Effects of Roughage Level and Fibrozyme™ Supplementation on Performance and Carcass Characteristics of Finishing Beef Steers

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Story in Brief

The objective of this experiment was to determine the effects of roughage level and Fibrozyme™ (a fibrolytic enzyme) supplementation on performance and carcass characteristics of finishing beef steers. Steers were fed a dry rolled corn-based finishing diet containing 4.5 or 9.0% alfalfa hay (DM basis), with or without Fibrozyme™ supplementation. Enzyme supplementation was more efficacious in the 4.5% roughage diet, particularly on a carcass-adjusted basis.

Key Words: Beef Cattle, Fibrolytic Enzyme, Roughage Level

Introduction

Roughage can be difficult to handle and process when compared to most cereal grains. When the cost of roughage is calculated on an energy basis, it can be one of the most costly ingredients in a finishing diet. However, some degree of roughage inclusion is required in feedlot diets to maintain normal ruminal function. Inadequate roughage levels can lead to increased incidents of acidosis, liver abscesses, and erratic feed intake, all causing a decrease in animal performance and profitability. Beauchemin et al. (2003) reported a 6 to 12% improvement in feed efficiency when fibrolytic enzymes were added to finishing diets. In fact, Beauchemin et al. (2003) has reported that the addition of fibrolytic enzymes to high-concentrate diets produces more consistent results than enzyme supplementation in high-roughage diets. Ruminal pH plays an important role in fiber digestion. When cattle are fed high-concentrate diets, ruminal pH typically ranges from 5.8 to 6.2, causing a depression in ruminal fiber digestion because the cellulolytic organisms within the rumen require a pH of 6.5 or greater for maximum growth. In fact, growth of these organisms may cease at a pH of less than 6.0 (Zinn and Ware, 2003). Therefore, it appears that the addition of an additive that may enhance the ruminal digestion of fibrous compounds in the diet may be beneficial to animal performance in beef finishing diets.

The objective of this experiment was to evaluate the effects of fibrolytic enzyme supplementation on the performance and carcass characteristics of steers fed a finishing diet with different levels of roughage inclusion (4.5 or 9.0% alfalfa hay).

Materials and Methods

Cattle. One hundred eighty-five crossbred yearling steers (avg initial BW = 755 ± 92.9 lbs) were delivered to the Willard Sparks Beef Research Center on April 30, 2004. Upon arrival, all cattle were weighed and ear tagged. The cattle were offered ad libitum access to water and hay. The following morning, all cattle were processed (Bovishield 5, Pfizer; Vision 7, Intervet; Ivomec Plus; Merial), implanted (Revalor-S, Intervet), and weighed again. Horns were tipped as needed. All bulls (one animal) were castrated. Initial weight of the steers was determined by calculating the average weight of each animal measured on d 0 and d 1.

Treatment and Pen Assignment. One hundred and eighty-four steers were used in the trial. Steers were stratified by BW into four blocks consisting of 40 steers in the lightest block and 48 steers per block in the remaining three blocks. Steers were then randomly assigned to one of eight pens within each block, resulting in five (lightest block) or six (three heaviest blocks) steers per pen. One of the four treatments was assigned randomly to each pen within a block, resulting in two pens for each treatment within block. During processing, steers were sorted into their treatment pens. The resulting number of experimental units for each treatment was eight. Step 1 of the adaptation diets began on May 1, 2004. Steers were gradually adapted to the final diets by offering 65, 75, 85, and 91% concentrate diets for approximately 5 d each. Steers assigned the diets containing 95.5% concentrate were offered their final diet after receiving the 91% concentrate diet for 5 d. Fibrozyme™ (Alltech Inc., Nicholasville, KY) was included in the adaptation diets of those pens assigned to Fibrozyme-containing final diets.

