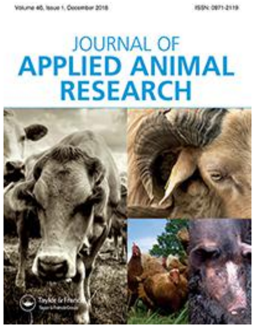

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Influence of feeding enzymatically hydrolysed yeast cell wall + yeast culture on growth performance of calf-fed Holstein steers

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ABSTRACT

One hundred and sixty-eight crossbred steers (133 ± 7 kg) were used in a 336-d experiment to evaluate the effects of enzymatically hydrolysed yeast cell wall plus yeast culture (EHY) supplementation on growth performance and carcass characteristics. Treatments consisted of steam-flaked corn-based diet supplemented with 0, 195, 390 or 585 mg/kg EHY. Supplemental EHY enhanced overall (336-d) dry matter intake (DMI, $P < .01$), averagde daily gain (ADG, $P = .04$), and final carcass weight ($P = .04$). Responses were maximal (quadratic effect, $P \leq .02$) at the 195 mg/kg level of EHY supplementation. Feed intake enhancements were observed throughout each 112-d period of the study. Improvements in ADG were largely the result of increased DMI, as gain efficiency and estimated dietary net energy (NE) were not affected by EHY supplementation. Effects of supplemental EHY on other carcass measures were not appreciable ($P > .20$), except for a slight lowering (0.7%, $P = .04$) in carcass yield. We conclude that throughout the growing-finishing period, supplemental EHY will enhance ADG, resulting in marked increases in final carcass weight. This effect is due to consistent increases in DMI, as supplementation did not affect gain efficiency or estimated dietary NE.

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KEYWORDS
Yeast; Holstein; feedlot; growth performance

1. Introduction

Supplementation with yeast and/or yeast cell wall components (mono- and oligosaccharides and beta glucans) has been associated with improved milk yield, enhanced immune status, and reduced incidence of mastitis and somatic cell counts in dairy cattle (Nocek et al. 2011; Liu et al. 2014) and improved health status, and reduced acute phase immune responses of cattle exposed to endotoxin challenge (Lowry et al. 2005; Chae et al. 2006; Li et al. 2006; Sanchez et al. 2013, 2014). Supplementation with enzymatically hydrolysed yeast cell wall plus yeast culture (EHY) enhanced average daily gain (ADG), and gain efficiency, and lowered rectal temperature in forage-fed lambs (Fabian et al. 2014). There is very limited information regarding the effects of EHY on growth performance of feedlot cattle. In a preliminary study, Sanchez-Mendoza et al. (2015) observed that a combination of EHY and chromium enhanced DMI and ADG of medium-weight feedlot steers during a period of high ambient temperature (average maximal temperature humidity index of 89.1). Likewise, Salinas-Chavira et al. (2015) observed that supplemental EHY enhanced DMI and ADG of medium-weight feedlot steers fed a steam-flaked corn-based growing-finishing diet. They also observed that supplemental EHY enhanced ruminal fibre digestion and decreased ruminal acetate:propionate molar ratios and estimated ruminal methane production. The objective of the present research was to evaluate influence of supplementing EHY on growth performance in calf-fed Holstein steers.

2. Materials and methods

All procedures involving animal care and management were in accordance with and approved by the University of California, Davis, Animal Use and Care Committee.

One hundred and sixty-eight Holstein steer calves (133 ± 7 kg) were utilized to evaluate the influence of EHY (Celmanax, Arm and Hammer Nutrition, Princeton, NJ) supplementation on growth performance and dietary energetics. The trial was initiated 26 May 2015 and completed 25 April 2016. Calves were obtained from a commercial calf ranch (CalfTech, Tulare, CA). Upon arrival at the University of California Desert Research and Extension Center (Holtville, CA), steer calves were vaccinated for infectious bovine rhinotracheitis, bovine viral diarrhea, parainfluenza virus 3, and bovine respiratory syncitial virus (Bovi-shield® Gold One Shot, Zoetis Animal Health, New York, NY), clostridials (Ultrabac® 7, Zoetis Animal Health, New York, NY), treated against internal and external parasites (Dectomax, Zoetis Animal Health, New York, NY), injected with 1500 IU vitamin E (as d-alpha-tocopherol) 500,000 IU vitamin A (as retinyl-palmitate) and 50,000 IU vitamin D_3 (Vital E-AD, Stuart Products, Bedford, TX), and 300 mg tulathromycin (Draxxin, Zoetis Animal Health, New York, NY). Calves were blocked by initial shrunk (off truck) weight into 7 groups and randomly assigned within weight groupings to 28 pens (6 steers per pen). Pens were 43 m^2 with 22 m^2 overhead shade, automatic waterers and 2.4 m fence-line feed bunks. Steers were allowed ad libitum access to feed and water. Fresh feed was

