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Research Article

Performance Effects from Supplementation of a Probiotic and Monensin in Feedlot Cattle

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Abstract

Thirty-two Hereford x Simmental steers (250.0 ± 15 kg Initial BW) were assigned to four dietary treatments in a completely randomized design (4 steers/pen, 2 pens/treatment) in order to evaluate the effects of supplementing Monensin (MON; Rumensin; Elanco Animal Health, Greenfield, IN) in comparison and in combination (CMB) with a proprietary Probiotic blend (PRO; MultSacch®, Biomart Nutrição Animal Imp. and Exp. Ltda.) on the growth performance, feed efficiency, and on cost of gain. Individual feed intake was monitored using a GrowSafe System (GrowSafe Systems Ltd. Calgary, AB, Canada) and weights were recorded weekly for a 90d growth data period. Supplementation with PRO and CMB both increased Gain:Feed (G:F) by 6% with respect to control (CON) steers ($P = 0.01$). No treatment effects were detected in initial body weight (IBW), final body weight (FBW), or average daily gain (ADG) ($P > 0.05$). DMI was lowest in CMB steers ($P = 0.04$), and this same group had the lowest cost of gain ($P < 0.001$). Present findings indicate that when compared with MON, under these experimental conditions PRO seems to be just as effective in stabilizing intraruminal milieu and increasing ruminal fiber utilization when steers are fed rapidly fermentable carbohydrate grain-based diets, thus improving feed efficiency without the need of MON supplementation. However, combined use of PRO and MON results in the lowest cost of gain ($P = 0.03$). Further experimentation is required to ascertain the effect substituting MON with different mixtures of Probiotics will have long term on cattle growth performance and profitability.

Keywords: *Yeast; Probiotics; Monensin; Feedlot Cattle*

Introduction

Ruminants in production settings utilize several different types of feedstuffs in order to meet growth performance expectations. In order to properly digest these feedstuffs that are vital for growth, a healthy and thriving ruminal ecosystem must be maintained [1]. Two options producers have for enhancing the ruminal ecosystem are ionophores and yeast based probiotics (YP).

Monensin (MON) is the most widely used ionophore among cattle feeders in the United States [2]. Monensin is classified as a polyether antibiotic; however, MON should not be confused with therapeutic antibiotics because it does not 'kill' bacteria, rather bacteria, more specifically gram-positive bacteria, are targeted in order to reduce lactic acid production and methanogenesis in the rumen and increase molar proportion of propionate and N retention [3]. In addition to helping reduce waste products, MON fed cattle have lower incidence of bloat, ruminal acidosis, and incidence of coccidiosis [4].

Supplementation of YPs has been considered to be an effective way to stabilize intraruminal milieu and fermentation in ruminants fed high-concentrate diets, increase nutrient digestibility and overall animal performance (e.g. feed efficiency and weight gain) [5,6]. One spe-

cies of yeast commonly incorporated in ruminant diets and in Probiotic blends is *Saccharomyces cerevisiae* (SC). *Saccharomyces cerevisiae* live cells have been reported to have the ability to remove oxygen from the rumen environment and release essential enzymes, vitamins and other nutrients or growth factors, which could facilitate bacteria to have a high viability and activity in the rumen [1,7]. Despite these known positive effects of YP supplementation in ruminants, MON remains the most common feed additive used around the globe to enhance feed efficiency and overall performance [5].

Based on the similarity in modulation of ruminal fermentation between MON and YPs, we hypothesize that combined supplementation of PRO and MON will result in a compounding of positive effects on ruminal fermentation that will translate into improved growth performance traits.

