Synopsis of original *Research Report*

ORAL DOSING OF FEEDLOT CATTLE WITH *Megasphaera elsdenii:*IMPACT ON ADAPTATION TO HIGH-CONCENTRATE DIETS

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# Introduction

Lactic acid, or lactate, is a fermentation product resulting from the partial digestion of starches by some classes of ruminal microorganisms. Accumulation of lactate within the rumen is common among cattle fed diets containing high proportions of grain, and is particularly inclined to occur when grains are initially introduced into the diet of feedlot animals. Introducing *Megasphaera elsdenii* into the gastrointestinal tract in large numbers prior to introduction of grains into the diet may reduce ruminal lactate concentrations, thus alleviating problems with acidosis. This study was conducted to evaluate effects of a single oral dosing of cattle with a stabilized *Megasphaera elsdenii* on consumption of high-grain diets throughout a 95-day period after arrival in the feedlot. The transition from a diet comprised entirely of forage to a final ration consisting of 94% concentrate occurred over a period of 8 or 17 days.

# Experimantal procedures

Hundred and thirty cattle, weighing between 385 to 450 kg, underwent standard feedlot processing and were then fed only legume hay and a mineral-vitamin-salt supplement ad lib for several weeks before the trial. Ten days before the onset of the trial 80 cattle were selected according to their live weight, blocked according to weight and were then randomly allocated to four treatments in a 2x2 factorial design. Treatments were MeCH4 *vs.* Placebo dosing, and 5-step *vs.* 3-step feeding regime. Eighty individual pens (1.6 m x 6.5 m) were randomly allocated to the animals. , but in such a way that MeCH4 and Placebo animals do not share a common water fountain, thus minimizing the opportunity for cross-inoculation of Placebo animals with MeCH4. On Day 1 of the trial, the MeCH4 treatment animals were dosed with 200 ml of MeCH4 (containing 1011 MeCH4). Placebo treatment animals were dosed with an equal volume of the culture media containing no MeCH4. The animals started with their respective diets on the same day (Table 1).

**Table 1.** 5-step and 3-step dietary regime fed to the cattle.

|  |  |  |
| --- | --- | --- |
| **Roughage % in Diet** | **5-Step** | **3-Step** |
| 45 | days 1 to 4 | days 1 to 3 |
| 35 | days 5 to 8 | --- |
| 25 | days 9 to 12 | days 4 to 7 |
| 15 | days 13 to 16 | --- |
| 6 | days 17 to 95 | days 8 to 95 |

The different TMR diets were fed *ad lib* to the animalsonce a day in the individual pens for the first 63 days of the trial. Individual feed intake was measured daily. From Day 64 to 95, animals from the same treatment were put into larger pens, each having 10 animals per pen and were group fed. The compositions of the diets (DM basis) are reported in Table 2.

**Table 2.** Composition of the feedlot diets fed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ingredient % | Step 1 | Step 2 | Step 3 | Step 4 | Final Diet |
| Alfalfa hay | 45 | 35 | 25 | 15 | 6 |
| Steam flaked corn | 41.53 | 54.48 | 63.45 | 72.40 | 80.02 |
| Corn steep liquor | 5 | 5 | 5 | 5 | 5 |
| Tallow | 4 | - | - | - | - |
| Soybean meal | 0.33 | 0.86 | 1.40 | 1.93 | 2.64 |
| Urea | 0.52 | 0.64 | 0.76 | 0.88 | 1.04 |
| Ground limestone | 0.28 | 0.60 | 0.91 | 1.23 | 1.65 |
| Potassium chloride | - | 0.08 | 0.15 | 0.23 | 0.33 |
| Vit & Min premix | 0.40 | 0.40 | 0.39 | 0.39 | 0.38 |
| Rumensin premix | 2.94 | 2.94 | 2.94 | 2.94 | 2.94 |

Animals were weight individually on Day 1, 63 and 95. DMI, DMI variation, average daily gain (ADG), feed conversion ratio (FCR) were determined during the feeding period. Carcass data collected on the date of slaughter included incidence of liver abscess and hot carcass weight. Following a 72-hour chill period, fat thickness over the 12th rib and an intramuscular fat deposition (marbling) was determined. Cattle were observed daily for clinical signs of digestive and metabolic disorders and other diseases daily throughout the feedlot experiment and were treated accordingly.

This study was performed as a randomized complete block using a 2 x 2 factorial arrangement of treatments with 20 observations per treatment. Individual animal constituted the experimental unit, and factors consisted of step-up regimen (3-step vs 5-step) and oral inoculation (MeCH4 vs. Placebo). Data were analyzed using the Generalized Linear Models Procedure of the Statistical Analysis System. Initial weight and pretrial rate of gain were included in the model as covariates. Significant differences were declared at P ≤ 0.10 and tendencies were declared at P ≤ 0.15.

# results and discussion

The effect of MeCH4 treatment on the production parameters are presented in Table 3. Overall, cattle dosed with MeCH4 maintained higher intakes throughout the experiment. During the initial phases of the experiment, intakes of the cattle fed the 3-step regimen were somewhat erratic, as perhaps would be expected. Though there were no significant differences in absolute intakes among cattle in the different treatments, analysis of intake variation indicates that cattle inoculated with MeCH4 maintained more consistent intakes (P=0.07) during the initial 3 days of the experiment compared to cattle given the placebo. This trend toward higher intakes and less variation in intake was maintained throughout the entire study, though the differences were not significant.