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provided twice daily at 06:00 hours and 14:00 h, offering approximately 40% of daily consumption in the morning feeding and the remainder in the afternoon feeding. Dietary treatments consisted of a steam-flaked corn-based growing-finishing diet supplemented with 0, 195, 390, or 585 mg/kg Celmanax. Composition of experimental diets is shown in Table 1. Diets were prepared at weekly intervals and stored in plywood boxes located in front of each pen. On days 112 and 224, all steers were reinjected subcutaneously with 500,000 IU vitamin A (Vital E-A + D, Stuart Products, Bedford, TX) and implanted with Revalor-S (Intervet, Millsboro, DE).

Hot carcass weights (HCW) were obtained at the time of slaughter. After carcasses were chilled for 24 h, the following measurements were obtained: Longissimus (LM) area (cm^2) by direct grid reading of the muscle at the 12th rib; subcutaneous fat (cm) over the LM at the 12th rib taken at a location 3/4 the lateral length from the chine bone end (adjusted by eye for unusual fat distribution); kidney, pelvic and heart fat (KPH) as a percentage of HCW; marbling score (USDA 1997; using 3.0 as minimum slight, 4.0 as minimum small, 5.0 as minimum modest, 6.0 as minimum moderate, etc.), and estimated retail yield of boneless, closely trimmed retail cuts from the round, loin, rib and chuck as a percentage of HCW(Yield, % = 52.56 – 1.95 × subcutaneous fat – 1.06 × KPH + 0.106 × LM area – 0.018 × HCW; Murphey et al. 1960).

Energy gain (EG, Mcal/d) was calculated by the equation: EG $= 0.0557W^{0.75} \times ADG^{1.097}$; where EG is the daily deposited energy and W is the body weight (NRC 1984). Maintenance energy (EM, Mcal/d) was calculated by the equation: EM $= 0.084W^{0.75}$ (Garrett 1971). From the derived estimates of energy required for maintenance and gain, the net energy for maintenance and gain (NE_m and NE_g, respectively) values of the diet were obtained using the quadratic formula: $x = (-b - \sqrt{b^2 - 4ac})/2c$, where $a = -0.41EM$, $b = 0.877EM + 0.41DMI + EG$, and $c = -0.877DMI$, and $NE_g = 0.877\ NE_m - 0.41$ (Zinn and Shen 1998).

The experimental data were analysed as a randomized complete block design experiment according to the following statistical model:

where μ is the common experimental effect, B_i represents initial weight group effect (df = 6), T_j represents dietary treatment effect (df = 3), and E_{ij} represents the residual error (df = 18). Treatments effects were tested using the following contrasts: 0 vs. EHY and linear and quadratic polynomials (Stastix 10, Analytical Software, Tallahassee, FL).

Table 1. Composition of experimental diets (DM basis).

Item	Celmanax level (mg/kg diet DM) 0	195	390	585
Ingredient composition (% DM)				
Sorghum Sudan	8.00	8.00	8.00	8.00
Alfalfa hay	4.00	4.00	4.00	4.00
Tallow	2.50	2.50	2.50	2.50
Molasses, cane	4.00	4.00	4.00	4.00
Distillers Grains w/solubles	10.00	10.00	10.00	10.00
Steam-flaked corn	68.10	68.10	68.10	68.10
Urea	1.15	1.15	1.15	1.15
Limestone	1.68	1.68	1.68	1.68
Dicalcium phosphate	0.10	0.10	0.10	0.10
Magnesium oxide	0.15	0.15	0.15	0.15
Rumensin 90	0.01820	0.01820	0.01820	0.01820
TM Salt[a]	0.30	0.30	0.30	0.30
Celmanax (mg/kg)	0	195	390	585
Nutrient composition, DM basis (NRC 2000)				
Dry matter (%)	87.9	87.9	87.9	87.9
NEm (Mcal/kg)	2.21	2.21	2.21	2.21
NEg (Mcal/kg)	1.54	1.54	1.54	1.54
Crude protein (%)	14.3	14.3	14.3	14.3
Rumen DIP (%)	62.7	62.7	62.7	62.7
Rumen UIP (%)	37.3	37.3	37.3	37.3
Ether extract (%)	6.70	6.70	6.70	6.70
Ash (%)	5.76	5.76	5.76	5.76
Nonstructural CHO (%)	58.0	58.0	58.0	58.0
NDF (%)	17.7	17.7	17.7	17.7
Calcium (%)	0.80	0.80	0.80	0.80
Phosphorus (%)	0.35	0.35	0.35	0.35
Potassium (%)	0.77	0.77	0.77	0.77
Magnesium (%)	0.28	0.28	0.28	0.28
Sulphur (%)	0.19	0.19	0.19	0.19

