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RESEARCH ARTICLE

The Effect of Post-Weaning Steer Diets Supplemented With Field Pea, Flaxseed and a Field Pea-Flaxseed Combination on Feedlot Finishing Performance, Carcass Quality and Immune Response [1]

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Summary

This study objective was to compare the effect of feeding field pea, flaxseed and field pea-flaxseed combination on steer performance and immune response during the 50-d post-weaning period (PWP). Subsequently, the effect on feedlot finishing performance, immune response and carcass quality were determined. Crossbred Angus x Hereford x Gelbvieh steers (castrated male calves, age=7.4 month, n=173) were used in the 3 year replicated study. The four pelleted 50-d PWP diets (PWD) were: 1) Control (C), 2) 12.5% Flaxseed (FLX), 3) 20.0% Field Pea (P), and 4) 20.0% Field Pea + 12.5% Flaxseed (PFLX). In the PWP, average daily weight gain (ADG) was increased (P<0.05) for FLX and PFLX when compared with C and P, but feed cost/kg of gain for FLX and PFLX was decreased (P<0.05). In the feedlot period, initial weight, slaughter weight, fattening period, weight gain, ADG, average daily feed intake and feed conversion ratio was not significantly different among the diets (P>0.10). For carcasses, PWD did not affect hot carcass weight, marbling score, percent US Department of Agriculture quality grade (P>0.05); however, FLX treatment reduced rib-eye area (REA), while P treatment increased REA (P<0.05). FLX and PFLX treatments did not increase serum neutralization titer level and did not reduce morbidity (P=0.96) and health care cost (P>0.10). Overall, Flaxseed improved 50-d PWP performance, but PWDs had no carryover effect on feedlot finishing period net return.

Keywords: *Beef cattle steer, Carcass quality, Field pea, Flaxseed, Immune response*

Sütten Kesilmiş Dana Rasyonlarına İlave Edilen Keten Tohumu, Yemlik Bezelye ve Keten Tohumu-Yemlik Bezelye Kombinasyonunun Besi Sonu Performansı, Karkas Kalitesi ve Bağışıklık Sistemi Üzerine Etkisi

Özet

Bu çalışmanın amacı, 50 gün boyunca sütten kesim sonrası periyot (PWP)'ta rasyona ilave edilen keten tohumu, yemlik bezelye ve keten tohumu-yemlik bezelye kombinasyonun danaların besi performansı ve bağışklık sistemi üzerine etkisini karşılaştırmaktır. Bunu takiben, besi sonu performansı, karkas kalitesi ve bağışılık sistemi üzerine etkisini belirlemektir. Üç yıl tekrarlanan bu çalışmada melez Angus x Hereford x Gelbvieh danaları (kısırlaştırılmış erkek dana, yaş=7.4 ay, n=173) kullanılmıştır. 50 günlük PWP rasyonları (PWD); 1) Kontrol (C), 2) %12.5 Keten tohumu (FLX), 3) %20.0 yemlik bezelye (P) ve 4) %20 yemlik bezelye + %12.5 keten tohumu (PFLX) olarak dört grupta peletlenmiştir. PWP'da FLX ve PFLX gruplarında günlük canlı ağırlık artışı (ADG) daha yüksek (P<0.05) ve birim ağırlık artışı için yem maliyeti daha düşüktür (P<0.05). C ve P gruplarında ADG (P=0.004) daha düşüktür. Besi döneminde; başlangıç ağırlığı, kesim ağırlığı, besi süresi, canlı ağırlık artışı, ADG, ortalama günlük yem tüketimi, yemden yararlanma oranında farklılık görülmemiştir (P>0.10). Karkas ölçümlerinde, PWD'leri sıcak karkas ağırlığını, kas içi yağ dağılımını, ve USA Tarim Bakanlığı kalite derece yüzdesini etkilememiştir (P>0.05); bununla birlikte, P grubunda sırt kası alanı (REA) artarken, FLX grubunda REA azalmıştır (P<0.05). FLX ve PFLX gruplarında serum nötralizasyon titre seviyesi artmamış ve morbidite oranı (P=0.96) ve tedavi maliyetleri (P>0.10) önemli ölçüde düşmemiştir. Genel olarak, keten tohumu 50-d PWP performansını artırmıştır, ancak PWD'nin daha sonraki besi bitirme peryodunda net kâr üzerine herhangi bir etkisi olmamıştır.

