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INFLUENCE OF YEAST CULTURE ON HEALTH, PERFORMANCE AND DIGESTIVE FUNCTION OF FEEDLOT STEERS

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ABSTRACT: One hundred twelve shipping-stressed crossbred calves (190 kg) were used to evaluate the influence yeast culture (0 vs 28.4 g Diamond V-XP/ steer/d; Diamond V Mill, Cedar Rapids, IA) for 28 d on health and performance during a 56-d receiving period. Yeast supplementation was evaluated in 2 starting programs (starting calves on chopped forage for the initial 7 d followed with a 72% concentrate receiving diet versus starting calves directly on the 72% concentrate receiving diet) in a 2×2 factorial arrangement. Steers were assigned to 16 pens (7 steers/pen). Yeast did not influence (P > .10) ADG and feed efficiency. However, yeast reduced (P < .05) morbidity (48%) and total sick days (44%). Yeast did not influence (P > .10) the average number of treatment days for calves pulled as sick. Starting program did not influence (P > .10) ADG. However, 56-d feed efficiency was greater (9%, P < .01) for calves started directly on the 72% concentrate receiving diet. Differences in feed efficiency were consistent with differences in diet energy density. Observed versus expected dietary NE was similar (104 versus 105%, respectively; P > .10) for the two starting programs. Four steers (252 kg) with ruminal and duodenal cannulas were used in a crossover design to evaluate the influence of yeast supplementation of the 72% concentrate receiving diet on characteristics of digestion. There were no treatment effects on ruminal and total tract digestion of OM, NDF, N, and starch, and ruminal pH and VFA molar proportions. We conclude that supplementation of the receiving diet with yeast may be a very effective means of reducing morbidity in shipping stress feedlot calves. However, yeast supplementation does not appear to have a direct effect on growth performance or digestive function.

Introduction

The use of yeast cultures as feed adjuvants has become commonplace in the feedlot cattle industry. Observed benefits include: reduced sick days during the receiving period (Cole et al., 1992); increased K, Cu, Zn, and Fe retention (Peterson et al., 1987; Cole et al., 1992); increased ruminal cellulolytic bacteria in ruminal fluid (Dawson et al., 1990); and increased rate of in situ (Williams et al., 1991) and in vitro (Ruf et al., 1953), in in vivo (Zinn and Borquez, 1993) fiber digestion. The objective of this study was to evaluate the effects of yeast culture supplementation on health and performance of shipping-stressed calves during a 56-d receiving-growing period, and on site and extent of OM, NDF, starch and N digestion.

Materials and Methods

Trial 1 (receiving). One hundred twelve crossbred male calves were used in a 56-d receiving trial to evaluate the influence of yeast culture on health and growth-performance. Calves were assembled from sale barns in Central Texas and trucked to the Desert Research and Extension Center, El Centro, CA. Calves were in-transit roughly 30 hr. Upon arrival (April 29, 1998), calves were vaccinated for bovine rhinotracheitis-parainfluenza$_3$ (TSV-2®, SmithKline Beecham, West Chester, PA), clostridials (Fortress 8®, SmithKline Beecham, West Chester, PA), and pasteurella haemolytica (One Shot®, SmithKline Beecham, West Chester, PA), treated for parasites (Spotton®, Miles, Shawnee Mission, KA), injected with 1 million units of vitamin A (Vita-jec® A&D "500", RXV Products, Porterville, CA), and implanted with Synovex-C (Forte Dodge Animal Health, Forte Dodge, IA). Bulls calves were castrated via elastration, and horns, if present, were trimmed at the base of the skull. Calves were blocked according to sex on arrival (steer vs bulls), and randomly assigned to 16 pens (5.48 × 9.14 m with 26.7 m^2 of shade). Two receiving strategies were evaluated: 1) 72% concentrate receiving diet (Flaked corn 54%, alfalfa hay 14%, sudangrass hay 14%, urea .4%, TM salt .4%, limestone .9%, magnesium oxide .15%, cane molasses 8.0%, chromic oxide .4%, fishmeal 2.0%, CSM 4.0%, and yellow grease fat 2.0%) or 2) 7 d of forage-based diet (alfalfa hay 46.5%, sudangrass hay 46.5%, and cane molasses 7%) followed by the 72% concentrate receiving diet. Yeast supplementation (0 vs 28.4 g Diamond V-XP/ steer/d for 28 d; Diamond V Mill, Cedar Rapids, IA) was evaluated across receiving strategy in a 2×2 factorial arrangement. Calves were allowed ad libitum access to experimental diets. Fresh feed was provided twice daily. Live weights were obtained on d 0, 28 and 56. Energy gain (**EG**) was weight gain, the energy gain was calculated by the equation: EG = (.0557BW$^{.75}$)ADG$^{1.097}$, where EG is the daily energy deposited (Mcal/d), ADG is weight gain (kg/d) and BW is the mean body weight (kg; NRC, 1984). Maintenance energy expended (Mcal/d, EM) was calculated by the equation: EM = .077BW$^{.75}$ (NRC, 1984). The NE$_m$ and NE$_g$ value of the diets were obtained by means of the quadratic formula ($x = \frac{-b \pm \sqrt{b^2-4ac}}{2c}$) where a = -.41EM, b = .877EM + .41DMI + EG, c = -.877DMI, and NE$_g$ = .877NE$_m$ - .41. Calves visually diagnosed as sick received medication until rectal temperature remained below 39.4 C for two consecutive d. This trial was analyzed as a completely randomized design experiment (Hicks, 1973).