**Table 3.** The effect of MeCH4 on the production parameters of feedlot cattle, fed either a 5-step or 3-step diets.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 5-step | |  | 3-step | |  |  | P-value | | |
| Parameter | Placebo | MeCH4 |  | Placebo | MeCH4 |  | s.e.m. | TMT | Diet | Interaction |
| DMI (kg): |  |  |  |  |  |  |  |  |  |  |
| Day 1-3 | 2.87 | 3.46 |  | 2.83 | 4.13 |  | 0.791 | 0.24 | 0.69 | 0.66 |
| Day 1-7 | 4.77 | 5.10 |  | 3.99 | 4.90 |  | 0.662 | 0.35 | 0.46 | 0.66 |
| Day 1-63 | 8.23 | 8.74 |  | 8.40 | 8.41 |  | 0.223 | 0.25 | 0.71 | 0.27 |
|  |  |  |  |  |  |  |  |  |  |  |
| Coefficients of variation |  |  |  |  |  |  |  |  |  |  |
| for feed intake: |  |  |  |  |  |  |  |  |  |  |
| Day 1-3 | 117 | 102 |  | 119 | 84 |  | 14.0 | 0.07 | 0.56 | 0.47 |
| Day 1-7 | 83 | 80 |  | 97 | 94 |  | 12.0 | 0.79 | 0.27 | 0.98 |
| Day 1-63 | 26 | 24 |  | 26 | 26 |  | 2.0 | 0.60 | 0.55 | 0.76 |
|  |  |  |  |  |  |  |  |  |  |  |
| Live weight (kg): |  |  |  |  |  |  |  |  |  |  |
| Day 1 | 408 | 408 |  | 408 | 408 |  | 4.1 | . | . | . |
| Day 63 | 513 | 531 |  | 521 | 521 |  | 5.4 | 0.11 | 0.83 | 0.11 |
| Day 95 | 549 | 552 |  | 535 | 548 |  | 6.6 | 0.20 | 0.18 | 0.46 |
|  |  |  |  |  |  |  |  |  |  |  |
| Average daily gain (kg): |  |  |  |  |  |  |  |  |  |  |
| Day 1-63 | 1.68 | 1.96 |  | 1.80 | 1.80 |  | 0.086 | 0.11 | 0.82 | 0.11 |
| Day 1-95 | 1.49 | 1.52 |  | 1.34 | 1.48 |  | 0.069 | 0.20 | 0.18 | 0.46 |
|  |  |  |  |  |  |  |  |  |  |  |
| Carcass adjusted ADG (kg)a |  |  |  |  |  |  |  |  |  |  |
| Day 1-95 | 1.25 | 1.31 |  | 1.08 | 1.25 |  | 0.073 | 0.09 | 0.12 | 0.47 |
|  |  |  |  |  |  |  |  |  |  |  |
| Kg DM/kg gain, Day 1-63 | 4.82 | 4.53 |  | 4.75 | 4.74 |  | 0.161 | 0.33 | 0.66 | 0.37 |
| Liver abscess (%) | 4.7 | 5.5 |  | 20.1 | 9.7 |  | 6.6 | 0.47 | 0.14 | 0.40 |
| Hot carcass weight (kg) | 334 | 338 |  | 324 | 335 |  | 4.4 | 0.10 | 0.13 | 0.48 |
| Dressing yield (%) | 63.4 | 63.8 |  | 63.1 | 63.6 |  | 0.44 | 0.35 | 0.56 | 0.88 |
| Subcutaneous fat (cm)b | 0.63 | 0.74 |  | 0.64 | 0.57 |  | 0.06 | 0.75 | 0.23 | 0.16 |
| Marbling score | 440 | 467 |  | 453 | 446 |  | 10.3 | 0.37 | 0.70 | 0.11 |

a Final weight was calculated as carcass weight divided by a standardized dressing percentage of 63.5% to account for differences in gastrointestinal tract fill. Average daily gain was then calculated: (adjusted final weight – initial live weight) / days on feed.

b Subcutaneous fat over 12th rib.

Cattle inoculated with MeCH4 had achieved numerically greater body weights and these differences approached significance by day 63 (P=0.11). Likewise, cattle dosed with MeCH4 had more rapid rates of gain by day 63 (P=0.11), particularly when fed the 5-step regimen (Interaction, P=0.11). It is likely that variation in gut fill contributed substantially to the variation in weight gain, thus limiting our ability to discern potentially important differences among treatment groups. When expressed on a carcass adjusted basis using a common dressing percentage, overall weight gain was improved (P=0.09) as a consequence of the single oral dose of MeCH4.

The incidence of liver abscesses among cattle fed the 5-step regimen was relatively low, but consistent with our observations in other studies for cattle fed diets comprised of steam-flaked corn. With the more rigorous step-up regimen, the incidence of liver abscess was increased by 2- to 4-fold, with the largest percentage occurring in cattle dosed with the placebo. Carcass weights increased by 4 to 11 kg (P=0.10) with the single inoculation of MeCH4, and tended (P=0.13) to be greater for cattle fed the 5-step compared to the 3-step regimen. Interestingly, cattle inoculated with MeCH4 and fed the 3-step regimen achieved comparable carcass weights as those fed the traditional step-up program without MeCH4, suggesting that it may be possible to reduce overall roughage use in feedlot diets.

# IMPLICATIONS

Based on these observations, we believe that MeCH4 constitutes a very logical candidate for a microbial additive to enhance performance of cattle fed high-concentrate diets.