Anahtar sözcükler: *Besi danası, Karkas kalitesi, Yemlik bezelye, Keten tohumu, Bağışklık sistemi*

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INTRODUCTION

Field pea and flaxseed are protein and energy dense feedstuffs for growing and finishing cattle. Field pea contains 20-27% crude protein (CP), 88-90% total digestible nutrients (TDN), 7-8% acid detergent fiber (ADF), and 1.40 Mcal NEg/kg for cattle. Field pea protein and starch components are highly rumen degradable and can replace corn and barley in beef cattle diets. Feeding field peas has resulted in better ADG and improved dry matter intake (DMI) in post - weaning calf diets [1,2].

Flaxseed contains 20-23% CP, 35-37% fat, 105-110% TDN, 7-8% ADF, and 1.97 Mcal NEg/ kg for cattle. Feeding up to 8% flaxseed to feedlot heifers has been associated with significant increases in gain and gain efficiency, but did not affect DMI [3]. Flaxseed is associated with enhancing immune resistance due to anti-inflammatory and immune aiding properties that may reduce morbidity and mortality among weaned, highly stressed, feeder calves during the PWP [4-6]. Kansas State University researchers compared the value of flaxseed to tallow, which is commonly fed in USA feedlots, and concluded that the addition of 10-15% flaxseed during the first 5 to 6 weeks after weaning would result in greater feed intake, growth, feed efficiency, and may reduce the incidence of bovine respiratory disease (BRD) [7-9]. In another experiment, the authors concluded that calves fed flaxseed during the stressful 5-6 week period following weaning illicit a stronger immune response, and may require less antibiotic therapy [10].

The purpose of this research was to compare 50-d PWD supplements formulated with P, FLX, and a PFLX combination to determine the effect on PWP steer performance and immune response, and to determine the carryover effect on feedlot finishing performance, carcass quality, immune response, and net return. We also hypothesized that 50-d PWD formulated with FLX and PFLX would have a positive effect on immune response, morbidity, and treatment cost.

MATERIAL and METHODS

This research project was conducted in accordance with guidelines approved by The North Dakota State University Institutional Animal Care and Use Committee (Protocol Approval number A401).

During a 3-year period, three annually replicated treatment groups (n=173) of 7.4 month old crossbred steers (Angus x Hereford x Gelbvieh) with an average weight of 293±0.51kg were weaned and randomly assigned to one of four pelleted PWD treatments. The treatments were: 1) C - no flaxseed and no field pea, 2) FLX - 12.5% flaxseed, 3) P - 20% field pea and, 4) PFLX - 20% field pea and 12.5% flaxseed. The steers were fed an alfalfa-brome grass hay (*Medicago sativa* and *Bromus inermis*,10.0% CP) and the experimental receiving diets were formulated according to National Research Council specifications *(Table 1)* [11]. Each treatment consisted of four pen replicates with four steers per pen. Steers were weaned the first week of November each year and fed for an average 50-d at the Dickinson Research Extension Center. The pelleted supplements were top-dressed over chopped alfalfa-brome grass hay (5.1 cm screen) and, as hay was removed, the amount of daily supplement was increased. The steers consumed an average 8.9, 9.6, 8.8, and 9.4 Mcal of ME for gain per day in the C, FLX, P, and PFLX, respectively.

