Kafkas Univ Vet Fak Derg
21 (2): 253-258, 2015
DOI: 10.9775/kvfd.2014.12216

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

Research Article

The Effect of Field Pea *(Pisum sativum)* Replacement in Starch- and Fiber-Based Post Weaning Transition Diets for 7.5 Month Old Beef Calves and Subsequent Effect on Feedlot Finishing Performance, Carcass Quality and Net Return [1]

Songül ŞENTÜRKLÜ [1,2] Douglas G. LANDBLOM [1]

[1] *Infrastructure for this study was provided by the Dickinson Research Extension Center (ND06253) and for the USDA/CSREES Cool Season Food Legume Special Program (BAK792-01)*

1 Dickinson Research Extension Center, North Dakota State University, Dickinson, North Dakota, 58601 USA
2 Çanakkale Onsekiz Mart Üniversitesi, BMYO, TR-17200 Çanakkale - TURKEY

KVFD-2014-12216 Received: 30.08.2014 Accepted: 30.12.2014 Published Online: 08.01.2015

Abstract

The research objective, during a 3-yr study, was to compare starch- and fiber-based 38 d weaning transition diets (WTD) to identify the effect on calf performance, feed intake and feed efficiency (FE). Subsequently, the effect of WTD on feedlot finishing performance and cow and calf net return was determined. Crossbred steer and female calves (Angus x Hereford x Gelbvieh; n=405; Age=7.5 month; BW=278±4.3 kg) were randomly assigned to six treatments (4 pen replicates/treatment) based on age and weaning weight. Starch-based WTD were formulated with soybean meal (SBM) and field pea (FP), and fiber-based diets were formulated with increasing levels of FP (0-30%). Pelleted WTD treatments were: 1-(CSBM) starch-base+SBM, 2-(CPEA) starch-base+FP, 3-(0PEA) fiber-base+0% FP, 4-(10PEA) fiber-base+10% FP, 5-(20PEA) fiber-base+20% FP, and 6-(30PEA) fiber-base+30% FP. The CSBM, 0PEA, 10PEA, and 20PEA treatments had greater gain and average daily gain (ADG) compared to the CPEA and 30PEA (P<0.01), and the CPEA treatment had the lowest gain and ADG (P<0.001). Dry matter intake (DMI) was greatest for the fiber-based 0PEA and 20PEA WTD treatments and lowest for the starch-based CSBM and CPEA (P<0.001), and WTD did not affect FE (P=0.39). In addition, feedlot finishing performance and carcass measurements were not affected by WTD (P>0.10). Therefore, we conclude that FP can replace up to 20% of fiber-based ingredients in WTD without affecting DMI and ADG. However, the highest cow-calf net return was from the CSBM, 20PEA and 30PEA WTD treatments (P<0.001).

Keywords: *Beef calf post weaning transition diet, Fiber-based diet, Field pea, Feedlot performance, Soybean meal, Starch-based diet*

Nişasta ve Lif Esaslı Sütten Kesim Sonrası Geçiş Rasyonlarına İkame Edilen Yemlik Bezelyenin 7.5 Aylık Yaştaki Besi Danalarının Daha Sonraki Besi Bitirme Performansı, Karkas Kalitesi ve Net Getirisi Üzerine Etkisi