[a]Trace mineral salt contained: CoSO4, 0.068%; CuSO4, 1.04%; FeSO4, 3.57%; ZnO, 0.75%; MnSO4, 1.07%; KI, 0.052%; and NaCl, 93.4%.

3. Results and discussion

Morbidity during the study was low, averaging 1.2 ± 1.7% and not affected ($P = .60$) by dietary treatments. Treatment effects on growth performance are shown in Table 2. Supplemental EHY enhanced overall (336-d) DMI ($P < .01$) and ADG ($P = .04$). Responses were maximal (quadratic effect, $P \leq .02$) at the 195 mg/kg level of EHY.

From the practical stand$Y_{ij} = \mu + B_i + T_j + E_{ij}$, point of cost, the objective of a titration study, such as this, is not only to verify responses, but also to ascertain minimum levels of supplementation where optimal responses are obtained. In a previous study involving crossbred steers, Salinas-Chavira et al. (2015) observed a maximal gain response to EHY supplementation at 240 mg/kg DMI (>130 and ≤ 240 mg/kg). Our findings, with calf-fed Holstein steers, are supportive of this earlier observation.

Consistent with previous studies evaluating EHY in feedlot cattle (Salinas-Chavira et al. 2015; Sanchez-Mendoza et al. 2015), improvements in ADG were largely the result of increased DMI, as gain efficiency and estimated dietary NE were not affected by EHY supplementation (Table 2). Finck et al. (2010) observed increased ADG associated with increased DMI in feedlot steers fed a receiving diet supplemented to provide 830 mg/kg yeast cell wall. In a 50-d feeding trial, Lei et al. (2013) observed increased ADG and gain efficiency in feedlot steers fed 2 g/kg of a yeast cell wall product.

The basis for enhanced energy intake with EHY supplementation is not certain, but may be attributable to modulating effects of EHY on immune status (Nocek et al., 2011; Lei, et al., 2013; Sanchez et al., 2013, 2014). Supplemental EHY has a selective effect against pathogenic bacteria (Ganner et al., 2010), effectively binding lipopolysaccharides within the intestine, preventing their translocation into the circulation (Lei et al., 2013).

Consistent with overall treatment effects on ADG, EHY supplementation enhanced ($P = .04$) carcass weight. Again, response tended to be maximal (15.6 kg; quadratic effect, $P = .07$) at the 195 mg/kg level of Celmanax supplementation. Treatment effects on other carcass measures (Table 3) were not statistically significant ($P > .20$) with the exception of estimated carcass boneless closely trimmed retail yield, which was slightly lower (0.7%, $P = .04$) with EHY supplementation.

Table 2. Influence of Celmanax supplementation on growth performance of feedlot steers.

