

# BURNETT CENTER INTERNET PROGRESS REPORT

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## **Effects of supplemental amylase and roughage source on performance and carcass characteristics of finishing beef cattle**

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### **Introduction**

The use of enzymes in feedlot diets has not been evaluated extensively, and most research with high-concentrate diets has been with barley. Beauchemin et al. (1997) evaluated the addition of two enzyme mixtures that varied in the proportion of xylanase and cellulase activity to 95.1% concentrate feedlot diets based on either barley or corn. Feed efficiency for the overall finishing period was improved approximately 11% with a high-xylanase activity enzyme treatment of barley compared with untreated steam-rolled barley. With corn, however, the addition of the high-cellulase activity enzyme improved feed efficiency compared with no enzyme addition. Less research has been done with the addition of enzyme preparations that contain amylase to cattle diets. Hristov et al. (2000) dosed 0, 100, 200, or 400 g/d of an enzyme preparation that contained carboxymethylcellulase, xylanase,  $\beta$ -glucanase, and amylase into the rumen of cannulated heifers fed an 85.5% rolled barley diet. Enzyme treatment linearly decreased ruminal pH and quadratically increased in situ effective degradability of the diet. Ruminal amylase activity was not increased by dosing the enzyme, but duodenal amylase activity increased quadratically with enzyme addition. J. M. Tricarico (Alltech, Inc., Nicholasville, KY, unpublished data) dosed 0, 12, 24, or 36 g/d of an amylase preparation to 24 Holstein

cows fed a corn silage-ground corn diet. The addition of 12 g/d of amylase increased 24-h ground corn digestibility, milk fat yield, and milk protein yield. Although these data suggest potentially positive effects on cattle performance with addition of enzymes to feedlot diets, performance results for enzyme preparations with high amylase activity are not available in the literature.

Dry matter intake (DMI) by beef cattle fed high-concentrate, grain-based diets is likely controlled by metabolic factors and not limited by bulk fill. Small changes (e.g., 5% of DM or less) in the level of bulky roughage and changing from less fibrous to more fibrous sources of roughage typically increase DMI by feedlot cattle. Galyean and Defoor (2003) hypothesized that much of the effect of roughage source and level on DMI by feedlot cattle could be accounted for by changes in dietary neutral detergent fiber (NDF) supplied by roughage.

The objectives of our experiment were twofold: first, to determine whether the addition of supplemental amylase to a finishing diet affected performance and carcass characteristics of beef cattle; and second, to evaluate whether differences in performance exist when diets are formulated to supply the same percentage of dietary NDF from different roughage sources.

## Experimental Procedures

One hundred twenty steers were blocked by body weight (BW) to six weight blocks, implanted with Ralgro (Schering-Plough Animal Health, Union, NJ) in their right ear, and sorted to their assigned Burnett Center pens. These steers had previously been vaccinated with Vision 7 Somnus (Intervet, Millsboro, DE) and with Bovishield 4 + Lepto (Pfizer Animal Health, Lee's Summit, MO), and had been administered Cydectin (Fort Dodge Animal Health, Overland Park, KS). Five days after assignment to pens, cattle were brought through the working chute to determine an individual starting BW for the experiment.

Four dietary treatments were arranged as a 2 x 2 factorial in a randomized complete block design. Pen was the experimental unit (six pens per treatment with five steers per pen for a total of 120 steers). The four treatments were as follows: **ALF-**, 88% concentrate diet with alfalfa as the roughage source and no added supplemental amylase; **CSH-**, 93.5% concentrate diet with cottonseed hulls as the roughage source and no added supplemental amylase; **ALF+**, 88% concentrate diet with alfalfa as the roughage source plus supplemental amylase; **CSH+**, 93.5% concentrate diet with cottonseed hulls as the roughage source plus supplemental amylase. The amylase enzyme preparation used in this study (Alltech, Inc., Nicholasville, KY) was added to the diets as a dry premix. The premix was 46.07% ground corn (DM basis) and 53.93% amylase enzyme preparation (DM basis). Ingredient composition of the diets fed during the experiment is shown in Table 1. Each diet contained the same intermediate premix (Table 2), which supplied protein, various minerals and vitamins, Rumensin (30 g/ton, DM basis), and Tylan (8 g/ton, DM basis).