Özet

Araştırmanın amacı, 3 yıllık çalışma süresince 38 gün nişasta ve lif esaslı sütten geçiş dönemi rasyonlarını (WTD) karşılaştırmak ve rasyonların buzağı performansı, yem tüketimi ve yemden yararlanma (FE) üzerine etkisini belirlemektir. Bunu takiben, WTD'lerinin besi bitirme performansı, inek ve buzağı net getirisi üzerine etkisi belirlenmiştir. Melez erkek ve dişi danalar (Angus x Hereford x Gelbvieh; n=405; Yaş=7.5 ay; BW=278±4.3 kg) yaş ve sütten kesim ağırlığı homojen olacak şekilde rastgele altı gruba (4 tekrar/grup) ayrılmıştır. Nişasta esaslı WTD'leri soya küspesi (SBM) ve yemlik bezelye (FP) ile lif esaslı WTD'leri de artan seviyelerde (%0-30) yemlik bezelye (FP) ile formüle edilmiştir. Peletlenmiş WTD grupları sırasıyla 1-(CSBM) nişasta-esaslı+SBM, 2-(CPEA) nişasta-esaslı+FP, 3-(0PEA) lif-esaslı+%0 FP, 4-(10PEA) lif-esaslı+%10 FP, 5-(20PEA) lif-esaslı+%20 FP, and 6-(30PEA) lif-esaslı+%30 FB şeklindedir. Canlı ağırlık ve ortalama günlük canlı ağırlık artışı (ADG) CSBM, 0PEA, 10PEA ve 20PEA gruplarında CPEA ve 30PEA gruplarına oranla daha yüksek (P<0.01) ve CPEA grubunda ise ağırlık ve ADG daha düşük bulunmuştur (P<0.001). Kuru madde tüketimi (DMI) lif esaslı 0PEA ve 20PEA WTD gruplarında en yüksek, nişasta esaslı CSBM ve CPEA gruplarında ise en düşüktür (P<0.001) ve WTD FE'i etkilememiştir (P=0.39). Ayrıca, besi sonu performansı ve karkas kriterleri WTD'den etkilenmemiştir (P>0.10). Bu nedenle, DMI ve ADG'ni etkilemeden, lif esaslı WTD'lerinde hammaddelerinin %20'lik kısmının yerini yemlik bezelyenin alabileceği sonucuna varılmıştır. Bununla birlikte, en yüksek inek-buzağı net getirisi CSBM, 20PEA ve 30PEA gruplarında bulunmuştur (P<0.001).

Anahtar sözcükler: *Etçi melez danaların sütten kesim sonrası geçiş diyeti, Lif-esaslı diyet, Yemlik bezelye, Açık besi, Soya küspesi, Nişasta-esaslı diyet*

İletişim (Correspondence)
+90 286 3162878
ssenturklu@comu.edu.tr; songuls2011@hotmail.com

INTRODUCTION

Beef cattle calves in the USA routinely nurse milk from their mothers for 6-7 months before weaning. Weaning is stressful. Therefore, management procedures that minimize stress during the critical change over, or transition period utilize weaning feeds that are part of a sound weaning management program. Calf weaning feed formulations are prepared with a variety of highly digestible fiber-based co-product ingredients (soybean hulls [1,2], wheat middlings [2] and barley malt sprouts [2]. Although North Dakota research with field pea (FP) has shown FP to be an excellent feedstuff in creep feeds for grazing calves [3,4], and as a source of protein and energy in growing and finishing diets [5,6], FP have received less attention as an ingredient in weaning transition diets (WTD).

The FP contained more than 50% starch and are a protein and energy dense feed ingredient containing 20-27% crude protein (CP), 88-90% total digestible nutrients (TDN), 7-8% acid detergent fiber, and 1.40 Mcal ME/kg for cattle on a dry matter (DM) basis [7]. FP protein is 78-94% rumen degradable [8]. The starch content of FP grain is of concern when FP are to be used as an ingredient in WTD, since starch, when introduced in forage-based diets, has been shown to decrease forage intake and (or) digestibility resulting in reduced performance [9,10] due to changes in TDN and rumen pH changes associated with starch-based grains like corn and FP. Canadian research with dairy cattle suggests that the degradability rate of pea starch is slower than that of conventional cereal grains such as barley, wheat and oats, and is similar to corn [11]. Due to the slower degradability of corn and FP, these ingredients may be nutritionally compatible with fiber-based ingredients.