Experimental Design and Methods

The protocol for this study was reviewed and approved by the University of Arizona Institutional Animal Care and Use Committee. A cattle feeding trial was conducted using 32 crossbred Hereford x Simmental steers (250 ± 15 kg Initial body weight) in order to evaluate the effects supplementation of a Probiotic blend with/without Monensin has on growth performance effects in growing steers. Steers were assigned to four dietary treatments in a completely randomized design (4 steers/pen, 2 pens/treatment). Steers received an experimental diet with the following treatments: (1) no additives (CRT); (2) Monensin (MON) supplementation (Rumensin Elanco Animal Health Indiana USA, 20% commercial premix) (1,412.7 mg Monensin Sodium/Supplement kg; fed at 2.14% of weight of delivered feed); (3) Probiotic additive brand MULTSACCH®, (PRO) composed of *Bacillus subtilis* (minimum of 3 x 10^9 CFU/g), *Bifidobacterium bifidum* (minimum of 1 x 10^9 CFU/g), *Enterococcus faecium* (minimum of 1 x 10^9 CFU/g), *Lactobacillus acidophilus* (minimum of 1 x 10^9 CFU/minimum), *Lactobacillus buchneri* (minimum of 2 x 10^9 CFU/g), *Lactobacillus casei* (minimum of 1 x 10^9 CFU/g), *Lactobacillus lactis* (minimum of 1 x 10^9 CFU/g), *Saccharomyces cerevisiae* (minimum of 2 x 10^8 CFU/g) manufactured by Biomart Animal Nutrition Import and Export. Ltd - Martinópolis/SP - Brazil (1g per 100 kg of live weight) and (4) Combination (CMB) of MON and PRO. Steers were fed an 88% concentrate diet mostly composed of ground-corn and alfalfa hay formulated to meet or exceed National Research Council recommendations. The ingredient and nutrient composition of the mixed concentrate is presented in table 1. Steers were fed once per day and supplements were added at feeding by top dressing feed then mixing thoroughly with handheld drill based agar. Individual feed intake was monitored using a GrowSafe System (GrowSafe Systems Ltd. Calgary, AB, Canada). Water was offered *ad libitum*. The growth performance trial lasted for 97 days, including a 7-day adaptation period and 90-day growth data collection period. Steers were weighed weekly throughout the 90-day period. The average daily gain (ADG) and dry matter intake (DMI) were determined and feed efficiency was calculated.

Item	Experimental Diet[1]
Ingredients % of DM	
Alfalfa (ground)	13.7
Corn (cracked)	73.2
Mineral Mix[2]	2.1
Molasses	6.3
Soybean Meal	3.8
Urea	0.9
Nutritional Composition	
% Total moisture	12.74
% Ash	6.34
%NDF	12.14
%ADF	6.37
% CP	14.2
% Nitrogen	2.28
TDN (na)	77

Table 1: *Ingredients and nutritional composition of diets.*

[1]Treatments were top dressed to delivered feed. (PRO; 1 g/100 kg of average pen live weight) and (RUM; (1,412.7 mg Monensin Sodium/Mineral mix kg, fed at 2.14% of weight of delivered feed)).

[2]Trace mineral-vitamin premix contained: calcium Carbonate, Processed Grains, Sodium Chloride, Ammonium Sulfate, Potassium Chloride, Dicalcium Phosphate, Molasses, Magnesium Oxide, Zinc Sulfate, Ferrous Carbonate, Copper Sulfate, Magnesium Sulfate, Ferrous Sulfate, Sodium Selenite, Potassium Iodide, Cobalt, Carbonate, Vitamin A Acetate, and Vitamin E Supplement. (Manufactured by Maid Rite Feeds, Wilcox, AZ).

Statistical analysis

A completely randomized experimental design was utilized. Data were analyzed cumulatively using the MIXED procedure of SAS (SAS 9.3, SAS Institute Inc., Cary, NC, USA). The LSMEANS option was used to calculate all comparison estimates for the fixed effects of treatment groups. Variables included treatment. Significance was declared at ($P < 0.05$). When significant effects were observed, differences between the means were evaluated.

Results

Table 2 summarizes the performance values for all experimental groups. Steers in the CON group had ADG, DMI, and G:F values comparable to facility values using the GrowSafe system. Supplementation with PRO and CMB both increased G:F by 6% with respect to CON steers ($P = 0.01$). No treatment effects were detected in ADG, IBW, or FBW ($P > 0.05$). Dry Matter Intake and cost of gain were lowest in CMB steers ($P = 0.04$ and $P < 0.001$, respectively). The PRO group was the second most profitable group in this trial based on cost of gain, and there were no significant differences in cost of gain between MON and CON steers. Present findings indicate that when compared with MON, PRO supplementation seems to be more effective in improving growth performance characteristics.