	Celmanax (mg/kg, DM)					*P*-value		
Item	0	195	390	585	SEM	*L*	*Q*	0 vs. TMT
Days on test	336	336	336	336				
Pen replicates	7	7	7	7				
Live weight (kg)[a]								
Initial	133.2	132.8	132.8	133.3	0.28	0.78	0.10	0.45
Final	587.8	616.0	604.3	597.0	6.9	0.62	0.02	0.04
ADG (kg)								
1–112 d	1.19	1.26	1.23	1.20	0.02	0.95	0.03	0.09
112–224 d	1.47	1.55	1.52	1.50	0.03	0.62	0.11	0.13
224–336 d	1.39	1.51	1.46	1.43	0.03	0.64	0.04	0.06
1–336 d	1.35	1.44	1.40	1.38	0.02	0.63	0.02	0.04
DMI (kg/d)								
1–112 d	5.33	5.61	5.46	5.46	0.08	0.48	0.08	0.06
112–224 d	8.02	8.65	8.45	8.36	0.11	0.12	<0.01	<0.01
224–336 d	10.03	10.92	10.69	10.46	0.13	0.14	<0.01	<0.01
1–336 d	7.79	8.39	8.20	8.01	0.09	0.12	<0.01	<0.01
ADG/DMI (kg/kg)								
1–112 d	0.224	0.225	0.225	0.221	0.002	0.44	0.35	0.87
112–224 d	0.184	0.179	0.180	0.180	0.002	0.32	0.37	0.15
224–336 d	0.139	0.138	0.137	0.138	0.003	0.65	0.72	0.61
1–336 d	0.174	0.171	0.171	0.171	0.002	0.37	0.62	0.30
Dietary NE (Mcal/kg)								
Maintenance								
1–112 d	1.88	1.87	1.88	1.86	0.02	0.40	0.70	0.55
112–224 d	2.12	2.09	2.09	2.08	0.02	0.23	0.50	0.15
224–336 d	2.17	2.16	2.14	2.15	0.03	0.61	0.78	0.63
1–336 d	2.12	2.11	2.10	2.10	0.02	0.45	0.83	0.47
Gain								
1–112 d	1.24	1.23	1.24	1.22	0.01	0.40	0.70	0.55
112–224 d	1.45	1.42	1.42	1.42	0.02	0.23	0.50	0.15
224–336 d	1.49	1.49	1.47	1.48	0.03	0.61	0.78	0.63
1–336 d	1.45	1.44	1.43	1.43	0.02	0.45	0.83	0.47
Observed: expected dietary NE								
Maintenance								
1–112 d	0.85	0.85	0.85	0.84	0.01	0.40	0.70	0.55
112–224 d	0.96	0.95	0.95	0.94	0.01	0.23	0.50	0.15
224–336 d	0.98	0.98	0.97	0.97	0.02	0.61	0.78	0.63
1–336 d	0.96	0.95	0.95	0.95	0.01	0.45	0.83	0.47
Gain								
1–112 d	0.81	0.81	0.81	0.80	0.01	0.40	0.70	0.55
112–224 d	0.95	0.93	0.93	0.93	0.01	0.23	0.50	0.15
224–336 d	0.98	0.97	0.96	0.97	0.02	0.61	0.78	0.63
1–336 d	0.96	0.95	0.95	0.95	0.01	0.45	0.83	0.47

[a]Initial weight is the shrunk off truck arrival weight. Interim and final weights were reduced 4% to account for digestive tract fill.

Table 3. Influence of Celmanax supplementation on carcass characteristics of Holstein steers.

	Celmanax (mg/kg, DM)					*P*-value		
Item	0	195	390	585	SEM	*L*	*Q*	0 vs. TMT
Pen replicates	6	6	6	6				
Hot carcass weight (kg)	366.5	382.1	378.0	375.7	4.6	0.27	0.07	0.04
Dressing percentage	62.5	62.2	62.7	63.1	0.6	0.41	0.58	0.82
Longissimus area (cm^2)	81.6	80.6	79.8	82.4	1.22	0.79	0.14	0.60
Fat thickness (cm)	0.81	0.95	0.76	1.00	0.06	0.19	0.40	0.23
KPH (%)[a]	2.34	2.46	2.26	2.41	0.06	0.98	0.81	0.60
Yield grade (%)[b]	50.1	49.6	50.0	49.7	0.2	0.24	0.23	0.04
Marbling score[c]	4.65	5.61	4.96	5.22	0.41	0.57	0.41	0.21

[a]Kidney, pelvic, and heart fat as a percentage of carcass weight.
[b]Estimated proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck (Murphey et al. 1960).
[c]Coded: minimum slight = 3, minimum small = 4, etc.

4. Conclusions

Supplementation with EHY enhances DMI and ADG of calf-fed Holstein steers throughout all phases of the growing-finishing period. However, effects of supplemental EHY on gain efficiency and dietary net energy were not appreciable. Improvement in daily weight gain is reflected in marked increase (15 kg) in final carcass weight.

Disclosure statement

No potential conflict of interest was reported by the authors.

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