The purpose of this calf weaning management research was to compare corn- and fiber-based 38 d WTD diets formulated with either soybean meal (SBM) or increasing levels of FP (0-30%) that replaced wheat middlings (midds) and barley malt sprouts. We hypothesized that dry matter intake (DMI) would increase with increasing FP level during the WTD period after weaning, but that WTD would not affect post weaning calf performance, feedlot finishing performance, carcass quality, or net return to retained ownership.

MATERIAL and METHODS

This research project was conducted at the Dickinson Research Extension Center, Ranch Headquarters, Manning, North Dakota, USA (47º11'34" N 102º50'17" W) in accordance with guidelines approved by The North Dakota State University Institutional Animal Care and use Committee (Protocol Approval Number A0209).

Over a 3-year period, six annually replicated treatment groups (n=405) of 7.5 month old crossbred steer and female calves (Angus x Hereford x Gelbvieh) with an average weight of 278±4.3 kg were weaned and randomly assigned to one of six pelleted WTD treatments based on age and weaning weight. The experimental treatment diets, which are described in detail in *Table 1*, consisted of two starch-based diets formulated with either corn or a combination of corn and FP. The starch-based diets were compared to fiber-based diets containing the highly digestible fiber ingredients soybean hulls, wheat middlings, and barley malt sprouts that were blended with FP. The WTD treatments evaluated were: 1- (CSBM) starch-base + SBM, 2- (CPEA) starch-base + FP, 3- (0PEA) fiber-base + 0% FP, 4- (10PEA) fiber-base + 10% FP, 5- (20PEA) fiber-base + 20% FP, and 6- (30PEA) fiber-base + 30% FP.

To test the WTD, four pen replicates of six to eight calves per pen were randomly assigned to treatment based on a 2-day starting weight and fed an average 38 d each year over the three year period. The pelleted weaning feeds *(Table 1)* were prepared as complete feeds and were medicated with decoquinate for coccidiosis control at the rate of 22.5 mg/45.4 kg body weight (BW). The calves were fed chopped alfalfa-bromegrass hay *(Medicago sativa* and *Bromus inermis*, 10.0% CP). The pelleted supplements shown in *Table 1* were formulated to be isonitrogenous, but not isocaloric, and were top dressed over the chopped alfalfa-bromegrass hay [12]. Using challenge feeding, chopped hay was replaced with the experimental weaning supplements until calves in the grain-based treatments (CSBM and CPEA) were consuming from 4.99 to 6.35 kg/head/day and up to 9.53 kg/head/day among the calves receiving the fiber-based FP supplements (0PEA, 10PEA, 20PEA, and 30PEA). Once on full supplement intake, the CSBM and CPEA treatments were consuming 67% of their intake as supplement and for the fiber-based treatments, 88% of their DMI was from supplement. The amount of supplement offered to calves receiving the SBM/Corn and FP/Corn treatments were limited due to the high level of starch present in these two supplements.

Five weeks before weaning all calves were vaccinated with Zoetis Bovi-Shield Gold-5 for bacterial and viral diseases and booster vaccinated at weaning with Zoetis One Shot Ultra for clostridial myonecrosis diseases and pneumatic pasturellosis.

At the end of the 38-d WTD evaluation, an average 2-day ending weight was recorded and the only the steer calves were shipped to a commercial feedlot (Decatur County Feed Yard, Inc., Oberlin, Kansas, USA) where they were grown and finished. At the end of the finishing period, the steers were slaughtered at the federally inspected Cargill Packing Plant, Ft. Morgan, Colorado, USA. The Decatur County Feedlot uses the ACCU-TRAC electronic cattle management system to determine slaughter time, which has been previously described by Senturklu and Landblom [13].