Treatments (Table 1) included: 1) no enzyme and 9% alfalfa hay (9N); 2) no enzyme and 4.5% alfalfa hay (4.5N); 3) Fibrozyme (10 $g \cdot steer^{-1} \cdot d^{-1}$) and 9% alfalfa hay (9Y); or 4) Fibrozyme (10 $g \cdot steer^{-1} \cdot d^{-1}$) and 4.5% alfalfa hay (4.5Y). All treatment diets were mixed in a batch mixer (Roto-Mix, Dodge City, KS), weighed into large buckets, and delivered to pens using these buckets. The level of Fibrozyme inclusion per batch was calculated based upon the pen (within each enzyme-containing treatment) consuming the least amount of feed to ensure minimum dietary enzyme dosage.

Table 1. Ingredient composition of the dietary treatments (DM basis)

	No Fibrozyme		Fibrozyme[a]	
Ingredient	4.5% Alfalfa	9.0% Alfalfa	4.5% Alfalfa	9.0% Alfalfa
Rolled corn	80.0	76.5	80.0	76.5
Alfalfa hay	4.50	9.00	4.50	9.00
Fat	3.00	3.00	3.00	3.00
Cane molasses	4.00	4.00	4.00	4.00
Soybean meal	3.90	3.15	3.90	3.15
Cottonseed meal	1.30	1.05	1.30	1.05
Wheat midds	.81	1.10	.81	1.10
Limestone, 38%	1.42	1.25	1.42	1.25
Urea	.60	.60	.60	.60
Salt	.25	.25	.25	.25
Availa Zn 100	.05	.05	.05	0.05
Vitamin A – 30,000	.011	.011	.011	.011
Zinc sulfate	.003	.003	.003	.003
Manganous oxide	.004	.004	.004	.004
Potassium chloride	.12	-	.12	-
Rumensin 80	.019	.019	.019	.019
Tylan 40	.013	.013	.013	.013
Nutrient composition, DM basis[b]				
NE_m, Mcal/cwt	99.9	98.1	99.9	98.1
NE_g, Mcal/cwt	65.4	63.9	65.4	63.9
Fat, %	6.5	6.5	6.5	6.5

NDF, %	10.2	11.9	10.2	11.9
CP, %	13.0	13.0	13.0	13.0
Ca, %	.70	.70	.70	.70
P, %	.30	.30	.30	.30

[a]Fibrozyme replaced corn or wheat midds per label instructions

[b]Values based on diet formulation

Management, Feeding, and Weighing Procedures. Feed refused was weighed at 28-d intervals and following inclement weather. Samples of these orts were dried to determine DM content of the feed refused to accurately measure DMI.

Interim unshrunk BW measurements were taken to assess performance of the cattle. Individual BW measurements were taken on d 28 and 84; pen BW measurements were taken on d 56 and 112. Once 60% of the animals within each block was subjectively estimated to have reached a Low-Choice USDA Quality Grade, the entire block was shipped to a harvest facility. The heaviest block of steers was shipped on the morning of d 126. The remaining three blocks of steers were shipped on the evening of d 159.

Statistical Analysis. Performance data and normally distributed carcass characteristics were analyzed as a randomized complete block design with a 2 x 2 factorial arrangement of treatments using the MIXED procedure of SAS Release 8.02 (SAS Institute Inc., Cary, NC). The model included terms for Fibrozyme, roughage level, and the Fibrozyme x roughage level interaction. Block was included as a random effect. Non-parametric USDA quality grade data was transformed using the Freidman's test by listing the percentage of Choice and Select for each pen within a block, and then analyzed as the normally distributed data from above. Pen was the experimental unit. Results were considered significant if $P \leq 0.10$.

Results and Discussion

Animal Performance. Effects of roughage level and Fibrozyme supplementation on feedlot steer performance are given in Table 2. Neither initial nor final BW was affected ($P \geq 0.15$) by treatment. Carcass-adjusted final BW were calculated by dividing the average hot carcass weight of the pen by the average dressing percent of the entire group of animals on trial in order to eliminate any effects gut fill may have on BW. An effect of Fibrozyme™ supplementation was detected (P=0.05) for carcass-adjusted final BW. Averaged across roughage levels, steers receiving Fibrozyme were 23.4 lbs heavier (1348 vs 1325 lbs) on a carcass-adjusted basis than steers not fed Fibrozyme. However, one must be cautious when interpreting these results because a roughage level x enzyme supplementation interaction was also detected (P=0.08) for carcass-adjusted final BW. Carcass-adjusted BW of steers fed the 4.5N diet was lighter (P=0.01) than the carcass-adjusted BW of steers fed the 4.5Y diet; however, carcass-adjusted BW of steers fed the 9N diet did not differ (P=0.86) from the carcass-adjusted final BW of steers fed the 9Y diet.

