Yeast Supplementation Alters the Immune Response in Feedlot Steers

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Summary

Newly received steers (462 hd), were utilized to evaluate the effect of supplementation of Saccharomyces cerevisiae subspecies boulardii CNCM I-1079 yeast for a period of 32 d on performance and immune responsiveness. Treatment groups consisted of yeast supplementation of Saccharomyces cerevisiae CNCM I-1079 at either 0, 0.5, 1, 3, or 5 g/steer daily. Supplementations of Saccharomyces cerevisiae CNCM I-1079 yeast did not enhance receiving performance. However, supplementation did alter the pro-inflammatory profile of steers during an immune challenge. These results suggest yeast supplementation may provide a beneficial response for morbidity typical in newly received cattle.

Introduction

Bovine respiratory disease (BRD) is the most common disease impacting the beef industry. A possible tool to mitigate BRD is the supplementation of yeast as a probiotic. Supplementation of yeast has the potential as a probiotic in cattle due to yeast's ability to alter the innate immune response, directly interact with pathogenic bacteria within the GIT, and/or through alteration of ruminant metabolism, which in turn may influence the immune response. To further evaluate yeast supplementation as a means to improve health and performance in cattle, a receiving and immune challenge study was conducted to evaluate the effects of active dry yeast, *Saccharomyces cerevisiae* subspecies *boulardii* CNCM I-1079 (Lallemand, Inc.)

Procedures

Newly received steers (n = 462; BW 584 ± 49 lb) were stratified upon processing order at the University of Nebraska-Lincoln Agricultural Research and Development Center (ARDC) near Mead, Neb and assigned randomly to five treatment groups: yeast supplementation of *Saccharomyces cerevisiae CNCM I-1079* at 0, 0.5, 1, 3, & 5 g/steer daily. Initial BW was a single day weight collected at time of processing. For supplementation, live yeast was mixed 1:1 with a ground corn carrier and top-dressed immediately after daily delivery of feed for a period of 32 d. During the last five d of the receiving period (28–32 d), steers were limit fed at 2.0% of BW with continued yeast treatment and individually weighed on consecutive d (31 and 32 d). The average of the two consecutive d served as the ending BW for the 32 d receiving period.

To evaluate the immune response, on d 25 of the 32 d receiving period, 18 steers (six steers each from 0, 0.5g, and 5.0g treatment groups) were randomly selected for an immune challenge and moved into a tie stall barn. On d 27, steers were fitted with indwelling jugular catheters for serial blood collection and indwelling rectal temperature (RT) recording devices, programed to record RT at 5-min intervals. After insertion of the jugular catheter and RT device, steers were returned to the individual tie stalls and allowed to rest for the remainder of the d.

On d 28, blood samples were collected from 0800 to 1800 h at 30 min interval; 2 h prior to the challenge (0800–1000 h) and 8 h after the challenge (1000–1800 h) and at 24 h (1000 h) post-challenge on d 29. At 1000 (0 h), following the collection of the 0 h blood sample, steers were administered an i.v. bolus of lipopolysaccharide (LPS, 0.5 µg/kg BW; from *E. coli* O111:B4). At each sample collection point, blood was collected for serum. Serum harvested stored at -112°F until analyzed. Serum was analyzed for cortisol and pro-inflammatory cytokines (tumor necrosis factor-α, TNF-α; Interferon-γ, IFN-γ; and Interleukin–6, IL-6).

Performance data were analyzed as a randomized block design using MIXED procedures of SAS (SAS Institute, Inc., Cary, NC) with pen serving as the experimental unit. The model included the fixed effect of treatment and orthogonal contrast to test linear and quadratic effects with block as random effect. Immune response data were analyzed as a completely randomized design with repeated measures using the MIXED procedures of SAS. The model included fixed effects of treatment and time, and treatment × time was used as the error term to test whole plot effect. For

Table 1. Performance of newly received steers supplemented with *Saccharomyces cerevisiae* CNCM I-1079 yeast supplemented at 0.0, 0.5, 1.0, 3.0, and 5.0 g/steer daily for 32 d.