Data was analyzed using procedures of the Statistical

Table 1. *WTD ingredient composition and nutrient analysis (Dry matter)*
Tablo 1. *WTD ham madde kompozisyonları ve besin analizleri (Kuru madde)*

Ingredient Composition	CSBM*	CPEA*	0PEA*	10PEA*	20PEA*	30PEA*
Corn, %	77.801	31.365	10.0	10.0	10.0	10.0
FP*, %	0.0	62.046	0.0	10.0	20.0	30.0
SBM*, %	15.601	0.0	0.0	0.0	0.0	0.0
Soybean Hulls, %	0.0	0.0	39.421	38.226	37.086	35.628
Wheat Middlings, %	0.0	0.0	24.56	20.748	16.888	13.346
Barley Malt Sprouts, %	0.0	0.0	20.0	15.0	10.0	5.0
Limestone, %	0.85	0.85	0.3	0.3	.03	.03
Decoquinate (6.0%), %	0.0489	0.0386	0.0269	0.0269	0.0269	0.0269
Other**, %	5.7	5.7	5.7	5.7	5.7	5.7
Total, %	100.0	100.0	100.0	100.0	100.0	100.0
Nutrient Analysis						
CP*, %	16.0	16.1	16.5	16.2	16.0	15.7
TDN*, %	85.2	79.2	69.3	69.9	70.7	77.5
Crude Fiber, %	2.8	5.0	18.0	17.9	17.9	17.7
Fat, %	3.6	2.2	2.4	2.4	2.3	2.2
NEm, Mcal/kg	2.12	1.92	1.61	1.63	1.65	1.68
NEg, Mcal/kg	1.43	1.30	1.02	1.04	1.06	1.08

** **CSBM:** Starch-base+SBM, **CPEA:** Starch-base+FP, **0PEA:** Fiber-base+0% FP, **10PEA:** Fiber-base+10% FP, **20PEA:** Fiber-base+20% FP, and **30PEA:** Fiber-base+30% FP, **SBM:** Soybean meal, **FP:** Field pea, **CP:** Crude protein, **TDN:** Total digestible nutrients; ** Other; Beet Molasses, 5.0%; Salt, 0.50%, Dicalcium Phosphate (21%), 0.10%, Feedlot Trace Mineral Premix, 0.075%, Feedlot Vitamin Premix, 0.025%*

Analysis System [14]. Transition, finishing, carcass, income and expense data were analyzed as a randomized complete block design using the PROC GLM procedure of SAS and USDA quality grade was analyzed using Chi-Square procedures in PROC GENMOD. Orthogonal contrasts were made to compare Starch and Fiber, SBM and FP, and for linear (L), quadratic (Q), and cubic (C) effects. Effects for L, Q, and C were only discussed when a significant *F*-test was detected. Pen served as the experimental unit. Differences between the experimental treatment groups were considered significant at P≤0.05.

RESULTS

Weaning Transition Period

The effect of WTD over a period of three years on steer and female calves' performance during the 38-d post weaning period is shown in *Table 2*. The mean starting weight of the steer and female calves in the study was 278 kg (P=0.73). Ending weight comparison between fiber-based treatments and starch-based (corn) treatments did not differ (P=0.28). Comparing starch- versus fiber-based diets, calves that were fed the CSBM, 0PEA, 10PEA, and 20 PEA had greater gain and average daily gain (ADG) compared to the CPEA and 30PEA (P=0.0001) feed treatments. The calves fed the CPEA feed treatment had the slowest ADG. It is critically important that newly weaned calves begin eating as soon as possible after weaning, if a post-weaning growth depression is to be avoided. Daily DMI was greatest for calves receiving the fiber-based 0PEA and 20PEA WTD and lowest for those calves that were fed the starch-based CSBM and CPEA WTD, and intermediary for the 10PEA and 30PEA WTD (P=0.0001).When feed treatments formulated with either SBM or FP were compared, there was no difference for gain or ADG; however, there was a significant DMI difference for FP (P=0.05). Orthogonal L, Q, and C fiber analysis of the data was unremarkable for Q and C; however, a L fiber feed treatment relationship for gain (P=0.0001), ADG (P=0.0002), and DMI (P=0.0001) were identified. Among treatments, greater DMI corresponded to greater ADG and smaller DMI also corresponded to smaller ADG. Therefore, for feed efficiency (FE), there was no statistical difference identified between treatments (P=0.39). When pea replaced 30% of the fiber ingredients (30PEA), gain and ADG were reduced (P=0.0001), DMI was intermediary, but FE did not differ (P=0.39). Feed cost per unit of gain was lowest for the CSBM and 0PEA WTD; however, the feed cost per unit of gain for the starch-based CSBM diet was 11.6% less than the fiber-based 0PEA WTD.

