Effects of Original XPC on Newly Weaned Beef Steer Growth Performance and Antioxidant Defense

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Summary and Implications

The objective of this study was to determine the effects of increasing inclusions of Diamond V Original XPC, a yeast fermentation product, on newly weaned beef steer performance and antioxidant defense. There was no effect of Original XPC on growth performance in the current study; however, blood measures indicated greater antioxidant capacity and lesser oxidative stress for steers fed XPC at 14 g/d. Further research is needed to better understand how oxidative stress impacts animal performance and health as well as the optimum supplementation dose of XPC for newly received beef cattle.

Introduction

Feedlot receiving is a particularly stressful period for beef cattle. Recent weaning, commingling, and transportation results in decreased feed intake and increased morbidity upon arrival at the feedlot. Transit has also been shown to increase markers of oxidative stress in various species. Diamond V Original XPC is produced through the anaerobic fermentation of *Saccharomyces cerevisiae*, causing the yeast to produce potentially beneficial metabolites. A meta-analysis examining the effects of Diamond V yeast products on receiving period performance suggests it improves ADG and G:F by 5.8 and 2.0%, respectively. An antioxidant effect of XPC has been observed in vitro. Therefore, the hypothesis of the current study was that increasing inclusions of XPC would improve feedlot performance and antioxidant defense.

Materials and Methods

Newly weaned (bawling) crossbred beef steers (n = 180; 615 ± 47 lb) were transported to ISU and fed a common corn-silage based diet (Table 1) for 7 d prior to trial initiation. Steers were blocked by initial BW into 6-steer pens (n = 10 per treatment) and randomly assigned to one of three daily doses of Original XPC: 0 g/steer (CON), 14 g/steer (XPC14), or 28 g/steer (XPC28). The dose of XPC currently recommended for receiving cattle is 14 g/hd. Treatments were delivered as part of the TMR, using DDGS as a carrier. Back calculated XPC intake was 14.4 and 28.7 g/steer/d for XPC14 and XPC28, respectively. At trial initiation (d 0) steers were implanted with Component E-S and vaccinated against viral and clostridial infections.

Steers were weighed prior to feeding on two consecutive days at the beginning and end of the trial as well as on d 14, 27, and 42. Average daily gain was calculated from d 0 to 27, 27 to 56, and 0 to 56. Total feed offered and bunk scores were recorded daily, and TMR samples were collected weekly for DM determination by drying in a forced air oven at 70ºC for 48 h. Refusals were weighed and sampled in conjunction with weigh dates to determine pen DMI and feed efficiency (G:F). Steers were visually assessed for signs of respiratory illness and treated by trained personnel if visual symptoms were detected and rectal temperature was ≥ 103ºF.

One steer per pen was selected as a sampling animal for blood collection; the same steer was sampled each time. Blood was collected via jugular venipuncture prior to feeding into vacuum tubes and transported to the laboratory on ice. Samples collected on d 0, 27, and 56 were analyzed for plasma malondialdehyde (MDA) concentrations, as well as red blood cell lysate (RBCL) superoxide dismutase (SOD) activity and glutathione (total = tGSH; oxidized = GSSG; reduced = GSH) concentrations using commercially available kits.

Data were analyzed as a randomized complete block design using the Mixed procedure of SAS 9.4. Pen was the experimental unit and the model included the fixed effects of treatment and block and the random effect of pen. Linear and quadratic contrast statements were used to compare treatment means. Morbidity data were analyzed using the Glimmix procedure of SAS. Significance was declared when $P \leq 0.05$ and tendencies were declared when $0.05 < P \leq 0.10$.