Table 1. *PWD ingredient composition and nutrient analysis (Dry Matter)*
Tablo 1. *Deneme rasyonlarının içeriği ve besin madde düzeyleri (%KM'de)*

Ingredients	C[a]	FLX[a]	P[a]	PFLX[a]
Flaxseed, %	0.0	12.5	0.0	12.5
Field Pea, %	0.0	0.0	20.0	20.0
Corn, %	15.0	15.0	15.0	10.0
Soybean Hulls, %	21.5	28.703	30.703	34.203
Wheat Midds, %	24.953	11.75	10.0	12.0
Barley Malt Sprouts, %	20.0	15.0	10.0	5.0
Distillers Dried Grain With Solubles, %	12.25	10.75	8.0	0.0
Other, % [b]	6.297	6.297	6.297	6.297
Total, %	100.00	100.00	100.00	100.00
Analysis				
CP, % [c]	15.54	15.54	15.53	15.56
ADF, % [c]	16.03	17.68	18.03	18.79
NEg, Mcal/kg	1.13	1.27	1.16	1.27

*[a] **C:** No Flaxseed and no Field pea, **FLX:** 12.5% Flaxseed, **P:** 20% Field pea, **PFLX:** 20% Field pea+12.5% Flaxseed; [b]Molasses, 5.0%; Salt, 0.50%; Calcium, 0.55%; Dicalcium Phos., 0.10%; TM Premix, 0.075%; Vitamin A & D Premix, 0.025%; Decoquinate, 0.027%; Monensin Sodium, 36.31 g/kg; [c] **CP:** Crude protein, **ADF:** Acid detergent fiber*

To evaluate the effect of flaxseed on health status, serum humoral antibody level and BRD incidence were monitored. Three weeks before weaning, the steers were vaccinated against economically important bacterial and viral diseases (Bovi-Shield Gold 5®) [12] and a booster vaccination for clostridial myonecrosis diseases and pneumonic pasteurellosis at weaning (One Shot Ultra 7®) [12]. Blood samples were collected from steers 3 weeks before weaning, at weaning and 30 and 90 days post-weaning. Serum humoral antibody levels for bovine virus diarrhea (BVD) Types I and II and infectious bovine rhinotracheitis (IBR) virus were determined, and morbidity and treatment cost were recorded. Virus serum neutralization was conducted using the procedure described by Leannette and Schmidt [13]. For IBR, neutralizations are run from 4 to 256 and for BVD viruses, dilutions are run from 4 to 4,096. Values < 4 were considered negative.

At the end of the 50-d PWP, the steers were shipped 1090 km to the Decatur County Feedlot, Oberlin, Kansas, USA, for feedlot finishing. Dietary energy concentration at the feedlot was increased incrementally until the steers were consuming 109.3 Mcal/kg of NEg per day. The Decatur County Feedlot is a commercial feedlot that uses the ACCU-TRAC electronic cattle management system to determine slaughter time [14]. Slaughter time prediction is determined based on the animal weight and ultrasound carcass measurements for fat depth (FD), REA, and percent of intramuscular fat (IMF) [14]. These measurements are collected at the start of the feedlot feeding period and after 80 d of feeding. Growth rate and fat deposition data collected are then used in the computer database to predict a future slaughter time when each steer is estimated to have attained a predetermined backfat depth of 12.0 mm. The steers were slaughtered at the Cargill Meat Solutions meat packing plant in Ft. Morgan, Colorado, USA. Carcass measurements were collected by Diamond Livestock Services and US Department of Agriculture quality grade (USDA QG) determinations were made by US Department of Agriculture meat graders.

Data was analyzed using analysis procedures of SAS [15]. Receiving, finishing, carcass trait and closeout data were analyzed as a randomized complete block design using PROC GLM, and USDA QG was analyzed using Chi-square procedures in PROC GENMOD. Antibody serum neutralization was analyzed using PROC MIXED procedures. In the models, diet served as the fixed effect and block, and year were random effects. Pen served as the experimental unit. Differences between treatment groups were considered significant at P≤0.05 and a trend at P≤0.10.