Feedlot Finishing Period

For finishing, only the steer calves from each treatment were fed to finish and slaughtered for performance and carcass data evaluation *(Table 3)*. Steers that received a 20% FP replacement diet during the 38 d transitioning required numerically fewer days to slaughter (129 vs. 134 d). Feedlot starting weight did not differ (P=0.79) and averaged 333.0

kg. Ending weight also did not differ (P=0.99) and averaged 531.0 kg. ADG was uniform across treatments and there was no statistical difference between WTD treatments at the end of finishing. Due to the uniform performance of steers during the growing-finishing period, WTD fed immediately after weaning did not affect subsequent feedlot FE, which was similar across treatments (P=0.55).

Carcass Measurements

Carcass measurements have also been summarized in *Table 3*. Carcass measurements for hot carcass weight (P=0.97), rib eye area (P=0.33), marbling score (P=0.14), USDA yield grade (P=0.72) and USDA quality grade (P=0.77) were not affected by treatment. Across treatments 54.5% of steers graded choice compared to 68% among steers receiving a 20% FP replacement diet during the 38 d WTD period. The 13.5% increase in the number of carcasses grading USDA Choice or better was not significantly greater (P=0.77).

Enterprise Analysis

Enterprise analysis with respect to revenue that is returned to the cow-calf business, when ownership of the cattle remains in the cow-calf operator's possession, has been summarized in *Table 4*. Income from finished carcasses and direct production expenses to including WTD, weaning transition yardage charge, animal health care (vaccine and antibiotic), ACCU-TRAC electronic cattle management fee, transportation charge, and annual cow cost of production were used to estimate net return to the cow and calf enterprise. Highest return to the cow/calf enterprise of $247 was obtained with the CSBM WTD

Table 2. *Effect of 38 d WTD on calf growth performance and economics (3-year)*
Tablo 2. *38 günlük WTD'nin buzağı büyüme performansı ve ekonomisi üzerine etkisi (3-yıl)*

Calf Growth Performance	CSBM*	CPEA*	0PEA*	10PEA*	20PEA*	30PEA*	SEM*	P-Value [e]			
								TRT*	Starch vs Fiber	SBM* vs FP*	Fiber (L)*
Number of Calves	68	68	68	68	67	66					
Starting Weight, kg	275	279	277	276	286	274	7.25	0.73			
Ending Weight, kg	319	313	324	322	330	312	7.40	0.28			
Gain, kg	44[a]	34[c]	47[a]	46[a]	44[a]	38[b]	1.81	0.0001	0.0004	0.23	0.0001
ADG*, kg	1.16[a]	0.90[c]	1.24[a]	1.21[a]	1.16[a]	1.0[b]	0.05	0.0001	0.0003	0.25	0.0002
DMI*, kg	7.59[c]	6.88[d]	8.78[a]	8.24[b]	8.46[a]	7.80[bc]	0.21	0.0001	0.0001	0.05	0.0001
Feed:Gain, kg	6.54	7.64	7.08	6.81	7.29	7.80	0.50	0.39	0.18	0.35	0.12
Feed Cost/Head,$	37.53	35.03	46.14	44.21	44.30	41.10	0.96				
Feed Cost/kg Gain, $	0.85	1.03	0.98	0.96	1.00	1.08	0.03				

