	20.9	20.8	20.3	0.60	0.51	0.84	0.70	0.45
Step-up DMI, Mcals Neg/d[2]	15.3	15.4	16.3	15.1	15.4	0.5	0.12	0.32	0.42	0.42
Finishing period DMI, lb[3]	28.9	26.7	27.9	28.2	27.6	1.2	0.36	0.48	0.69	0.16
Challenge DMI, lb[4]	45.4	43.6	47.4	46	48.1	3.0	0.76	0.30	0.30	0.99
Recovery DMI, lb[5]	22.9	19.4	26.5	23.7	23.9	2.5	0.85	0.07	0.11	0.26
Recovery DMI, % of pre-challenge intake[6]	78.3	68.8	88.7	83.2	86.9	7.7	0.64	0.05	0.06	0.57

[1] DMI for d 1–19

[2] DMI for d 1–19 expressed as Mcals of net energy for gain per day

[3] DMI for d 20–88

[4] DMI for d 90

[5] DMI for d 91, 92, and 93

[6] Recovery DMI, % of pre-challenge intake, is expressed as % of the average intake of the 9 days immediately prior to challenge

Table 3. Disappearance of Lactate over time from rumen fluid collected on d 88

	Treatments					*P*-value		
Incubation time, h	Control	Drench	Low	Medium	High	Treatment	Hour	Treatment x Hour
0	3.30[1]	3.34	3.26	3.24	3.27	0.13	<0.01	0.18
12	2.85[a]	2.94[a]	2.21[b]	1.85[b]	1.97[b]			
24	0	0	0	0	0			

[a,b] Means within a row that lack a common superscript differ (P ≤ 0.05).

[1] Lactate values are reported in mmol of lactate.

Table 4. Disappearance of Lactate over time from rumen fluid collected on d 90, 91, and 92

	Treatments					*P*-value[2]		
Incubation time, h	Control	Drench	Low	Medium	High	Treatment	Hour	Treatment x Hour
0	3.30[1]	3.28	3.29	3.26	3.26	0.14	<0.01	0.01
12	2.31[a]	2.16[ab]	1.88[b]	1.21[c]	1.77[b]			
18	0.23	0.52	0.65	0.30	0.20			

[a,b] Means within a row that lack a common superscript differ (P ≤ 0.05).

[1] Lactate values are reported in mmol of lactate.

[2] The model included day as the repeated measure animal as the subject, and compound symmetry as the covariance structure The Treatment × Day × Hour interaction was tested before selecting the repeated model (*P* = 1.00).

drenched with the commercial dose of LactiproNXT on d 1 of the experiment and received 1×10^7 CFU of encapsulated *M. elsdenii* daily throughout the experiment. LactiproNXT+10^8 (High) steers were drenched with the commercial dose of LactiproNXT on d 1 of the experiment and received 1×10^8 CFU of encapsulated *M. elsdenii* daily throughout the trial. Treatments of Drench, Low, Medium, and High were stepped up to the finishing ration over 9 days. Steers were individually fed for 100 days in the Calan gate system. Diet and supplement composition are shown in Table 1. The diet contained 5% supplement and all supplements were formulated to include 30 g/ton of monensin (Rumensin®, Elanco Animal Health, Greenfield, IN) and 8.8 g/ton of tylosin (Tylan®, Elanco Animal Health). Steers were fed once daily at 0700 h and had ad libitum access to water. The experiment included five continuous phases: step-up period (d 1–19); finishing period (d 20–88); feed restriction (d 89, 24-h full feed restriction); challenge period (d 90, cattle were fed at 150% of max DMI from finishing period); and recovery period (d 91–96). Feed refusals were collected every 3 days during the step-up period, every 7 days during the finishing period, and every day during challenge and recovery periods. Samples were collected at 0600 h and dried in a forced-air oven to correct for dry matter (DM) to determine dry matter intake (DMI). Rumen fluid samples were collected every 3 days in the step-up period, every 7 days in the finishing period, and every day during challenge and recovery periods at 1300 h. During the challenge and recovery periods (d 88, 90, 91, 92), a small tube of rumen fluid collected was retained at room temperature and 0.1 mL of the fluid was

injected into glass tubes containing a lactate culture to estimate lactate disappearance. A total of three tubes per day per animal were injected at 1400 h. Tubes were incubated in a 38°C water bath for either 0, 12, and 24 h for d 88 and for d 90–92 at 0, 12, and 18h, then frozen for analysis of lactate using gas chromatography.

Repeated measures were used within three phases of step-up period (d 1–19), finishing period (d 20–88), and recovery period (d 91–93). However, challenge period (d 90) was not repeated since it was only one day. Data were tested for linear and quadratic effects of dose with drench as the intercept. Data were tested for linear and quadratic effects of time tested and time × treatment interaction tested using covariate regression. The following contrast were reported control vs Lactipro (cattle fed any *Megasphaera elsdenii)* and drench vs daily (low, medium, and high treatments). Proc IML was used to get contrast coefficient for unequal spacing. Statistical significant was declared at $P \leq 0.10$ and a tendency $P \leq 0.15$.

Results

Intake

In the step-up period (d 1–19), there were no significant linear, quadratic, or contrasts between treatments; however, there was a tendency for steers fed M. *elsdenii* to have greater intake of NE_g per day ($P = 0.12$, Table 2) because they were stepped up to the HCD in 9 d vs. 18 d. Throughout the finishing period (d 20–88) and on the challenge day (d 90) there were no significant differences in DMI. However, steers fed *M. elsdenii* daily had greater DMI during recovery period (d 91–93; $P \leq 0.07$), as well as a tendency for a linear increase in DMI with increasing the dose of *M. elsdenii* ($P = 0.11$), primarily due to the low DMI during the recovery period by steers receiving only the drench. When recovery of pre-challenge intake is expressed as a percentage of the average intake of the 9 days immediately prior to challenge, there was a higher % DMI for cattle fed *M. elsdenii* daily compared to the one-time drench ($P \leq 0.05$, Table 2).

Lactic Acid Disappearance

Disappearance of lactic acid was measured on d 88 (pre-challenge), d 90 (challenge day), and d 91–92 (recovery days). On d 88 there was no significant treatment × hour effect, however, there was a significant hour effect ($P < 0.01$, Table 3) and a tendency for a treatment effect ($P \leq 0.13$). There were greater rates of disappearance of lactate for cattle fed *M. elsdenii* daily compared to the one-time drench. On d 90, 91, and 92 there were no effects of treatment × day × hour or treatment day ($P = 1.00$, Table 4). There was an hour ($P < 0.01$) and treatment × hour effect ($P \geq 0.01$).

Conclusion

These results suggest that the one-time LactiproNXT drench does not last up to 90 days in the rumen. Steers fed *Megasphaera elsdenii* 41125 daily, tended to have a greater DMI after the acidosis event occurred. The daily dosed steers consumed more feed sooner after an off-feed event, which suggest that the daily feeding *M. elsdenii* can be beneficial to a feed yard on days where there can be an off-feed event. However, daily feeding of *M. elsdenii* appeared to impact outcomes regardless of the amount that it was fed. When an acidosis event occurs, cattle fed *M. elsdenii* daily, may have greater utilization of lactate, which could contribute to faster intake recovery at the bunk.

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