Results and Discussion

Oxidative stress, an imbalance between oxidants and antioxidants, leads to damage of cellular components including lipids, proteins, and DNA. Measures of antioxidant defense in the current study included SOD, a potent antioxidant enzyme responsible for eliminating superoxide radicals, as well as glutathione, an endogenous antioxidant that must be in the reduced form to exert its

antioxidant effects. Plasma MDA was measured as a marker of lipid damage by free radicals and thus an indicator of oxidative stress. Day 0 values were used as covariates in the analysis of RBCL SOD (Table 3), GSH (Table 4), and plasma MDA (Table 3), therefore only means are presented for this sampling day.

There was a quadratic effect of XPC on RBCL SOD activity on d 56 ($P = 0.004$), driven by XPC14-fed steers having lesser SOD activity vs. CON or XPC28-fed steers. This could indicate lesser oxidative stress and thus a lesser need for antioxidant enzymes for XPC14-fed steers. Regardless of treatment, SOD activity was numerically greater on d 0 vs. d 27 and 56, possibly a result of recent transportation to the feedlot. On d 27, there was a tendency for a quadratic effect of XPC on GSH concentrations ($P = 0.09$), driven by greater concentrations for XPC14-fed steers, resulting in a quadratic effect of treatment on GSSG:GSH ($P = 0.05$). An oxidized to reduced glutathione ratio > 0.1 is indicative of oxidative stress. A lesser GSSG:GSH ratio for XPC14-fed steers on d 27 indicates lesser oxidative stress. Regardless of treatment and sampling day, the GSSG:GSH of all steers was greater than 0.1, indicating some degree of oxidative stress. On d 56, a tendency for a linear effect of XPC on tGSH was observed ($P = 0.09$) as well as a tendency for a quadratic effect on GSH ($P = 0.07$). A tendency for a linear increase in MDA concentrations was observed due to treatment on d 27 ($P = 0.09$).

Final BW did not differ by treatment ($P \geq 0.89$; Table 2) and no linear or quadratic effects of XPC were noted for DMI, ADG, or G:F from d 0 to 27, 27 to 56, or 0 to 56 ($P \geq 0.12$). Previous research has shown variable performance responses to yeast product supplementation, likely due to a variety of factors including the amount of stress calves are experiencing, the product and rate of supplementation, as well as the nutritional status of calves prior to entering the feedlot. The calves in the current study were experiencing the stress of recent weaning and transportation; however, they were from a single source which may have eliminated the stress of commingling that calves often encounter in typical marketing channels. There was a quadratic effect of XPC on percentage of steers treated for respiratory illness ($P = 0.02$; Table 2). Despite experiencing over twice the percentage of treatments, steers fed XPC at 14 g/d maintained similar performance as steers fed XPC at 0 or 28 g/d.

While there was no performance benefit noted, XPC fed at 14 g/d increased antioxidant enzyme activity and endogenous antioxidant concentrations. Further research is necessary to determine the optimal dosage of XPC as well as the conditions under which yeast product supplementation is beneficial for newly weaned beef cattle.

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Table 1. Ingredient composition of receiving diet.

DM, %	58.2
Ingredient, % DM basis	
Corn silage	27
WCGF[1]	20
Dry-rolled corn	20
DDGS[2]	23.022
Chopped grass hay	8
Limestone	1.52
Salt	0.31
Bovatec91[3]	0.023
Vitamin A premix[4]	0.11
Trace mineral premix[5]	0.024
Analyzed composition[6], %	
Crude protein	15.9
NDF	31.8
Ether extract	5.4

[1]Wet corn gluten feed.
[2]Dried distillers grains with solubles; carrier for micro-ingredients and Original XPC (Diamond V, Cedar Rapids, IA) treatments.
[3]Provided 300 mg lasalocid·steer·day^{-1} (Zoetis, Florham Park, NJ).
[4]Contained 4,400,000 IU/kg Vitamin A premix.
[5]Provided trace minerals as recommended by NRC.
[6]Based on TMR analysis from Dairyland, Inc., Arcadia, WI.

Table 2. Effect of increased inclusions of Original XPC[1] on feedlot performance and morbidity of newly weaned beef steers.