Dry matter intake was not affected ($P \geq 0.21$) by roughage level nor Fibrozyme supplementation during any period in the study.

Average daily gain was unaffected (P≥0.13) by treatment during any period of the study. However, Fibrozyme supplementation increased (P=0.10) carcass-adjusted ADG, calculated using carcass-adjusted final BW minus initial BW divided by days on feed. Steers receiving Fibrozyme gained 3.19% more weight per day on a carcass-adjusted basis than steers not receiving Fibrozyme (4.01 vs 3.89 lbs/d). A roughage level x enzyme supplementation interaction was also detected for carcass-adjusted ADG (P=0.07). Steers fed the 4N diet gained less weight (P=0.02) on a carcass-adjusted basis than those receiving the 4Y diet; however, there was no difference (P=0.89) in carcass-adjusted ADG between steers fed the 9N and 9Y diets.

The main effects of enzyme supplementation and roughage level on feed conversion (reported as feed:gain; F:G) were not significant (P≥0.14) during any period of the study. The adjusted feed efficiency, calculated as DMI divided by the carcass-adjusted ADG, was not affected (P≥0.34) by the enzyme supplementation or roughage level main effects. However the interaction was significant (P=0.10) for the adjusted feed conversion. Steers fed the 4N diet were less efficient (P=0.07) than those fed the 4Y diet; however, there was no difference (P=0.63) in the adjusted feed efficiency of steers receiving the 9N or 9Y treatments.

Table 2. Effects of roughage level and Fibrozyme™ supplementation on feedlot steer performance

	No Fibrozyme		Fibrozyme		
Item	4.5% Alfalfa	9.0% Alfalfa	4.5% Alfalfa	9.0% Alfalfa	SEM[a]
BW, lbs					
Initial[b]	741	738	748	744	50.3
Final	1322	1331	1353	1338	41.0
Adj. final[ch]	1311	1338	1355	1341	45.2
ADG, lbs/d					
d 1-28	4.77	4.58	4.87	5.04	.230
d 1-56	4.78	4.54	4.87	4.80	.142
d 1-84	4.29	4.36	4.54	4.29	.124
d 1-112	4.10	4.12	4.18	4.19	.102
d 1-end	3.85	3.94	4.03	3.95	.108
Adj. 1-end[fh]	3.78	3.99	4.04	3.98	.130
DMI, lbs/d					
d 1-28	19.5	18.6	19.4	19.5	.736
d 1-56	21.3	20.9	21.3	21.4	.815
d 1-84	21.6	21.7	21.8	22.0	.827
d 1-112	21.6	22.0	21.8	22.2	.797
d 1-end	21.3	22.0	21.9	22.1	.800
Efficiency, F:G					
d 1-28	4.15	4.07	4.02	3.89	.118
d 1-56	4.47	4.60	4.36	4.46	.094
d 1-84[e]	5.05	4.99	4.81	5.12	.102
d 1-112	5.28	5.35	5.21	5.29	.116
d 1-end	5.53	5.59	5.42	5.60	.110
Adj. 1-end[h]	5.64	5.51	5.41	5.57	.100

[a]Standard error of the mean, n = 8 pens per treatment

[b]Calculated as the average weight of the animal as measured on d 0 and d 1

[c]Enzyme effect, P≤0.05

[d]Roughage level effect, P≤0.05

[e]Enzyme x roughage level interaction, P≤0.05

[f]Enzyme effect, P≤0.10

[g]Roughage level effect, P≤0.10

[h]Enzyme x roughage level interaction, P≤0.10

Carcass Characteristics. Effects of roughage level and Fibrozyme supplementation on carcass characteristics of feedlot steers are given in Table 3. An enzyme effect was significant (P=0.05) for hot carcass weight. Averaged across roughage levels, carcasses of steers fed diets containing Fibrozyme were 13.9 lbs heavier than carcasses of steers not receiving the enzyme (801 vs 787 lbs). An interaction was also detected (P=0.08) for hot carcass weight. Steers fed the 4Y diet had heavier (P=0.01) carcass weights than those steers fed the 4N diet. No difference was detected (P=0.86) in hot carcass weights of steers fed the 9N and 9Y diets. The main effect of roughage level on hot carcass weights was not significant (P=0.60). Dressing percent was not affected (P≥0.19) by treatment.