	CON[a]	0.5g[b]	1.0g[c]	3.0g[d]	5.0g[e]	SEM	*P*-value	Linear	Quadratic
Initial BW, lb	569	563	600	589	576	18.5	0.61	0.69	0.15
Ending BW, lb	655	664	704	688	679	26.5	0.64	0.96	0.43
Gain, lb	86	101	104	99	103	2.8	0.63	0.70	0.85
DM Offered lb/d	15.4	15.8	15.9	15.9	15.9	0.57	0.69	0.25	0.41
ADG, lb	3.3	3.2	3.2	3.1	3.2	0.10	0.47	0.36	0.78
Feed:Gain	4.93	5.09	4.87	5.05	5.01	—	0.66	0.75	0.80
Morbidity (%)	7.3[h]	18.5[fg]	10.4[gh]	15.4[fgh]	21.0[f]	3.9	0.05	0.01	0.78

[a]Control group, did not receive S*accharomyces cerevisiae*
[b]Supplemented S*accharomyces cerevisiae* at a rate of 0.5 g/hd/d
[c]Supplemented S*accharomyces cerevisiae* at a rate of 1.0 g/hd/d
[d]Supplemented S*accharomyces cerevisiae* at a rate of 3.0 g/hd/d
[e]Supplemented S*accharomyces cerevisiae* at a rate of 5.0 g/hd/d
[f,g,h]Denotes differences ($P < 0.05$) between treatment groups

both feedlot and immune response data, when results of F-test were significant ($P < 0.05$), group means were compared by use of least significant difference. Pair wise differences among least squares means at various sample times were evaluated with the Tukey-Kramer option of SAS

Results

In terms of morbidity, regardless of treatment, 14.2% of the steers were treated for respiratory diseases during the trial. The majority (75%) of cattle treated for respiratory disease occurred during the first 8 d of the study (regardless of treatment). There was a linear response ($P = 0.01$) to SC supplementation. Steers within the CON, 1.0g and 3.0g groups had a decreased ($P = 0.05$) overall rate of morbidity due to respiratory disease, when compared to the steers in the 0.5g and 5.0g treatment groups (Table 1.).

There was no treatment effect for ending BW ($P = 0.64$), DM offered ($P = 0.69$), ADG ($P = 0.47$), and F:G ratio ($P = 0.63$). There was also no difference ($P = 0.63$) in total weight gained between the five treatment groups; the average gain of treatment groups were 94 ± 8.3 lb. during the 32 d receiving period.

For the immune challenge portion of the trial, there was a difference in RT between the three treatment groups ($P = < 0.001$) prior to the LPS challenge. Prior to challenge (−4 to 0 h), 0.5g steers had a greater ($P = 0.004$) RT (102.8 +0.1°F), when compared to 5.0g (102.0 + 0.1°F) and CON steers (101.8+0.1°F; Figure 1). Due to difference in RT prior to the challenge, temperature was analyzed as the change from the average RT prior to the LPS challenge (−4 to-1 h; Figure 1). In response to the LPS challenge, RT increased in all three groups within 1 h of challenge ($P < 0.01$). The change in RT from baseline indicated a treatment effect ($P < 0.01$) but no treatment x time interaction ($P = 0.10$); CON steers had the greatest ($P < 0.01$) change in RT (2.01 ± 0.5°F) from baseline compared to 0.5g (1.51 ± 0.4°F) and 5.0g (1.19 ± 0.5°F) steers.