[a-d] Means with different superscripts within a line are significantly different, ($P<0.05$); [e] P-Values for treatment and orthogonal contrasts. Only linear (L) P-Value is shown; Quadratic and Cubic were NS; ****CSBM:*** *Starch-base+SBM,* ***CPEA:*** *Starch-base+FP,* ***0PEA:*** *Fiber-base+0% FP,* ***10PEA:*** *Fiber-base+10% FP,* ***20PEA:*** *Fiber- base+20% FP, and* ***30PEA:*** *Fiber-base+30% FP,* ***SEM:*** *Pooled standard error of the mean,* ***TRT:*** *treatments,* ***SBM:*** *Soybean meal,* ***FP:*** *Field pea,* ***L:*** *Linear,* ***ADG:*** *Average daily gain,* ***DMI:*** *Dry matter intake*

Table 3. *Feedlot finishing performance and carcass measurements (3-year)*
Tablo 3. *Besi sonu performansı ve karkas parametreleri (3-yıl)*

Feedlot Finishing Performance	CSBM*	CPEA*	0PEA*	10PEA*	20PEA*	30PEA*	SEM*	P-Value
Days at Feedlot	135	141	131	135	129	136	4.0	0.40
Starting Weight, kg	331	328	332	333	339	329	12.7	0.79
Ending Weight, kg	531	530	529	532	528	531	13.9	0.99
ADG*, kg	1.48	1.43	1.50	1.47	1.47	1.49	0.07	0.75
Feed:Gain	6.0	6.0	5.85	6.0	6.0	5.81	0.10	0.55
Carcass Measurements								
Hot Carcass Weight, kg	335	331	335	334	331	332	10.0	0.97
Ribeye Area, sq.cm.	77	75	75	78	76	75	0.16	0.33
Marbling Score	49.0	54.4	52.8	52.7	54.3	48.0	51.9	0.14
Yield Grade	3.15	3.21	3.27	3.11	3.21	3.14	0.07	0.72
Quality Grade	2.46	2.44	2.53	2.46	2.36	2.48	0.08	0.77
Percent Choice, %	56.0	55.3	53.2	55.8	68.0	52.0	56.8	0.15

*** ***CSBM:*** *Starch-base+SBM,* ***CPEA:*** *Starch-base+FP,* ***0PEA:*** *Fiber-base+0%FP,* ***10PEA:*** *Fiber-base+10%FP,* ***20PEA:*** *Fiber-base+20%FP, and* ***30PEA:*** *Fiber-base+30%FP,* ***SEM:*** *Pooled standard error of the mean,* ***ADG:*** *Average daily gain*

Table 4. *Feedlot income, expenses and net return to the cow and calf enterprise (3-year)*
Tablo 4. *İnek ve buzağı işletmesinin besi gelir, giderleri ve net getirisi (3-yıl)*

Parameter	CSBM*	CPEA*	0PEA*	10PEA*	20PEA*	30PEA*	SEM*	P-Value
Feedlot Economics								
Income								
Carcass Value, $	886	849	871	863	871	880	16.6	0.71
Expenses								
Calf Cost/Head, $	633	624	632	634	644	630	8.1	0.70
Feedlot Cost/Head, $	236	242	231	233	226	233	7.7	0.81
Finishing Net Return/Head, $	17	17	8	4	1	17		
Cow-Calf Enterprise Analysis								
Income								
Carcass Value, $	886	849	871	863	871	880		
Expenses								
Transition Feed Cost/Head, $	38	35	46	44	44	41		
Feedlot Feed Cost/Head, $	236	242	231	233	226	233		
Other**, $	365	365	365	365	365	365		
Total Expense, $	639	642	642	642	635	639		
Net Return to Cow and Calf Enterprise	247	207	229	221	236	241		

