Performance of backgrounding steers fed diets containing monensin or a lactobacillus fermentation product[1]

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Transl. Anim. Sci. 2018.XX:XX–XX
doi: 10.1093/tas/txy035

INTRODUCTION

Backgrounding of beef calves after weaning is an increasingly common practice. Many value-added feeder calf programs require calves to be weaned and backgrounded for 45 to 60 d. Although premiums are paid for weaned, backgrounded cattle, the economic advantage to the producer is highly variable and is dependent on a variety of factors and marketing scenarios (Avent et al., 2004; Dhuyvetter et al., 2005). However, increasing the additional kilograms gained by animals during the backgrounding phase consistently improves returns to the operation (Dhuyvetter et al., 2005).

Ionophores (monensin, lasalocid, and laidlomycin proprionate) are often included in backgrounding and finishing cattle diets to improve gains, increase feed efficiency, reduce bloat, and decrease acidosis (Goodrich et al., 1984; Callaway et al., 2003). Ionophores can also act as a coccidiostat when provided in higher concentrations. Limitations of inclusion of ionophores in backgrounding diets include variable consumption rates and interactions with feed availability.

Organic and most natural beef programs do not allow the use of ionophores in cattle diets (Troxel, 2012). Therefore, calf-backgrounding operations either give up benefits of including ionophores in cattle diets, or experience a reduction in marketing options when ionophores are used. Potential alternatives to ionophores in natural or organic beef operations are probiotics and/or prebiotics. When added to cattle diets, probiotics, and prebiotics can alter ruminal microflora and fermentation (Dhama et al., 2008; Rai et al., 2013). These alterations in ruminal fermentation do not consistently result in changes in animal performance (Uyeno et al., 2015). It appears that animal performance is highly dependent on the type and concentration of the probiotic/prebiotic.

Several FDA prebiotic products are available for use in beef cattle. A commercially produced fermentation product of *Lactobacillus acidophilus* (RumaCell, Pacer Technologies INC., Murtaugh, ID) is readily available to beef and dairy producers. However, producers need more research-based information on impact of this product and similar prebiotics on rumen function and animal performance.

[1]Research presented in this manuscript was supported by the Idaho Agricultural Experiment Station, UI Department of Animal and Veterinary Science, UI Nancy M. Cummings REEC and the Hatch Program project number IDA01493 of the National Institute of Food and Agriculture, U.S. Department of Agriculture. The authors would like to thank Pacer Technologies, Inc. for donation of the RumaCell containing liquid supplement, and PerforMix Nutrition Systems for formulating and mixing all liquid supplements.

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Received March 16, 2018.
Accepted April 14, 2018.

The experimental hypothesis was that steers fed diets containing monensin would outperform steers fed diets containing a *L. acidophilus* prebiotic. The objectives of this study were to 1) compare effects of a *L. acidophilus* prebiotic or monensin on animal performance, feed intake and feed efficiency in steers during short-term (42 d) backgrounding period, and 2) conduct a preliminary examination of in vitro fermentation characteristics.

MATERIALS AND METHODS

All in vitro and in vivo procedures were approved by the University of Idaho Animal Care and Use Committee (IACUC 2017–51 and 2015–19).

For the in vitro study, rumen fluid was harvested from three lactating Holstein cows 2 h after morning feeding, squeezed through four layers of cheesecloth in a bottle, and transferred to the laboratory in warm water (40 °C). Once in the lab, incubations were carried out similar to Au et al. (2010), using a 1:4 ratio of rumen fluid to pre-warmed buffer. Each vial contained 0.5 g of a low-starch dairy close-up diet with either monensin (**MON**), *L. acidophilus* prebiotic (**LaP**; RumaCell, Pacer Technologies Inc., Murtaugh, ID) treatment, or a control; two technical replicates were used per day, and the in vitro analysis was carried out on three separate days. Samples were taken at 24 h and analyzed for volatile fatty acids using established gas chromatography methods, as described previously (Laarman et al., 2012).

In the in vivo study, crossbred beef steers (n = 160; 199.9 ± 1.2 d of age) were weaned and placed on pasture for 2 wk prior to initiation of the trial. At the beginning of the experiment, steers were stratified by weight and randomly assigned to receive either MON or LaP treatment. All animals were fed in a GrowSafe system (GrowSafe Systems Ltd, Calgary, AB) consisting of five nodes per pen and two pens per treatment. Steers were fed a total mixed ration consisting of 75% ground alfalfa hay, 10% cracked corn, 10% wheat middlings, and 5% liquid supplement (Table 1). The molasses-based liquid supplement (PerforMix Nutrition Systems, Nampa, ID) provided minerals, vitamins, and MON or LaP (Table 2). Diets were formulated to provide 200 mg per animal per day of MON or 5 mL per animal per day of LaP. Steers were allowed ad libitum access to diets and water. There was a 14-d warm-up period followed by a 42-d test period. For the first 5 d of the warm-up period, liquid supplement was not included in the diets because it serves as the carrier for MON or LaP, and delivery of the LaP was delayed.