For serum cortisol, there was a treatment × time interaction ($P < 0.01$). Prior to the LPS challenge (−2–0 h), cortisol concentrations were similar ($P \geq 0.63$) between the treatment groups. Regardless of treatment, cortisol concentrations increased ($P < 0.01$) 0.5 h after the LPS challenge. At 0.5 h and

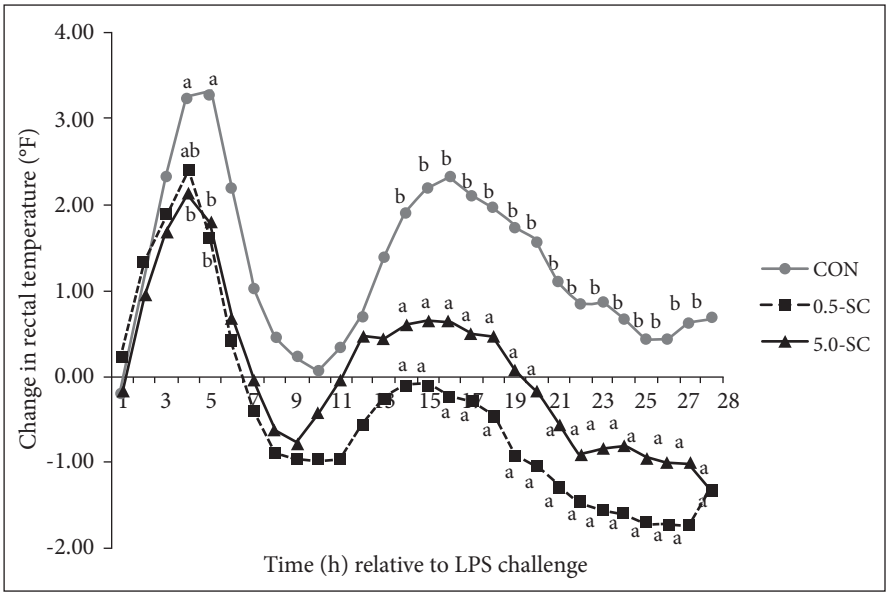

Figure 1. Change in rectal temperature (°F) from baseline (prior to challenge) during a lipopolysaccharide (LPS) challenge of newly received steers supplemented with S*accharomyces cerevisiae* CNCM I-1079 yeast supplemented at a rate of 0.0 (CON), 0.5 (0.5g), and 5.0 g/hd/d (5.0g) for a period of 32 d.

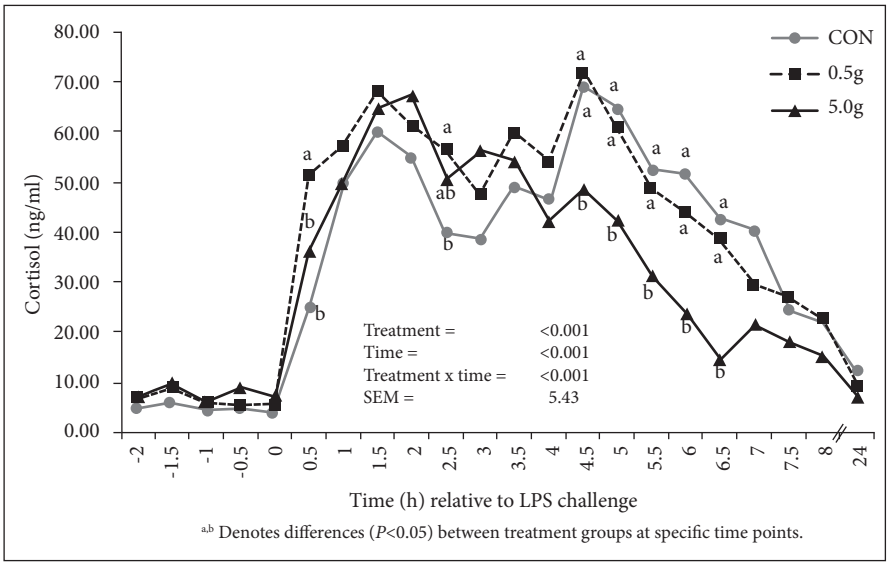

Figure 2. Cortisol concentrations during the lipopolysaccharide (LPS) challenge of newly received steers supplemented with S*accharomyces cerevisiae* CNCM I-1079 yeast supplemented at a rate of 0.0 (CON), 0.5 (0.5g), and 5.0 g/hd/d (5.0g) for a period of 32 d.