	Original XPC, g/d				*P*-value	
	0 n = 10 pens	14 n = 10 pens	28 n = 9 pens[2]	SEM[3]	Linear	Quadratic
Initial BW, lb	613	613	618	16.2	0.84	0.91
Final BW, lb	840	836	837	17.2	0.91	0.89
DMI, lb/d						
d 0 to 27	17.2	16.8	16.6	0.34	0.26	0.76
d 27 to 56	20.3	20.4	20.2	0.34	0.92	0.71
d 0 to 56	18.7	18.6	18.4	0.24	0.37	0.95
ADG, lb/d						
d 0 to 27	3.92	3.85	3.89	0.117	0.84	0.72
d 27 to 56	4.17	4.03	3.91	0.121	0.13	0.95
d 0 to 56	4.05	3.98	3.91	0.075	0.18	0.94
G:F						
d 0 to 27	0.231	0.232	0.237	0.006	0.49	0.78
d 27 to 56	0.205	0.199	0.195	0.005	0.12	0.86
d 0 to 56	0.217	0.214	0.213	0.003	0.38	0.82
Treated, %	10.3	25.2	10.3	---	1.00	0.02

[1]Diamond V, Cedar Rapids, IA.
[2]One pen removed from analysis due to chronically poor performance by one steer, unrelated to treatment.
[3]Highest SEM of any treatment is reported.

Table 3. Effect of increased inclusions of Original XPC[1] on superoxide dismutase activity and plasma malondialdehyde concentrations of newly weaned beef steers.

	Original XPC, g/d				*P*-value	
	0	14	28	SEM[2]	Linear	Quadratic
Red blood cell lysate						
Superoxide dismutase[3,4]						
d 0	19.5	22.2	19.7	-	-	-
d 27	9.8	9.4	9.8	0.66	0.95	0.60
d 56	12.0	9.8	11.0	0.45	0.11	0.004
Plasma						
Malondialdehyde, μM[4]						
d 0	3.7	4.0	4.1	-	-	-
d 27	3.5	3.9	4.1	0.24	0.09	0.80
d 56	4.5	4.0	4.3	0.22	0.55	0.13

[1]Diamond V, Cedar Rapids, IA.
[2]Highest SEM of any treatment is reported.
[3]Superoxide dismutase activity; one unit of SOD activity (U) is defined as the enzyme required to dismutate 50% of the superoxide radical; reported as 1,000 U·g hemoglobin^{-1}.
[4]Day 0 values used as a covariate in analysis.

Table 4. Effect of increased inclusions of Original XPC[1] on total, oxidized, and reduced glutathione concentrations of newly weaned beef steers.

	Original XPC, g/d				*P*-value	
	0	14	28	SEM[2]	Linear	Quadratic
Red blood cell lysate						
Glutathione[3], μM						
d 0						
Total	229.0	282.2	245.5	-	-	-
Oxidized	67.6	72.5	69.3	-	-	-
Reduced	161.4	209.7	176.2	-	-	-
Ratio[4]	0.44	0.37	0.43	-	-	-
d 27						
Total	173.6	203.8	187.0	11.04	0.38	0.11
Oxidized	51.4	51.6	52.3	4.26	0.88	0.97
Reduced	118.9	152.4	134.6	11.48	0.32	0.09
Ratio	0.50	0.34	0.47	0.055	0.65	0.05
d 56						
Total	289.4	334.2	343.7	23.12	0.09	0.53
Oxidized	88.7	93.4	98.2	4.86	0.19	0.99
Reduced	198.9	244.2	227.1	12.91	0.13	0.07
Ratio	0.43	0.38	0.39	0.024	0.25	0.39

[1]Diamond V, Cedar Rapids, IA.
[2]Highest SEM of any treatment is reported.
[3]Day 0 values used as a covariate in analysis.
[4]Ratio of oxidized:reduced glutathione.