Table 1. Nutrient analysis of diets supplemented with monensin[a] or *Lactobacillus acidophilus* prebiotic (LAP)[b] to backgrounding steers

	Feed additive			
Component	Monensin	LaP	SE	*P* value
Dry Matter (**DM**), %	89.9	88.9	0.31	0.06
Crude protein, %DM	13.1	13.9	0.42	0.25
Acid detergent fiber, %DM	37.5	35.5	1.10	0.26
Neutral detergent fiber, %DM	48.7	46.4	1.44	0.31
Crude fat, %DM	1.35	1.54	0.09	0.18
Ash, %DM	8.82	9.10	0.32	0.55
Ca, %DM	1.02	1.07	0.02	0.26
P, %DM	0.28	0.29	0.01	0.37
Mg, %DM	0.23	0.25	0.01	0.16
K, %DM	2.27	2.27	0.02	0.88
Total digestible nutrients, %	57.0	58.3	1.01	0.41
Net energy maintenance, mcal/kg	1.25	1.26	0.02	0.86
Net energy gain, mcal/kg	0.68	0.69	0.02	0.86

[a]Monensin—200 mg per animal per day

[b]RumaCell, prebiotic fermentation product of *L. acidophilus*—5 mL per animal per day

Table 2. Composition of basal liquid supplement that included monensin[a] or *L. acidophilus* prebiotic[b]

Nutrient name	Dry matter
Dry matter, %	65.50
Invert sugars, %	31.69
Crude protein, %	20.25
CP as NPN, %	6.88
Crude fat, %	1.52
Salt, %	9.07
Calcium, %	3.15
Phosphorus, %	1.53
Magnesium, %	0.34
Potassium, %	11.15
Sulfur, %	0.52
Iron, ppm	405.50
Manganese, ppm	674.05
Zinc, ppm	840.72
Copper, ppm	269.31
Cobalt, ppm	12.21
Iodine, ppm	78.89
Selenium, ppm	5.02
Vitamin A, IU/kg	53,442.67
Vitamin D, IU/kg	3,817.34
Vitamin E, IU/kg	673.38
Net energy maintenance, mcal/kg	3.64
Net energy gain, mcal/kg	2.54
Net energy lactation, mcal/kg	3.55

[a]Monensin—346.17 g/907 kg

[b]RumaCell, prebiotic fermentation product of *L. acidophilus*—8.3 L/907 kg

Diets were mixed either once or twice daily. Diets were mixed in different feed trucks to prevent cross contamination of diets. Same lots of ground hay,

corn, and commodities were used for diets. However, variation in diets can occur due to loading practices, improper mixing times, weighing errors, segregation of ingredients, and changes in ingredients (Vogel and Laudert, 2015). Feed samples were collected daily from all bunks for each treatment. Daily samples were pooled by treatment. Daily samples were weighed and dried to determine dry matter content. Daily steer feed intakes were adjusted for daily dry matter content to calculate individual animal dry matter intake (**DMI**). Feed samples from each 14-d period were composited by treatment and analyzed by near infrared spectrometry (Cumberland Valley Analytic Services, Chambersburg, PA).

Steers were weighed on two consecutive days at the beginning and end of the experiment. In addition, steers were weighed every 2 wk during the experiment. Beginning and final weights were used to calculate trial average daily gain (**ADG**). Individual animal feed intakes were recorded daily. Diet dry matter was determined daily for each treatment and used to calculate individual animal daily DMI. G:F ratio was calculated from using daily DMI and ADG.

Data from feed nutrient analysis were analyzed by ANOVA using GLM Procedures of SAS (Cary, NC). In vitro data were analyzed using MIXED procedure of SAS, with fixed effects of supplement. All performance and intake data were subjected to statistical analysis using MIXED procedures of SAS. The independent variable was diet and dependent variables included beginning weight, final weight, ADG, DMI, and G:F.

RESULTS AND DISCUSSION

Diets for LaP steers had a tendency ($P < 0.06$) to contain less dry matter than MON-supplemented diets (Table 1), but were isoenergetic and isonitrogenous (Table 1), indicating that differences in performance were due to treatment, not a result of nutrient density of the diet. BW at the beginning and end of the trial were similar ($P > 0.89$ and $P > 0.40$, respectively) between MON and LaP-supplemented steers (Table 3). Steers were allocated to treatment based on BW, which ranged from 213.1 to 384.6 kg at the beginning of the study. This variation was maintained throughout the study with final weights ranging from 255.8 to 454.4 kg. Therefore, the animal-to-animal variation in BW and the short duration of the study make detecting a BW difference challenging.