2.5 h post LPS challenge cortisol concentrations in the CON steers was less ($P < 0.01$) than steers in the 0.5g treatment group. Starting at 4.5 h and continuing until 6.5 h post LPS challenge, cortisol concentrations for steers within the 5.0g group were less than CON and 0.5g steers (Figure 2). Cortisol concentrations in all three groups returned to near baseline concentrations within 24 h of the LPS challenge.

There was a treatment effect ($P < 0.01$) for all pro-inflammatory cytokines (IFN-γ, TNF-α, and IL-6) and there was a treatment × time interaction ($P < 0.01$) for TNF-α and IL-6. Concentrations of IFN-γ were greater ($P < 0.01$) in the CON steers, when compared to the 0.5g and 5.0g. Concentrations of TNF-α increased ($P < 0.01$) in all treatment groups 1 h after the LPS challenge, and started to return to near baseline concentrations by 3 h post challenge (Figure 3). Concentrations of TNF-α in the CON steers from 1–1.5 h after the LPS challenge were greater ($P < 0.01$) than 0.5g and 5.0g

steers, and remained greater ($P = 0.001$) than the 5.0g steers until 3 h post challenge. Prior to the LPS challenge, concentrations of IL-6 were similar ($P = 0.95$) between all groups and remained similar until 1 h post LPS challenge (Figure 4). One h post challenge, IL-6 concentrations started to increase ($P < 0.01$) in all treatments, and concentrations in 5.0g steers were greater ($P = 0.05$) than CON steers, with 0.5g steers intermediate. Following the difference at 1 h post challenge, IL-6 concentrations were similar between treatments until 3.5 h post challenge. Starting at 3.5 h, concentrations of IL-6 in the 5.0g steers began to decrease and were less ($P = 0.009$) than CON and 0.5g. For the next 4.5 h (3.5–8 h post LPS challenge), concentrations of IL-6 for the 5.0g steers were less ($P = \leq 0.05$) than both the CON and 0.5g treatment groups. Twenty-four h after the LPS challenge, concentrations of IL-6 had returned to near baseline and were similar ($P \geq 0.53$) between all treatments.

While the 0.5g and 5.0g treatment groups had a greater rate of morbidity, there was no difference in performance between these two treatments and that of the CON, 1.0g, and 3.0g. The ability to maintain similar performance while having a greater rate of morbidity is supported by the LPS challenge results. Data from the LPS challenges suggest that the *Saccharomyces cerevisiae* subspecies *boulardii* CNCM I-1079 supplemented steers had a lesser response to the challenge compared to CON steers, indicated by decreased production of cytokines and decreased production of cortisol in the 5.0g supplemented steers.