Trial 2 (metabolism). Four steers (252 kg) with ruminal and duodenal cannulas were used in a crossover design to evaluate the influence of yeast culture (0 vs 28.4 g Diamond V-XP/ steer/d) on characteristics of digestion of the 72%

concentrate receiving diet used in Trial 1. Chromic oxide (.4%) was added to the diet as a digesta marker. Yeast was mixed directly with the basal diet at the time of feeding. Steers were maintained in individual slotted-floor pens (3.9 m^2) with free access to water. Feed intake was restricted to 5.7 kg/d (2.3% of BW). Steers were adapted to the basal diet for 14 d prior to beginning the trial. Diets were fed to all steers in equal proportions at 0800 and 2000 daily. During collection, duodenal and fecal samples were taken twice daily as follows: d 1, 0750 and 1350; d 2, 0900 and 1500; d 3, 1050 and 1650, and d 4, 1200 and 1800. During the final day of each collection period, ruminal samples were obtained from each steer at 4 h after feeding, via the ruminal cannula. Ruminal fluid pH was determined on fresh samples. Ruminal fluid samples were strained through 4 layers of cheesecloth. Freshly prepared 25% (wt/vol) *m*-phosphoric acid (2 mL) was added to 8 mL of strained ruminal fluid. Samples were then centrifuged (17,000 x g for 10 min) and supernatant fluid stored at -20^o C for analysis of VFA concentrations (gas chromatography). Upon completion of the trial, approximately 500 mL of ruminal fluid were obtained from each steer, and composited; bacteria were isolated via differential centrifugation (Bergen et al., 1968). The microbial isolates were prepared for analysis by oven drying at 70^{o}C and ground with mortar and pestle. Feed, duodenal and fecal samples were prepared for analysis by oven drying at 70^{o}C and ground in a lab mill (Micro-Mill, Bel-Arts Products, Pequannock, NJ). Samples were oven dried at 105^{o}C until no further weight was lost and stored in tightly sealed glass jars. Samples were subjected to all or part of the following analyses: ash, ammonia N, Kjeldahl N (AOAC, 1984); chromic oxide (Hill and Anderson, 1958); NDF (Goering and Van Soest, 1970, corrected for neutral detergenent insoluble ash); purine (Zinn and Owens, 1986); and starch (Zinn, 1990). Microbial organic matter (MOM) and N (MN) leaving the abomasum were calculated using purine as a microbial marker (Zinn and Owens, 1986). Organic matter fermented in the rumen was considered equal to OM intake minus the difference between the amount of total OM reaching the duodenum and MOM reaching the duodenum. Feed N escape to the small intestine was considered equal to total N leaving the abomasum minus ammonia-N and MN and, thus, includes any endogenous additions. This trial was analyzed as a crossover design experiment.

Results and Discussion

Treatment effects on health and growth performance are shown in Table 1. Consistent with numerous earlier studies (Hatch et al., 1972; Adams et al., 1981; Phillips and VonTungeln, 1985; Cole et al., 1992; Zinn and Borquez, 1993), yeast supplementation did not influence (P > .10) ADG and feed efficiency. In contrast, Phillips and VonTungeln (1985) observed increased ADG and DM intake with yeast supplementation during a 21-d period following a 36-h fast.

Yeast supplementation produced a marked reduction (P < .05) in morbidity (48%) and total sick days (44%). Cole et al (1992) observed a reduction in average sick days (from 6.1 to 4.5 d) with yeast supplementation. Yeast did not influence (P > .10) the average number of treatment days per calf pulled as sick.

Starting calves on chopped forage vs the 72% concentrate receiving diet did not affect (P > .10) ADG. However, 56-d feed efficiency was better (9%, P < .01) for calves started directly on the 72% concentrate receiving diet. Differences in feed efficiency between starting programs were consistent with diet energy density, as evidenced by the similarity in ratios of observed/expected dietary NE (104 versus 105%, respectively; P > .20).