Additionally, diets were formulated to contain the same percentage of NDF from roughage (approximately 6%).

Samples of mixed feed delivered to feed bunks were taken weekly throughout the experiment. These bunk sample DM values were used to compute feed DM deliveries to each pen. Samples of feed taken from the bunk were composited across periods of the experiment and analyzed for DM, ash, CP, acid detergent fiber, Ca, and P (Table 3) using AOAC (1990) procedures. Alfalfa hay and cottonseed hull samples were analyzed for NDF using procedures described by Goering and Van Soest (1970).

Feed bunks were evaluated visually at approximately 0700 to 0730 daily. The quantity of feed remaining in each bunk was estimated, and the suggested daily allotment of feed for each pen was recorded. This bunk-reading process was designed to allow for little or no accumulation of unconsumed feed (0 to 1 lb per pen). Feed bunks were cleaned, and unconsumed feed was weighed and dried at intervals (corresponding to intermediate weigh dates) throughout the trial. Feed DM deliveries and weights of unconsumed feed bunk DM were used to calculate DMI by each pen.

After 28, 84, and 112 d on feed, cattle were weighed on a pen basis using a platform scale ( $\pm 5$  lb). On d 56 and just before shipment to slaughter, BW measurements were obtained for individual animals using a single-animal scale (C & S Single-Animal Squeeze Chute set on four load cells). Both scales were calibrated with 1,000 lb of certified weights (Texas Dept. of Agric.) on the day before each scheduled weigh day. On d 56, at the time of the scheduled BW measurement each steer was implanted with Revalor S (Intervet). On d 112, it was visually estimated that steers in

Blocks 5 and 6 would have sufficient finish to grade USDA Choice in approximately 2 wk; therefore, these steers were scheduled to ship to slaughter on d 133 of the experiment. Steers in Blocks 3 and 4 were weighed individually, and shipped to slaughter on d 154 of the experiment, whereas steers in Blocks 1 and 2 were weighed individually on d 168 and shipped to slaughter. All cattle were slaughtered at the Excel Corp. facility in Plainview TX.

**Carcass Collection.** Carcass data were collected by personnel of the Texas Tech University Department of Animal and Food Sciences. Data included hot carcass weight, fat thickness at the 12<sup>th</sup> rib, longissimus muscle area, percentage of kidney, pelvic, and heart fat, liver score, marbling score, quality grade, and yield grade.

**Statistical Analyses.** Performance and carcass data were analyzed as a randomized complete block with a 2 x 2 factorial arrangement of treatments. The fixed effects in the model included roughage source, amylase addition, and the interaction of roughage source x amylase addition. Block was a random effect. Data were analyzed using PROC MIXED of SAS (SAS Inst. Inc., Cary, NC). Percentage of abscessed livers and carcasses grading USDA Choice were analyzed using a non-parametric model (PROC GENMOD of SAS).

## Results and Discussion

**Performance Data.** Performance data are presented in Table 4. An amylase x roughage source interaction was detected for d 0 to 28 average daily gain (ADG;  $P = 0.02$ ). Cattle fed CSH+ had greater ADG than those fed CSH-, ALF+, or ALF-. Similarly, for ADG from d 0 to 112, an amylase x roughage source interaction was

observed ( $P = 0.04$ ), again with cattle fed CSH+ having greater ADG than those fed CSH-. However, for d 0 to 56, d 0 to 84, and overall ADG, no effects ( $P > 0.10$ ) of roughage source, amylase, or the interaction of amylase x roughage source were detected.

An amylase x roughage source interaction ( $P < 0.10$ ) was observed for DMI on d 0 to 56 and on d 0 to 112. Cattle fed the CSH+ diet had greater DMI than those in the other three treatments. In contrast, J. M. Tricarico (Alltech, Inc., Nicholasville, KY, unpublished data) found no difference in DMI by Holstein cows fed graded levels of amylase. In the present study, no differences ( $P > 0.10$ ) were noted among treatments for feed efficiency at any period during the finishing phase.