* ***CSBM:*** *Starch-base+SBM,* ***CPEA:*** *Starch-base+FP,* ***0PEA:*** *Fiber-base+0% FP,* ***10PEA:*** *fiber-base+10% FP,* ***20PEA:*** *Fiber-base+20% FP, and* ***30PEA:*** *Fiber-base+30% FP,* ***SEM:*** *Pooled standard error of the mean; ** Other; Transition period yardage cost, $8.00/steer; annual cow maintenance cost, $341.00/cow; cattle transportation to feedlot cost, $16.00/steer*

supplement followed by $241 and $236 for the 30PEA and 20PEA WTD supplements, respectively. The CPEA WTD yielded the smallest return to the cow/calf enterprise of $207. The WTD tested that were formulated with 0PEA and 10PEA resulted in net returns per cow of $229 and $221, respectively.

DISCUSSION

Weaning protocols that promote DMI and ADG minimize weaning growth depression and help calves transition from grazing to a feedlot environment. In this evaluation of weaning transition protocols, the ratio of starch to fiber in the concentrate supplements ranged from high starch (CPEA) to high fiber (0PEA). Soybean hulls, wheat midds, and barley malt sprouts were the sources of highly digestible fiber and corn was the primary starch source. Dietary energy from grain is primarily from starch or nonstructural carbohydrate. Energy from forage is primarily from fiber or structural carbohydrate. When small amounts of starch-based ingredients (0.25-0.40% of BW or less) are fed in fiber-based diets, forage intake and digestibility are not adversely affected or may improve slightly. At higher starch intake, forage intake and digestibility decline affecting performance [9,10]. Changes in TDN that result from the partial replacement of fiber-based ingredients with starch-based ingredients is referred to as a negative associative effect and is dependent on forage quality and amount of grain (starch) fed. The onset of a negative relationship is variable, but when the production goal is to achieve maximum forage intake and digestibility, adding a starch-based grain to forage-based diets in which starch intake will be 0.4-0.5 percent of BW may lead to reduced forage digestibility [9,10,15].

In *Table 2*, FP replaced up to 30% of the fiber-based ingredients (soybean hulls, wheat middlings, and barley malt sprouts). With increasing level of FP, ADG and DMI increased up to 20% FP, but declined at the 30% FP level. Total weight gain was affected, but not FE. For CSBM, DMI declined, but ADG was not affected (P=0.0001), and for CPEA both DMI and ADG declined (P=0.0001).

Paralleling this current field investigation a companion intake and digestibility study was conducted to evaluate the effect of replacing fiber-based ingredients with increasing level of FP from 0-45% [16] in medium concentrate diets. The findings of Soto-Navarro [16] serve to explain the response observed in this study. In the companion study, DMI declined linearly with increasing FP level (P<0.07), which is in agreement with the current study and others [17] who supplemented gestating cows with increasing levels of FP grain, but does not agree with others who reported an increase in DMI when barley and SBM [18] or barley and canola meal [19] were replaced with FP. Explanation for the decline in DMI in our study may be explained by reported results for fluid dilution rate [16], in which DMI declined linearly with increasing FP level. Compared to the current study, the highest fluid dilution rate was associated with the 0% FP level, which was also associated with the greatest DMI. Decreased DMI has also been associated with decreased passage rate [20]. Similarly, for the CPEA and CSBM, DMI was reduced and could be explained by fluid dilution rate in which substrate passage was probably slowed compared to the WTD supplemented with increasing levels of FP. In the paralleling digestibility study, organic matter (OM) intake and total-tract OM digestibility were not affected by increasing FP level, which was not expected, because the TDN level of FP is higher than the combined TDN value of the fiber ingredients that FP replaced.

In a 39-d weaned calf receiving diet study, intake, digestibility, and feedlot performance were evaluated [21]. Compared to our experiment in which DMI and ADG declined when corn-pea (CPEA) was fed, they [21] measured an increase in DMI ($P \leq 0.07$) and BW gain ($P \leq 0.04$) when corn- FP, corn-chickpea, and corn-lentil receiving diets were fed. Considering the results of others that studied receiving (42-d) [5,22], growing [23,24] and finishing [6,25] cattle diets supplemented with FP, many have reported no change or increases in DMI, gain, and gain efficiency.