RESULTS

Post-Weaning Period

The effect of the PWD on steer performance during the 50-d PWP is summarized in *Table 2*. Control steers and steers that were fed P had similar gain (P=0.005) and ADG (P=0.004), which was less than steers that received either PFLX or FLX supplements (P=0.005). Steers that were fed P also tended to consume more feed per kg of gain resulting in a tendency for poorer feed to gain ratio (F:G; P=0.075). The P diet cost per kg of gain was similar to the C, and higher than steers fed either PFLX or FLX.

Table 2. *Effects of post weaning rations on growth performance.*
Tablo 2. *Sütten kesim sonrası rasyonlarının büyüme performansı üzerine etkileri*

Post Weaning Performance	C[a]	FLX[a]	P[a]	PFLX[a]	SEM[a]	P-Value
Growth performance						
Number of Steers [b]	43	43	44	43		
Initial Weight, kg	292.4	293.3	293.1	293.6	4.34	0.99
Final Weight (50-d), kg	363.6	371.5	362.9	371.9	4.76	0.38
Gain, kg [c]	71.2[y]	78.2[x]	69.8[y]	78.0[x]	1.99	0.005
ADG, kg [c, d]	1.42[y]	1.56[x]	1.40[y]	1.56[x]	0.040	0.004
Feed intake						
DMI, kg [d]	8.28	8.34	8.09	8.14	0.183	0.74
Hay/Day, kg	3.88	3.94	3.69	3.74	0.115	0.41
Supplement/Steer, kg	4.39	4.40	4.39	4.39	0.094	0.99
F:G, kg [d]	5.83	5.34	5.78	5.20	0.090	0.075
Feed cost						
Feed Cost/Steer, $	$41.44	$41.20	$39.97	$39.56	0.688	0.17
Feed Cost/kg Gain, $ [c]	$0.5820[y]	$0.5269[x]	$0.5726[y]	$0.5072[x]	0.0082	0.012

*[a] **C:** No Flaxseed and no Field pea, **FLX:** 12.5% Flaxseed, **P:** 20% Field pea, **PFLX:** 20% Field pea+12.5% Flaxseed, **SEM:** Standard error of the mean; [b] One steer died of bloat in the C, FLX, and PFLX treatments; [c] Means in a row with unlike superscripts differ significantly (P<0.05); [d] **ADG:** Average daily gain, **DMI:** Dry matter intake, **F: G** Feed to gain ratio*

Compared to the C treatment diet, supplements that contained FLX were calculated to be 2.0 times higher in fat content and contained 6.2% greater net energy for gain. Average DMI did not differ between treatments (P=0.74). When flaxseed occurred alone in the supplement (FLX), or was blended with P (e.g. PFLX), there was a tendency for improved F:G (P=0.075) and feed cost per kg of gain was significantly lower (P=0.012) compared to either the C or P treatments. Feed cost per kg of gain was lower in treatments that included flaxseed (e.g. FLX and PFLX; P=0.012) and compared to feeding supplements containing P alone, feed cost per kg of gain was reduced 11.7%.

Feedlot Finishing Period

Upon completion of the 50-d PWP the carryover effect on finishing performance, carcass trait measurements, and finishing net return was evaluated and has been summarized in *Table 3*. Within the data set, treatment, year, and treatment x year interactions were analyzed. For feedlot finishing performance, carcass measurements, and net return, there were significant year effects identified. However, for feedlot finishing performance, there were no treatment or treatment x year interactions that were significant. There was no significant feedlot performance differences determined for slaughter weight, number of feedlot days, ADG, DMI, or F:G (P>0.10).