Although differences were not significant, there were strong trends for an amylase x roughage source interaction for overall ADG ( $P < 0.12$ ), DMI ( $P < 0.20$ ), and feed:gain ( $P < 0.18$ ). These trends were largely the result of the increased ADG and DMI, and improved feed:gain when amylase was supplemented to cattle fed cottonseed hulls as the roughage source (CSH+ diet). It is unclear, however, why cattle fed the amylase enzyme preparation and cottonseed hulls responded in this manner. Perhaps differences in ruminal digesta kinetics between alfalfa and cottonseed hulls affected the need for supplemental amylase either in the rumen or intestines. Additionally, diets containing cottonseed hulls had a higher concentration of cottonseed meal than diets containing alfalfa. Perhaps different protein sources alter the need for additional amylase or the effect of amylase on ruminal fermentation. Effects of supplemental amylase on ruminal fermentation and on digestion of starch in the rumen and intestines are largely unknown and merit further study.

Percentage of NDF from roughage source for the diets (6.32% for ALF+ and ALF-, and 5.86 for CSH+ and CSH-) was determined using chemically measured values for alfalfa and cottonseed hulls. Roughage source did not affect DMI, ADG, or feed efficiency at any point in the feeding period. Based on these data, it seems that performance is not affected by roughage source when the percentage of NDF supplied by the roughage source is similar. This result agrees with the recent findings of Galyean and Defoor (2003).

**Carcass Data.** Carcass data are presented in Table 5. Neither amylase, roughage source, nor the interaction affected ( $P > 0.10$ ) hot carcass weight, dressing percent, fat thickness, percentage of kidney, pelvic, and heart fat, marbling score, yield grade, or percentage of cattle grading USDA Choice or better. The addition of amylase increased longissimus muscle area ( $P = 0.05$ ), but it is unclear why this happened. No effect ( $P > 0.10$ ) of amylase, roughage, or amylase x roughage was noted for liver score data.

### Summary and Conclusions

Based on the results of this study, roughage source did not affect performance when diets were balanced for the percentage of NDF supplied by roughage. The addition of supplemental amylase to a diet containing cottonseed hulls but not alfalfa as the roughage source, increased ADG and DMI at various times during the feeding period (up to 112 d on feed). Perhaps the dynamics of ruminal digesta differed between the alfalfa and cottonseed hull diets, which might have affected the need for amylase at varying times during the feeding period.

Further research is required to determine the need for amylase in diets containing cottonseed hulls as the roughage source, potential effects of amylase on ruminal fermentation, and the role that protein source might play in the effects of amylase.

### Literature Cited

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Table 1. Ingredient composition (% DM basis) of the experimental diets

Ingredient	Treatments <sup>a</sup>			
	ALF+	ALF-	CSH+	CSH-
Alfalfa hay, mid-bloom	12.13	12.13	-	-
Cottonseed hulls	-	-	6.53	6.53
Steam-flaked corn	75.66	75.67	79.47	79.46
Cane molasses	4.14	4.14	4.14	4.14
Yellow grease	3.05	3.05	3.05	3.05
Urea	0.92	0.92	1.22	1.22
Cottonseed meal	1.30	1.30	2.52	2.52
TTU 2.5 supplement <sup>b</sup>	2.54	2.54	2.54	2.56
Limestone	-	-	0.27	0.27
Control premix <sup>c</sup>	-	0.25	-	0.25
Amylase enzyme premix <sup>d</sup>	0.26	-	0.26	-

<sup>a</sup>Dietary treatments: ALF+ = alfalfa as the roughage source plus amylase; ALF- = alfalfa as the roughage source without amylase; CSH+ = cottonseed hulls as the roughage source plus amylase; CSH- = cottonseed hulls as the roughage source without amylase.

<sup>b</sup>Composition of the premix is shown in Table 2.

<sup>c</sup>Control premix was composed of ground corn only.

<sup>d</sup>Amylase enzyme premix was composed (DM basis) of 46.07% ground corn and 53.93% amylase enzyme (Alltech Inc., Nicholasville, KY).

