Effects of Original XPC on Newly Weaned Beef Steer Nutrient Digestibility and Response to a Vaccination Challenge

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Summary and Implications

The study was designed to determine the effects of Diamond V Original XPC, a yeast fermentation product, in the diets of newly weaned beef steers on nutrient digestibility and response to a vaccination challenge. Although no overall performance benefit was noted, XPC improved total tract CP digestibility. Steers fed XPC at 14 g/d exhibited lesser concentrations of APP, greater DMI, and more efficient rumination post-vaccination. Further research is needed to determine the optimal supplementation rate of XPC to newly received beef cattle.

Introduction

Stress resulting from recent weaning, commingling, and transportation negatively impacts performance of newly received feedlot cattle. Upon arrival calves typically consume less feed and become sick. The stress of receiving can also result in an acute phase protein (APP) response and immune system activation. While this is vital to the health of the animal, prolonged activation can be detrimental and result in skeletal muscle catabolism to supply the immune system with amino acids and energy.

Diamond V Original XPC is produced through the anaerobic fermentation of *Saccharomyces cerevisiae.* Yeast fermentation products have been shown to stabilize the rumen environment and reduce markers of inflammation. Therefore, the hypothesis of the current study was that increasing inclusions of XPC would improve total tract nutrient digestibility by newly weaned beef steers and would positively modulate the APP response following a *Mannheimia haemolytica* vaccination challenge.

Materials and Methods

Thirty-six newly weaned (bawling) crossbred beef steers (711 ± 26 lb) were transported to the Iowa State University Beef Nutrition Farm and utilized in a 56 d study. Steers were received onto a common corn silage based diet (Table 1). Five days after arrival, steers were sorted into pens with bunks capable of measuring individual steer intake where they were acclimated for 7 d prior to trial initiation. On d 0 steers were blocked by BW into pens (n = 6 steers/pen) and randomly assigned to dietary treatments (n = 12 steers/treatment): Original XPC at 0 (CON), 14 (XPC14), or 28 (XPC28) g/steer/d. Additionally, all steers were vaccinated against viral and clostridial infections, implanted with Component E-S, and received ear tags (CowManager) that recorded real time ear surface temperature, rumination, and activity. Steers were weighed on two consecutive days at the beginning and end of trial as well as on d 14, 28, and 42. Average daily gain was calculated from d 0 to 28, 28 to 56, and 0 to 56. Feed efficiency (G:F) was calculated from steer DMI and weight gain. Steers were monitored daily for signs of respiratory illness. If visual symptoms (i.e. nasal discharge, cough, etc.) were observed and rectal temperature was ≥ 103ºF the animal was treated by trained personnel.

To determine the effect of XPC on total tract nutrient digestibility, titanium dioxide was fed as an indigestible marker to all steers from d 12 to 27. Fecal samples were collected prior to feeding on d 26 and 27. Samples of total mixed ration and feces from the titanium feeding period were analyzed for DM, OM, NDF, ADF, CP, and titanium dioxide. To determine the effect of XPC on APP, all steers received a *Mannheimia haemolytica* vaccination on d 34 to induce an inflammatory response. Blood was collected on d 34 (prior to vaccination) as well as 3, 6, 9, 11, and 14 d post-vaccination; blood was analyzed for serum interleukin-8 (IL-8), serum amyloid A (SAA), and haptoglobin. CowManager data were compiled in Excel; activity and rumination minutes were subtotaled by day while ear surface temperature was averaged by day. A Penn State particle separator box was used to determine percentage of peNDF in the TMR.

Data were analyzed as a randomized complete block design using Proc Mixed of SAS 9.4 with the fixed effects of treatment and block and the random effect of steer. Because individual intake was recorded, steer served as the experimental unit. Contrast statements were constructed to compare treatment means. Average DMI from the digestibility period (d 12 through 26) was used as a covariate in the analysis of all nutrient digestibilities. Blood measures and CowManager data were analyzed as repeated measures using the repeated effect of day. Values from d 34 (prior to vaccination) were used as covariates in analysis of blood measures while average DMI, activity, rumination, and ear surface temperature for the 7 d prior to vaccination were used as covariates in analysis of CowManager data. Morbidity data were analyzed using Proc Glimmix of SAS. Significance was declared when $P \leq 0.05$ and tendencies were declared when $0.05 < P \leq 0.10$.