In contrast to impacts on BW, LaP enhanced ADG ($P < 0.01$) and DMI ($P < 0.05$) compared with MON (Table 3). However, G:F ratio was similar

Table 3. Performance of steers during a 42-d backgrounding trial when supplemented with monensin[a] or *L. acidophilus* prebiotic (LaP)[b]

Treatment	LaP	Monensin	Difference[c]	*P* value
Initial wt, kg	311.6 ± 3.9	310.8 ± 3.8	0.8	0.89
Final wt, kg	375.6 ± 4.4	370.3 ± 4.4	5.3	0.40
ADG, kg/d	1.52 ± 0.03	1.42 ± 0.03	0.10	0.01
DMI, kg/d	10.6 ± 0.16	10.1 ± 0.16	0.5	0.05
G:F	0.145 ± 0.004	0.142 ± 0.004	0.003	0.50

[a]Monensin—200 mg per animal per day

[b]RumaCell, prebiotic fermentation product of *L. acidophilus*—5 mL per animal per day

[c]Difference = LaP – Monensin

($P > 0.50$) among LaP and MON-supplemented steers. Average daily gains were increased by 0.10 kg/d in LaP-supplemented steers compared to MON-supplemented steers. As G:F were similar, it appears that a majority of the increase in ADG in LaP-supplemented steers was a result of the 0.5 kg/d increase in DMI compared to MON steers. Why LaP increased DMI compared to MON is unclear.

Monensin is well known to act by selectively reducing acetate producing bacteria in the rumen which results in decreased methane production and increased availability of propionate (Calloway et al., 2003). In addition, monensin reduces ruminal amino acid fermentation resulting in increased amino acid availability to the hindgut. The result is enhanced ADG and feed efficiency. In the present study, MON was supplemented at 200 mg per animal per day, a concentration demonstrated to increase ADG in multiple pasture and forage feeding experiments (Kunkle et al, 2000). Therefore, we used MON-supplementation as a positive control for comparison with LaP.

As a prebiotic, LaP should act by enhancing growth of certain types of bacteria in the rumen and perhaps inhibiting others (Dhama et al., 2008; Rai et al., 2013). Inclusion rate was 5 mL per animal per day because this concentration resulted in the most consistent effect on fermentation in vitro based on a preliminary study (data not shown). In the in vitro study, LaP improved ($P < 0.05$) valerate and isovalerate production similar to MON (Table 4). In contrast to MON, LaP enhanced ($P < 0.05$) butyrate production and decreased ($P < 0.05$) propionate production. Therefore, the exact mechanism that resulted in the observed effects in LaP-supplemented steers on this high forage diet is unclear. Propionate is a known appetite suppressant in cattle (Oba and Allen, 2003), so the small decrease in propionate proportions may contribute to greater DMI. More research on mechanisms of

Table 4. Fermentation profile of diets supplemented with monensin (MON) or a *L. acidophilus* prebiotic (LaP; 5 mL/d) after 24-h incubation in vitro[a]

	Control	LaP	MON	*P* value
DM Digestibility, %	51.4 ± 1.3	50.9 ± 1.3	49.8 ± 1.3	0.93
Acetate, %	35.0 ± 0.5	34.1 ± 0.5	34.4 ± 0.5	1.00
Propionate, %	27.6 ± 0.6[b]	25.8 ± 0.8[c]	27.2 ± 0.6[b]	<0.01
Butyrate, %	20.3 ± 0.6[b]	21.8 ± 0.6[c]	19.9 ± 0.6[b]	<0.01
Isobutyrate, %	2.61 ± 0.05	2.68 ± 0.05	2.73 ± 0.05	0.80
Valerate, %	7.76 ± 0.43[b]	8.28 ± 0.43[c]	8.41 ± 0.43[c]	0.01
Isovalerate, %	6.17 ± 0.25[b]	6.57 ± 0.25[c]	6.62 ± 0.25[c]	0.05

[a]Means in the same row with a different superscript are different ($P < 0.05$)

prebiotic action is needed as other plausible mechanisms may yield similar results

In conclusion, we reject our hypothesis that MON-supplemented steers would outperform LaP-supplemented steers. Caution must be used when interpreting these results as these are short-term studies. A conservative interpretation is that LaP may be able to replace MON in some diets.

IMPLICATIONS

In the present study, supplementation of a forage-based backgrounding diet with a *L. acidophilus* prebiotic (LaP), RumaCell, increased ADG and DMI compared with a diet supplemented with monensin. These results indicate that LaP may be an alternative to monensin in diets for cattle in natural beef programs. Further larger scale studies on LaP in diets of varying forage to concentrate ratios are needed to confirm positive effects observed in this study. In addition, investigations into the mechanism of action of LaP, and its impact on the rumen microbiome are warranted.

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