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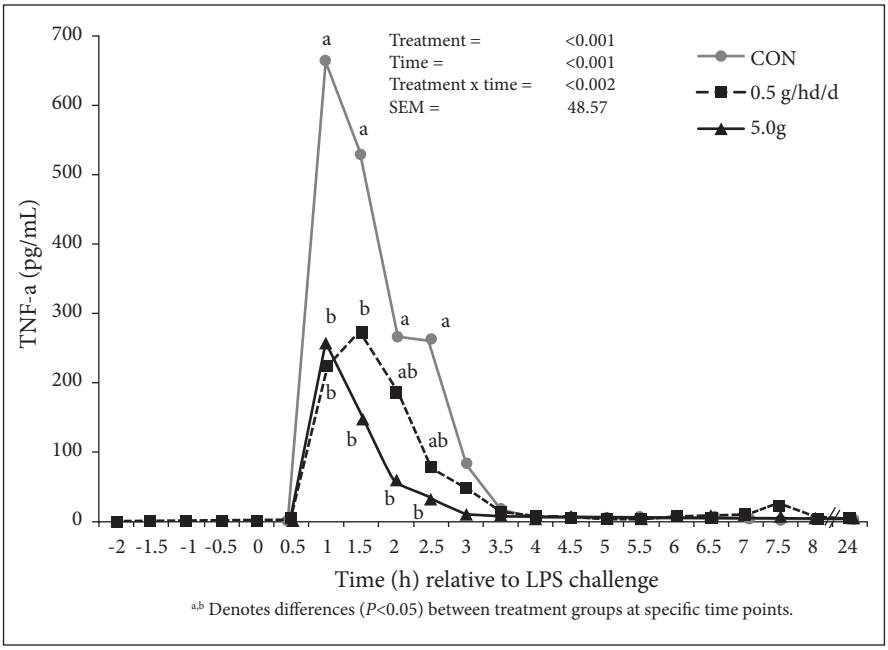

Figure 3. Tumor necrosis factor–α (TNF-α) concentrations during the lipopolysaccharide (LPS) challenge of newly received steers supplemented with *Saccharomyces cerevisiae* CNCM I-1079 yeast supplemented at a rate of 0.0 (CON), 0.5 g/hd/d (0.5g), and 5.0 g/hd/d (5.0g) for a period of 32 d.

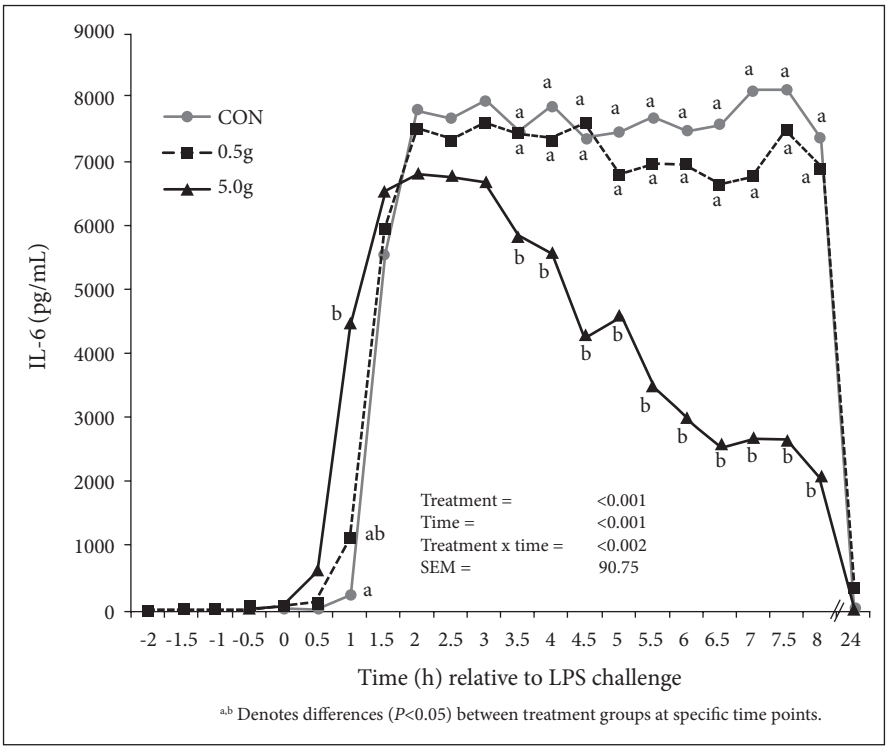

Figure 4. Interleukin–6 (IL-6) concentrations during the lipopolysaccharide (LPS) challenge of newly received steers supplemented with *Saccharomyces cerevisiae* CNCM I-1079 yeast supplemented at a rate of 0.0 (CON), 0.5 g/hd/d (0.5g), and 5.0 g/hd/d (5.0g) for a period of 32 d.