For carcass measurements, there were no treatment differences identified (P>0.10) for hot carcass weight (HCW), marbling score (MS) or percent USDA QG. When FLX had previously occurred alone in the 50-d PWD, finishing REA was smaller (P=0.044), FD tended to be greater (P=0.074), and US Department of Agriculture yield grade (USDA YG) also tended to be greater (P=0.083), suggesting that steers fed supplements during the 50-d PWP that contained FLX had an increased propensity for a greater fat to lean ratio that reduced carcass value (CV). Moreover, when FLX was blended with P in the PWD, there was a year-over-year tendency for USDA YG score to be less desirable. Carcass value was effected by yearly fluctuations in US fed cattle prices (P=0.0001) resulting in an ending numerical CV difference, but the observed numerical difference was not statistically significant for CV (P=0.862). Year-over-year interactions for USDA YG score (P=0.008) and MS (P=0.031) were identified; however, the subsequent and final effect

Table 3. *Effect of 50-d PWD on feedlot finishing performance, carcass parameters, expense and net return*
Tablo 3. *50 günlük PWD'nin besi sonu performansı karkas parametreleri, maliyet ve net kâr üzerine etkisi*

Feedlot Finishing Performance	C[a]	FLX[a]	P[a]	PFLX[a]	SEM[a]	P Value		
						TRT[a]	YR[a]	TRT x YR[a]
Feedlot performance								
Number of Steers	43	43	44	43				
Initial Weight, kg [b]	356.7	364.5	358.1	366.7	4.36	0.269	0.0001	0.943
Slaughter Weight, kg [b]	587.8	582.8	588.3	589.2	6.22	0.898	0.0001	0.481
Feedlot Days	147.3	137.0	143.6	141.3	3.91	0.291	0.0001	0.463
Gain, kg	231.1	218.3	230.2	222.5	5.94	0.355	0.0006	0.623
DMI, kg [d]	8.85	8.87	8.95	8.84	0.155	0.959	0.7790	0.456
ADG, kg [d]	1.568	1.593	1.603	1.575	0.032	0.834	0.0033	0.397
F:G, kg [d]	5.65	5.57	5.59	5.61	0.824	0.609	0.0001	0.888
Carcass parameters								
Carcass Number	43	43	44	43				
HCW, kg [d]	368.8	366.2	368.9	369.4	4.40	0.955	0.0001	0.284
REA, sq. cm [c,d]	87.03[xy]	83.23[y]	88.39[x]	87.10[xy]	1.330	0.044	0.0001	0.268
FD, mm [d]	11.25	13.08	11.79	11.63	0.518	0.074	0.0001	0.063
MS [d]	4.70	3.66	3.57	3.77	0.638	0.562	0.124	0.031
USDA YG Score [d]	2.43	2.69	2.39	2.60	0.940	0.083	0.057	0.008
USDA QG, % [d]	60.5	37.2	43.2	44.2		0.112	0.219	0.066
Expense and net return								
CV, $ [d]	1104.93	1088.67	1106.61	1108.44	18.24	0.862	0.0001	0.015
Calf & Feed Cost, $	1096.03	1086.30	1093.38	1095.39				
Net Return, $	8.90	2.37	13.23	13.05	17.85	0.943	0.0001	0.017

[a] ***C:*** *No Flaxseed and no Field pea,* ***FLX:*** *12.5% Flaxseed,* ***P:*** *20% Field pea,* ***PFLX:*** *20% Field pea+12.5% Flaxseed,* ***SEM:*** *Standard error of the mean,* ***TRT:*** *Treatment,* ***YR:*** *Year,* ***TRT x YR:*** *Treatment x year interaction;* [b] *Feedlot start weight age 9.3 months; slaughter age 14.0 months;* [c] *Means in a row with unlike superscripts differ (P<0.05);* [d] ***DMI:*** *Dry matter intake,* ***ADG:*** *Average daily gain,* ***F:G*** *Feed to gain ratio,* ***HCW:*** *Hot carcass weight,* ***REA:*** *Rib-eye area,* ***FD:*** *Fat depth,* ***MS:*** *Marbling score,* ***USDA YG:*** *US Department of Agriculture yield grade,* ***USDA QG:*** *US Department of Agriculture quality grade* ***CV:*** *Carcass value*

of PWD treatment on finishing net return did not differ (P=0.943).