Table 2. Composition of the premix used in experimental diets

Ingredient	%, DM basis
Cottonseed meal	23.3634
Endox (antioxidant) <sup>a</sup>	0.5000
Limestone	42.1053
Dicalcium phosphate	1.0363
Potassium chloride	8.0000
Magnesium oxide	3.5587
Ammonium sulfate	6.6667
Salt	12.0000
Cobalt carbonate	0.0017
Copper sulfate	0.1572
Iron sulfate	0.1333
EDDI	0.0025
Manganese oxide	0.2667
Selenium premix, 0.2% Se	0.1000
Zinc sulfate	0.8450
Vitamin A, 650,000 IU/g <sup>b</sup>	0.0122
Vitamin E, 275 IU/g <sup>b</sup>	0.1260
Rumensin, 80 mg/lb <sup>b</sup>	0.6750
Tylan, 40 mg/lb <sup>b</sup>	0.4500

<sup>a</sup>Kemin Industries, Des Moines, IA.

<sup>b</sup>Concentrations noted by the ingredient are on a 90% DM basis.

Table 3. Chemical composition of the experimental diets

Dietary component	Treatments <sup>a</sup>			
	ALF+	ALF-	CSH+	CSH-
Dry matter, % <sup>b</sup>	81.77	81.96	81.62	81.78
Ash, %	3.91	3.69	3.37	3.46
Crude protein, %	12.24	12.02	12.19	12.66
Acid detergent fiber, %	7.38	7.29	9.31	8.55
Calcium, %	0.67	0.57	0.56	0.65
Phosphorus, %	0.30	0.29	0.31	0.32
NDF from roughage <sup>c</sup>	6.32	6.32	5.86	5.86

<sup>a</sup>Dietary treatments: ALF+ = alfalfa as the roughage source plus amylase; ALF- = alfalfa as the roughage source without amylase; CSH+ = cottonseed hulls as the roughage source plus amylase; CSH- = cottonseed hulls as the roughage source without amylase.

<sup>b</sup>All values except Dry matter, % are expressed on a DM basis.

<sup>c</sup>Calculated based on chemically analyzed values of 52.08% NDF for alfalfa hay and 89.69% NDF for cottonseed hulls.

Table 4. Effects of roughage source and the addition of supplemental amylase on feedlot performance by finishing beef steers<sup>a,b</sup>

Item	ALF		CSH		SE <sup>d</sup>	Effect <sup>c</sup>		
	+	-	+	-		A	R	A x R
Final BW, lb	1,258.9	1,272.1	1,282.9	1,250.2	26.64	0.55	0.95	0.17
Adj. BW, lb <sup>e</sup>	1,258.9	1,271.0	1,289.6	1,248.1	27.85	0.38	0.81	0.12
ADG, lb								
d 0 to 28	3.79	3.85	4.14	3.60	0.16	0.06	0.66	0.02
d 0 to 56	3.19	3.29	3.35	3.10	0.14	0.47	0.87	0.10
d 0 to 84	3.26	3.37	3.44	3.20	0.11	0.58	0.98	0.15
d 0 to 112 <sub>f</sub>	3.16	3.23	3.37	3.05	0.09	0.19	0.87	0.04
d 0 to end <sup>f</sup>	2.94	3.05	3.07	2.89	0.11	0.66	0.88	0.12
Adj. d 0 to end <sup>g</sup>	2.95	3.04	3.12	2.87	0.13	0.44	0.94	0.11
DMI, lb								
d 0 to 28	16.60	16.06	17.28	16.60	0.53	0.10	0.10	0.85
d 0 to 56	16.37	16.41	17.26	16.42	0.48	0.12	0.09	0.09
d 0 to 84	16.35	16.31	17.18	16.31	0.45	0.09	0.11	0.11
d 0 to 112 <sub>f</sub>	16.47	16.51	17.33	16.36	0.43	0.07	0.16	0.05
d 0 to end <sup>f</sup>	16.68	16.73	17.47	16.77	0.42	0.27	0.16	0.20
Feed:gain								
d 0 to 28	4.40	4.18	4.20	4.63	0.13	0.43	0.38	0.02
d 0 to 56	5.16	5.01	5.18	5.34	0.18	0.99	0.22	0.30
d 0 to 84	5.03	4.85	5.00	5.11	0.12	0.75	0.34	0.25
d 0 to 112 <sub>f</sub>	5.22	5.11	5.15	5.37	0.10	0.60	0.36	0.13
d 0 to end <sup>f</sup>	5.70	5.52	5.70	5.82	0.12	0.80	0.19	0.18
Adj. d 0 to end <sup>g</sup>	5.71	5.53	5.61	5.86	0.14	0.82	0.44	0.15