Results and Discussion

The APP response begins with the release of cytokines and chemokines including IL-8. Cytokines cause the liver to secrete APP including SAA, haptoglobin, and ceruloplasmin, all well accepted markers of the APP response in cattle. Steers fed XPC14 tended to have lesser serum IL-8 and haptoglobin concentrations vs. XPC28-fed steers (Table 4; $0.07 \leq P \leq 0.08$). This could indicate that XPC14-fed steers were experiencing less inflammation or that XPC28-fed steers were able to mount a greater immune response due to the greater dosage of XPC. Day effects ($P < 0.01$) were observed for haptoglobin (Figure 1A) and SAA (Figure 1B) where concentrations peaked 3 d post-vaccination indicating that vaccination caused an inflammatory response similar to what has been observed previously. A similar trend was observed for plasma ceruloplasmin (Figure 3); however, XPC-14 fed steers had lesser ceruloplasmin concentrations 14 d post-vaccination vs. CON or XPC28-fed steers (treatment × day $P = 0.004$). This suggests that XPC14-fed steers were able to return to pre-vaccination concentrations sooner than CON or XPC28-fed steers.

In addition to increased concentrations of APP, vaccination has been shown to negatively impact feedlot performance. Steers fed XPC14 had greater DMI for the 15 d post-vaccination when compared to steers fed XPC28 (Table 5; $P = 0.02$). Because the vaccination challenge occurred on d 34, greater DMI by XPC14-fed steers likely contributed to the greater ADG observed from d 28 to 56 compared to XPC28-fed steers (Table 2; $P = 0.05$). However, there was no effect of treatment on final BW or overall (d 0 to 56) DMI, ADG, or G:F ($P \geq 0.19$). While total rumination min/d did not differ by treatment (Table 5; $P \geq 0.14$), XPC14-fed steers spent less time ruminating/lb DM, NDF, and peNDF vs. CON or XPC28-fed steers ($P \leq 0.07$). Average ear surface temperature was less for XPC14-fed steers vs. CON-fed steers ($P = 0.01$), however the correlation to core body temperature needs to be further evaluated. Total tract nutrient digestibility of DM and OM was greater for XPC14-fed steers vs. XPC28-fed steers (Table 3; $P \leq 0.03$). Steers fed either dose of XPC exhibited greater digestibility of CP than CON-fed steers ($P < 0.01$). Similar to the current study, previous research in dairy has shown improved CP digestibility with yeast culture supplementation.

In conclusion, XPC14-fed steers seemed to respond better to a vaccination challenge indicated by lesser concentrations of APP, maintaining greater DMI, and more efficient rumination post-vaccination. The greater dose of XPC negatively impacted DM and OM total tract digestibility. Regardless of dose, XPC improved total tract digestibility of CP.

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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 at NRC.
[6]Based on TMR analysis from Dairyland, Inc., Arcadia, WI.

Table 2. Effect of increased inclusions of Original XPC[1] on BW, intake, gain, and efficiency of newly weaned beef steers.

	Original XPC				*P*-value	
	0 n = 12 steers	14 n = 12 steers	28 n = 12 steers	SEM	CON vs XPC14	XPC14 vs XPC28
Initial BW, lb	710	715	710	7.6	0.62	0.65
Final BW, lb	944	948	924	13.1	0.80	0.20
DMI lb/d						
d 0 to 28	19.4	19.3	17.9	0.80	0.90	0.25
d 28 to 56	22.9	23.3	22.3	0.91	0.78	0.46
d 0 to 56	21.1	21.3	20.1	0.77	0.92	0.30
ADG lb/d						
d 0 to 28	4.83	4.27	4.33	0.256	0.14	0.88
d 28 to 56	3.53	4.06	3.31	0.257	0.16	0.05
d 0 to 56	4.18	4.17	3.82	0.182	0.96	0.19
G:F						
d 0 to 28	0.256	0.221	0.244	0.014	0.10	0.28
d 28 to 56	0.154	0.176	0.152	0.013	0.23	0.18
d 0 to 56	0.200	0.197	0.193	0.010	0.81	0.79
Treated, %	16.7	8.3	25.0	---	0.57	0.33

[1]Diamond V, Cedar Rapids, IA.

Table 3. Effect of increased inclusion of Original XPC[1] on total tract nutrient digestibility[2] by newly weaned beef steers.

	Original XPC				*P*-value	
	0	14	28	SEM[3]	CON vs XPC14	XPC14 vs XPC28
DM, %	64.7	66.2	63.2	0.90	0.24	0.02
OM, %	67.1	68.4	65.2	0.97	0.36	0.03
NDF, %	61.2	61.5	60.5	0.87	0.80	0.39
ADF, %	58.6	57.9	57.3	1.13	0.64	0.72
CP, %	60.0	63.8	64.0	0.61	<0.01	0.74

[1]Diamond V, Cedar Rapids, IA.
[2]Average DMI for titanium feeding period (d 12 through 26) used as a covariate in analysis of all nutrients.
[3]Highest SEM of any treatment reported.

Table 4. Effect of increased inclusion of Original XPC[1] on acute phase proteins and a chemokine in response to *Mannheimia haemolytica* vaccination challenge[2].