Immune Response

The subsequent effect of treatments fed during the initial 50-d PWP on humoral antibody titer change is shown in *Fig. 1*, and morbidity and treatment cost during the critical first 60 days of the finishing period are depicted in *Fig. 2*. Pre-vaccination humoral antibody level, when vaccines were administered on pasture 3 weeks before weaning, was low and increased across treatments each time blood was drawn for serum recovery, but did not differ between dietary treatments for IBR (P=0.78), BVD Type I (P=0.11), and BVD Type II (P=0.90). The incidence of BRD during receiving and finishing was similar for all treatment groups and medical treatment cost did not differ (P=0.96).

DISCUSSION

Separating calves from their mothers at weaning (e.g. 7-8 months old) is stressful and limits feed intake immediately after weaning. For this study, steers were offered palatable alfalfa-brome grass mixed hay, which was readily consumed at the start. Then, during the 50-d PWP, hay was removed and the nutrient dense supplements were increased until the steers were consuming approximately 4.40 kg of supplement/steer/day.

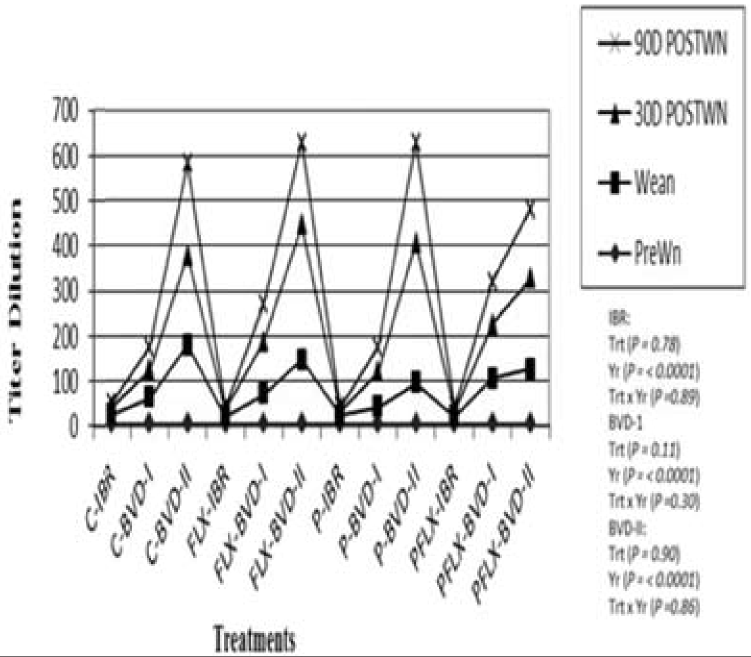

Fig 1. Effect of 50-d PWD treatments on antibody titer dilution

Şekil 1. 50 günlük PWD'nin grupların antikor titreleri üzerine etkisi

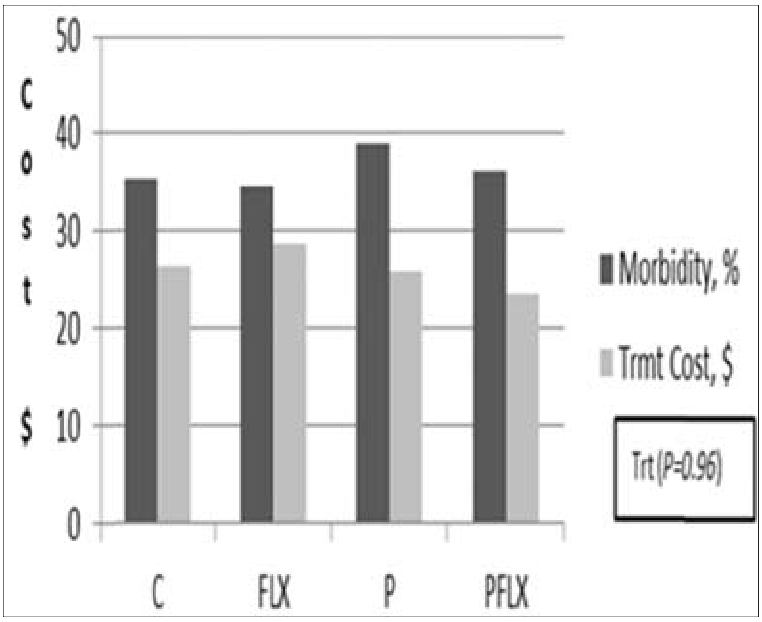

Fig 2. Effect of 50-d PWD treatments on morbidity and treatment cost

Şekil 2. 50 günlük PWD'nin grupların morbidite dilüsyonları ve tedavi giderleri üzerine etkisi

Field pea grain was included in the 50-d PWP supplements, since previous research with P has shown that DMI can be improved when P is included in both growing and finishing steer diets [1,2]. Including P alone or combined with FLX (e.g. PFLX) in the current study, resulted in DMI that did not differ from the other treatments (P=0.74). Steers that were fed the P supplement during the 50-d PWP performed as well as the steers that were fed the other PWD supplements. However, slower ADG from P and a subtle numerically lower DMI among the steers fed the P supplement combined to increase the feed to gain ratio. The resulting feed cost/kg of gain was higher for P compared to the FLX and PFLX treatments. At the end of the 50-d PWP, steers that were fed the P supplement had poorer performance, however, there was no death loss in the P treatment.