<sup>a</sup>Roughage source: ALF = alfalfa hay; CSH = cottonseed hulls.

<sup>b</sup>Amylase addition: + = added amylase to the diet; - = no added amylase to the diet.

<sup>c</sup>Observed significance level for the effect: A = amylase effect; R = roughage effect; A x R = amylase x roughage interaction.

<sup>d</sup>Standard error of the treatment means, n = six pens per treatment.

<sup>e</sup>Adjusted final BW = hot carcass weight divided by a common dressing percent of 62.84%.

<sup>f</sup>Blocks 5 and 6 were fed for 133 d, Blocks 3 and 4 were fed for 154 d, and Blocks 1 and 2 were fed for 168 d.

<sup>g</sup>Calculated using adjusted final BW.



Table 5. Effects of roughage source and the addition of supplemental amylase on carcass characteristics of beef steers<sup>a,b</sup>

Item	ALF		CSH		SE <sup>d</sup>	Effect <sup>c</sup>		
	+	-	+	-		A	R	A x R
Adjusted BW, lb <sup>e,f</sup>	1,258.9	1,271.0	1,289.6	1,248.1	27.85	0.38	0.81	0.12
HCW, lb <sup>g</sup>	791.1	798.4	809.9	784.2	18.07	0.42	0.84	0.16
Dress, % <sup>h</sup>	62.76	62.79	63.09	62.73	0.32	0.60	0.68	0.54
Fat thickness, in <sup>i</sup>	0.49	0.50	0.52	0.47	0.04	0.60	0.93	0.43
LMA, in <sup>2j</sup>	13.79	13.41	13.78	12.83	0.31	0.05	0.35	0.37
KPH, % <sup>k</sup>	2.08	2.08	2.13	2.13	0.14	0.99	0.52	0.95
Marbling <sup>l</sup>	484.0	485.2	489.6	480.7	15.16	0.80	0.97	0.74
Yield grade	2.73	2.91	2.89	2.98	0.19	0.44	0.50	0.81
Choice, %	86.7	93.1	92.9	96.6	-	0.54	0.54	0.97
Abscessed liver, % <sup>m</sup>	13.3	13.8	17.9	17.2	-	0.87	0.72	0.53

<sup>a</sup>Roughage source: ALF = alfalfa hay; CSH = cottonseed hulls.

<sup>b</sup>Amylase enzyme addition: + = added amylase to the diet; - = no added amylase to the diet.

<sup>c</sup>Observed significance level of the effect: A = amylase; R = roughage effect; A x R = amylase x roughage interaction.

<sup>d</sup>Standard error of the treatment means, n= six pens per treatment.

<sup>e</sup>Blocks 5 and 6 were fed for 133 d, Blocks 3 and 4 were fed for 154 d, and Blocks 1 and 2 were fed for 168 d.

<sup>f</sup>Adjusted final BW = hot carcass weight divided by a common dressing percent of 62.84%.

<sup>g</sup>Hot carcass weight.

<sup>h</sup>(Carcass weight/final weight) x 100.

<sup>i</sup>Back fat thickness at the 12<sup>th</sup> rib.

<sup>j</sup>Longissimus muscle area.

<sup>k</sup>Percentage of kidney, pelvic, and heart fat.

<sup>l</sup>Marbling score: 400 = Small<sup>00</sup>, 500 = Modest<sup>00</sup>.

<sup>m</sup>Percentage of A-, A, and A+ abscessed livers.