Because dressing percent was unaffected by treatment, it cannot be assumed that the differences detected in carcass weights of the steers was due to gut fill. The effect of enzyme supplementation on hot carcass weights was most likely a result of numerically heavier final BW of the steers receiving Fibrozyme compared with those steers not receiving the enzyme (1345 vs 1327 lbs). The heavier BW of the steers fed Fibrozyme likely resulted in heavier carcass weights compared with steers not receiving the enzyme; a slight decrease in variability of carcass weights could explain why the enzyme-supplemented steers produced statistically significant heavier carcasses while final BW were unaffected.

Neither longissimus muscle area, back fat measured at 12/13th rib, nor kidney, heart, and pelvic fat were affected by treatment (P≥0.17). Neither the main effect of roughage level nor enzyme supplementation affected (P=0.30) calculated yield grade scores. However, a roughage level x enzyme supplementation interaction was detected (P=0.06) for yield grade. Steers fed the 4N diets had lower (P=0.04) yield grade scores than steers fed the 4Y diets. Steers fed the 9N and 9Y diets did not differ (P=0.53) in yield grade scores. This interaction may be of little consequence and repeatability because none of the measurements used in the yield grade equation exhibited significant interactions. Neither marbling score nor the percentage of Choice or better were affected (P≥0.18) by treatment.

Table 3. Effects of roughage level and Fibrozyme™ supplementation on feedlot steer carcass characteristics

	No Fibrozyme		Fibrozyme		
Item	4.5% Alfalfa	9.0% Alfalfa	4.5% Alfalfa	9.0% Alfalfa	SEM[a]
Carcass wt, lb[bg]	779.4	795.1	805.5	796.8	26.9
Dressing percent	58.95	59.71	59.54	59.52	.004
LM area, in^2	13.38	13.40	13.12	13.47	.453
Grade fat, in	.537	.591	.587	.570	.031
KPH, %	1.78	1.87	1.79	1.76	.052

Yield Grade[g]	2.88	3.09	3.18	3.00	.112
Marbling score	495	511	506	484	29.4
Choice, %[h]	77.50	85.00	78.75	74.79	-
Select, %[h]	22.50	15.00	21.25	25.21	-

[a]Standard error of the mean, n = 8 pens per treatment

[b]Enzyme effect, P≤0.05

[c]Roughage level effect, P≤0.05

[d]Enzyme x roughage level interaction, P≤0.05

[e]Enzyme effect, P≤0.10

[f]Roughage level effect, P≤0.10

[g]Enzyme x roughage level interaction, P≤0.10

[h]Distribution of Choice + Prime vs. Select + Standard carcasses did not differ among treatments (P≥0.34)

Implications

Fibrozyme™ supplementation may be more efficacious for steers fed finishing diets with lower roughage levels (4.5% alfalfa hay used in the present study). If ruminal fiber digestion was more limited in steers fed the diets containing 4.5% alfalfa hay because of a lower ruminal pH and greater inhibition of ruminal fibrolytic bacteria compared to steers fed the diets containing 9.0% alfalfa hay, it may be logical to assume that Fibrozyme™ supplementation would be more efficacious in diets containing steam-flaked corn or wheat because of a more rapidly degradable source of starch in the rumen, possibly depressing ruminal fiber degradation more than a rolled corn-based diet.

Literature Cited

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Acknowledgements

The authors thank Alltech Inc. for providing funding for this project. Gratitude is also expressed to Cimarron Feeders (Grandfield, OK) for providing the cattle used in the study. Many thanks go to the numerous graduate and undergraduate students who helped with this project.

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