Comparing the C, P, and FLX treatments, formulations with FLX were calculated to contain twice as much fat. Based on previous research [6-10], we hypothesized that including FLX in the 50-d PWP diets would increase DMI and growth performance as well as improve health status resulting in greater immune response, less morbidity, and lower treatment cost. Including flaxseed did not result in greater immune response or improved health status, and did not result in greater DMI. However, growth performance was enhanced by FLX inclusion, which may have been due to the higher energy level from fat in the FLX treatments. Nonetheless, FLX tended to improve feed efficiency and lowered the feed cost/kg of gain making FLX inclusion a cost effective ingredient decision. Regardless of FLX inclusion success during the 50-d PWP, there was no compelling data to support a positive carryover effect from feeding FLX during the 50-d PWP on health status, finishing growth performance, carcass measurements or finishing net return. This is in sharp contrast to the results reported for highly stressed feeder cattle [7], but is in agreement with research that documented an improvement in PWD performance in one experiment without a positive reduction in mortality in a second experiment [8].

Reasons for the inability of the steers' immune system to demonstrate a difference in response to vaccine or the incidence of BRD are unknown. Data from this study indicates that flaxseed does not appear to influence serum neutralization titers in vaccinated cattle. The complexity of the immune system would preclude identifying any specific cause for this result, but different levels of stress can affect the occurrence of respiratory disease. Our study steers were not highly stressed compared to the highly stressed Kansas State University steers [7-10]. Steers in the current study were transported less than 16 km to the PWP study site. After completing the 50-d PWP, the steers were transported 7.5 h to the finishing feedlot. In the United States, calves that have just been weaned become highly stressed after spending nearly 30 hours or more in the marketing and transit process before feedlot arrival. This markedly increases a stress related inflammatory response. Moreover, development of BRD is dependent upon numerous factors such as pathogen dose, pathogen strain, presence of co-pathogens, and pathogen exposure pathway. Considering the myriad of possible variables, it is difficult to insure that when a group of animals are exposed to a certain pathogen load of infective agents that they will respond in the same way. Since the steers used in this study were exposed to a greatly reduced level of stress, flaxseed does not appear to increase a steers' ability to respond favorably to BRD.

We conclude from the results of this research and the results reported elsewhere [7-10] that moderately stressed feeder steers probably will not respond to FLX supplementation, whereas, highly stressed feeder steers are the most likely cattle to illicit a positive pro-anti-inflammatory response to FLX.

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