	Treatment					
Item	**CON**	**CMB**	**MON**	**PRO**	**SEM**	**P-value**
Initial body weight, kg	241.3	242.0	246.7	242.5	6.32	0.93
Final body weight, kg	382.1	378.5	391.5	375.5	12.43	0.82
ADG, kg	1.31	1.29	1.37	1.37	0.04	0.28
DMI, kg/d	8.27^{b}	7.59^{a}	8.24^{cb}	7.98^{ab}	0.18	0.04
G:F	0.16^{a}	0.17^{b}	0.165^{cab}	0.17^{bc}	0.002	0.01
Cost of feed/d, $	0.45	0.44	0.47	0.46	-	-
Total cost of feed, $	40.50	39.63	42.30	41.40	-	-
Cost of gain, $/kg[1]	2.84^{b}	2.60^{a}	2.84^{cb}	2.69^{d}	0.03	< 0.0001

Table 2: *Performance and cost effects of with/without probiotic and monensin supplementation.*
[1](Cost of feed/d)/(G:F).

Discussion

Feed supplements play a crucial role in improving growth and feed efficiency in beef cattle. As previously mentioned, MON and YP supplementation both contribute to improvements in rumen health, thus resulting in greater overall animal performance. These analogous benefits to rumen function and overall productivity make PRO supplementation an attractive option for cattle feeders to incorporate into their feed formulations. Combined use of PRO and MON in this experiment resulted in the lowest DMI and the lowest cost of gain. This boosted performance can potentially be a result of a compounding of the complementary benefits that both of these additives provide to the rumen environment, which is what dictates feed efficiency.

It is well documented that the efficacy of YPs, alone or in combination with MON, varies at different types and doses of live yeast cells, levels of concentrate in the diet, and age of the animal [8]. High concentrate diets, like the one used in this experiment, are often associated with a lowering of the ruminal pH, which is linked to negative effects on growth performance in afflicted cattle [9]. Jiao., *et al*. [9] further reports that diets supplemented with SC result in an increase in anaerobic bacteria that increase fiber digestion and flow of microbial protein from the rumen and that yeasts stabilize rumen pH by reduction of lactic acid producers and stimulation of lactic acid utilizers,

thus alleviating incidence of subacute rumen acidosis. In this trial where a high concentrate diet was fed to the steers for 97d, it is expected that the ruminal pH of the steers was altered due to the significant inclusion of grain in the diets. Future experimentation should consider measuring ruminal pH levels in order to correlate the differences in feed efficiency with the counteracting effects PRO and MON have on the ruminal disturbance caused by the high grain diet.

A trial of similar length and experimental diet content but with a different probiotic blend observed no added benefits in growth performance parameters through combined supplementation of YP and MON [10]. This difference can potentially be attributed to the use of different YP blends and the fact that the cattle in the trial Pancini., *et al*. [10] conducted were in a later stage of production compared to the steers in our study (IBW = 446 vs IBW = 250 kg).

The improvement of feed efficiency observed through PRO supplementation in this experiment with respect to the CON group is comparable to an improvement in feed efficiency noted in a meta-analysis where the results of 18 experiments involving YP supplementation in beef cattle performance were examined [8]. However, this meta-analysis noted a correlation between an increase in DMI and ADG through YP supplementation, which differs from the results in this experiment where no significant difference in ADG or feed intake was observed between the experimental groups. This inconsistency can be explained if the days on feed (DOF) is taken into consideration. Wagner., *et al*. [8] noted the highest improvement in DMI occurred in experiments where cattle were supplemented YPs for 200d vs 100d. The current study supplemented YPs for 90d. Therefore, the DOF appears to have a significant impact on the effectiveness of the YP blend in stabilizing intraruminal milieu and increasing ruminal fiber utilization when steers are fed rapidly fermentable carbohydrate grain-based diets.

With regard to MON vs PRO supplementation, the results from this experiment differ from a previous experiment where YP supplementation lowered ADG and had no effect on feed efficiency, cost of gain, or DMI [11]. Swyers., *et al*. [11] attributed these effects on the composition of the finishing ration fed to the cattle. The finishing ration consisted of 19.7% dry distillers grains and solubles, which resulted in a lower component of grain in the ration (63%). The ration used in our trial had 73% grain, which is closer in line with recommended range (70 - 85%) Swyers., *et al*. [11] noted in their discussion. Thus, the difference in results can be attributed to differing levels of grain in the rations fed to the cattle.

Conclusion

Under our experimental conditions, YP supplements have the potential to improve growth performance characteristics when used in combination with MON; however, any decision to consider YPs as an alternative for MON must take into consideration the added benefits of MON supplementation that are not observed in YP supplementation, such as the reduction in coccidiosis incidences. Further experimentation is required in order to understand the growth performance effects of YP supplementation in beef cattle.

Conflict of Interest

The authors declare no conflict of interest.

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