	Original XPC				P-value			
	0	14	28	SEM[3]	CON vs XPC14	XPC14 vs XPC28	Day	Trt × Day
Serum								
IL-8, pg/mL[4]	255.1	217.5	294.7	35.39	0.35	0.08	0.01	0.69
SAA, µg/mL[4, 5]	43.6	62.4	51.7	18.50	0.37	0.69	<0.01	0.84
Haptoglobin, mg/dL[4]	14.7	13.9	17.9	1.71	0.67	0.07	<0.01	0.58

[1]Diamond V, Cedar Rapids, IA.
[2]Vaccination given on d 34. Blood samples from day 3, 6, 9, 11, and 14 post vaccination. Data from blood samples taken prior to vaccination used as a covariate in analysis.
[3]Highest SEM of any treatment reported.
[4]Natural log transformed; back transformed means and SEM presented.
[5]Blood samples from 18 animals (n = 6 per treatment) from day 3, 6, 9, and 11 post vaccination.

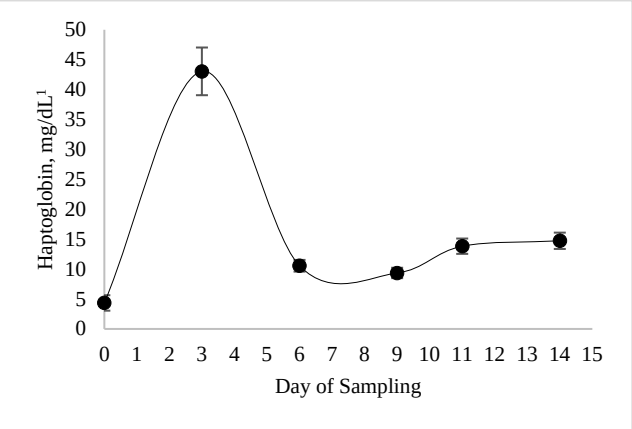
Table 5. Effect of increased inclusion of Original XPC[1] on newly weaned beef steer behavior and ear surface temperature during the *Mannheimia haemolytica* vaccination period[2].

	Original XPC				*P*-value			
	0	14	28	SEM	CON vs XPC14	XPC14 vs XPC28	Day	Trt × Day
DMI, lb/d	22.0	23.1	21.2	0.57	0.15	0.02	0.07	0.99
Active, min/d	79	77	81	1.8	0.50	0.11	<0.01	0.02
Ruminating, min/d	594	614	608	8.9	0.14	0.60	<0.01	<0.01
Min/lb DM[3]	28	26	29	0.9	0.07	0.01	<0.01	0.95
Min/lb NDF[3]	73	66	75	2.2	0.05	0.01	<0.01	0.95
Min/lb peNDF	277	256	287	18.8	0.07	0.01	<0.01	0.95
Average Temp, °F[3]	76.8	76.0	76.1	0.21	0.01	0.71	<0.01	0.04

[1]Diamond V, Cedar Rapids, IA.
[2]Vaccination given on d 34. Average DMI, activity, rumination, and temperature from one week prior to vaccination used as a covariate in analysis.
[3]Natural log transformed; back transformed means and SEM presented.

Figure 1. Effect of day relative to *Mannheimia haemolytica* vaccination given on d 34 on serum haptoglobin (Panel A) and SAA (Panel B) concentrations of newly weaned beef steers following a *Mannheimia haemolytica* vaccination challenge (day $P < 0.01$). Data from blood samples taken prior to vaccination used as a covariate in analysis. [1]Natural log transformed; back transformed means and SEM presented.

A.



B.

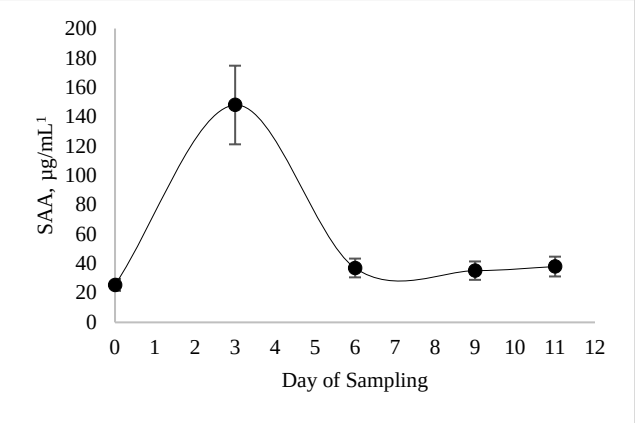


Figure 2. Effect of Original XPC (Diamond V, Cedar Rapids, IA) and day on plasma ceruloplasmin concentrations of newly weaned beef steers following a *Mannheimia haemolytica* vaccination challenge (treatment × day $P = 0.004$). Data from blood samples taken prior to vaccination used as a covariate in analysis. Unlike superscripts differ ($P \leq 0.05$) within day of sampling relative to *Mannheimia haemolytica* vaccination given on d 34. [1]Natural log transformed; back transformed means and SEM presented.