Treatment effects on characteristics of digestion are shown in Table 2. Consistent with some earlier studies (LeGendre et al., 1957; Adams et al., 1981; Malcolm and Kiesling (1990), yeast supplementation did not affects (P > .20) on ruminal or total tract digestion of OM, NDF, N, or starch. However, in some instances (Ruf et al., 1953; Dawson et al., 1990; Williams et al., 1991; Zinn and Borquez, 1993) yeast supplementation has increased fiber digestion.

Consistent with Zinn and Borquez (1993), there were no treatment effects on and ruminal pH and VFA molar proportions (Table 3).

Implications

We conclude that supplementation of the receiving diet with yeast culture can be a very effective means of reducing morbidity in shipping stress feedlot calves. However, yeast culture supplementation does not appear to have a direct effect on growth performance or digestive function.

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Table 1. Treatments effects on health and growth performance of feedlot steers.

	Treatments[a]				
Item	Y-FG	0-FG	Y-CC	0-CC	SEM
Days on test	56	56	56	56	
Pens	4	4	4	4	
Live weight, kg					
Initial	167	166	165	167	3
d 28	196	195	196	199	4
d 56	233	229	233	238	4
DM intake, kg/d					
d 1 - 28	3.76	3.80	3.67	3.83	.15
d 28 -56	5.82	5.70	5.47	5.71	.16
d 1 - 56	4.79	4.75	4.57	4.77	.13
Daily weight					
d 1 - 28	1.06	1.04	1.12	1.16	.07
d 28 -56[b]	1.30	1.21	1.32	1.38	.05
d 1 - 56[b]	1.18	1.13	1.22	1.27	.05
Feed/gain					
d 1 - 28[b]	3.63	3.79	3.36	3.36	
d 28 -56[c]	4.50	4.75	4.20	4.18	.19
d 1 - 56[d]	4.04	4.24	3.75	3.78	.12
Treated as sick[e]	21.4	42.9	17.9	39.3	7.6
Total sick days[e]	5.3	12.8	4.5	9.5	2.4
Sick days[f]	3.4	4.1	2.6	3.6	.6
Death loss	0	0	3.6	3.6	2.5
Dietary NE,					
Maintance[c]	1.97	1.92	2.08	2.07	.05
Gain[c]	1.32	1.27	1.42	1.40	.04
Observed/expected diet					
Maintance	1.04	1.02	1.04	1.03	.03
Gain	1.06	1.02	1.06	1.05	.03

[a]0-FG = 0g yeast/d, 7-d forage diet; Y-FG = 28g yeast/d, 7-d forage diet; 0-CC = 0g yeast/d, 72% concentrate diet; Y-CC = 28.4g yeast/d, 72% concentrate diet.

[b]Roughage effect, P < .10.

[c]Roughage effect, P < .05.

[d]Roughage effect, P < .01.

[e]Yeast effect, P < .05.

[f]Averaged on sick-steer days

Table 2. Influence of yeast culture on characteristics of digestion in steers.

	Treatments[a]		
Item	Control	Yeast	SEM
Steers	4	4	
Intake, g/d			
DM	5730	5730	
OM	5319	5319	
NDF	1229	1229	
N	119	119	
Starch	2151	2151	
Rumen digestion, %			
OM	54.1	55.1	2.8
NDF	40.0	43.0	1.3
Feed N	47.3	44.3	2.6
Starch	79.6	82.3	2.9
MN_{eff}[a]	28.4	26.5	.96
N_{eff}[b]	1.21	1.20	.03
Post ruminal digestion, %			
OM	55.8	54.8	.6
N	69.6	70.1	1.5
Starch	92.0	89.6	1.1
Total tract digestion,			
OM	73.1	73.1	.9
NDF	39.9	40.8	2.5
N	62.6	63.2	1.2
Starch	98.4	98.0	.4

[a]Control = 0g yeast/d, 72% concentrate recediet; Yeast = 28.4g yeast/d, 72% concentrate diet.

[b]Grams microbial N/kg OM fermented.

[c]Nonammonia N leaving the abomasum/N intake

Table 3. Influence of yeast culture additon on ruminal pH, VFA molar proportions, and estimated methane production.

	Treatments[a]		
Item	Control	Yeast	SEM
Ruminal pH	6.32	6.19	.14
Ruminal VFA, mol/100 mol			
Acetate	57.7	58.0	1.2
Propionate	31.2	30.2	1.05
Butyrate	11.1	11.7	1.3

[a]Control = 0g yeast/d, 72% concentrate diet; Yeast = 28.4g yeast/d, 72% concentrate diet.