In our study, the carryover effect of WTD on ending carcass measurements was unremarkable and consistent with others [6,25,26] that found no difference between treatments that evaluated the effect of FP on carcass measurements. However, FP has been shown to improve meat tenderness [25,26] when fed in high grain diets without altering performance.

In conclusion, based on the results of the current study and the results of the paralleling digestibility study and others, up to 20% FP can replace fiber-based ingredients in 38 d WTD without negatively affecting DMI or ADG. Moreover, our data suggests that when ownership of calves continues through finishing and slaughter, the highest net return to the cow and calf enterprise will be from WTD feed treatments where DMI and ADG were less and feed cost per kilogram of gain was lowest. The decision to consider using FP in WTD should be based on cost per unit of protein compared to other protein-energy sources.

REFERENCES

1. Ferreira EM, Pires AV, Susin I, Mendes CQ, Gentil RS, Araujo RC, Amaral RC, Loerch SC: Growth, feed intake, carcass characteristics, and eating behavior of feedlot lambs fed high-concentrate diets containing soybean hulls. *J Anim Sci*, 89, 4120-4126, 2011. DOI: 10.2527/jas.2010-3417

2. Lardy GP, Anderson VL: Alternative feeds for ruminants. North Dakota State University Extension Bulletin, AS-1182, 2007.

3. Anderson VL: Field peas in creep feed for beef calves. North Dakota State University Carrington Research Extension Center Beef and Bison Field Day Proc. 22:1, 1999.

4. Landblom DG, Poland WW, Lardy GP: Application of salt-limited pea/wheat midds creep diets in Southwestern North Dakota. North Dakota Cow/Calf Conference and Beef Cattle Range Research Report, Bismarck, North Dakota, 2000.

5. Anderson VL, Stoltenow CS: Field peas in preconditioning diets for beef calves. *J Anim Sci,* 82 (Suppl.1): 65 (Abstr), 2004.

6. Lardy GP, Loken BA, Anderson VL, Larson DM, Maddock-Carlin KR, Ilse BR, Maddock R, Leupp JL, Clark R, Paterson JA, Bauer ML: Effects of increasing field pea *(Pisum sativum)* level in high-concentrate diets on growth performance and carcass traits in finishing steers and heifers. *J Anim Sci,* 87, 3335-3341, 2009. DOI: 10.2527/jas.2009-1785

7. Anderson VL, Lardy GP, Ilse B: Field pea grain for beef cattle. http://www.ag.ndsu.edu/ pubs/ansci/beef/as1301.pdf. *Accessed*: 08.01.2014.

8. Aufrere J, Graviou D, Michalet-Doreau B: Degradation in the rumen of proteins of 2 legumes: Soybean meal and field pea. *Reprod Nutr Dev*, 34, 483, 1994. DOI: 10.1051/rnd:19940509

9. Chase CC Jr, Hibberd CA: Utilization of low-quality native grass hay by beef cow fed increasing quantities of corn grain. *J Anim Sci,* 65, 557-566, 1987.

10. Sanson DW, Clanton DC: Intake and digestibility of low-quality meadow hay by cattle receiving various levels of whole shelled corn. *J Anim Sci*, 67, 2854-2862, 1989.

11. Robinson PH, McQueen RE: Non-structural carbohydrates in rations for dairy cattle. *Proc. 10th Western Nutr. Conf. Univ. Saskatchewan, Saskatoon, Saskatchewan,* Canada. p.153, 1989.

12. NRC: Nutrient Requirements of Beef Cattle. 7th ed., Natl. Acad. Press, Washington, DC, 1996.

13. Senturklu S, Landblom DG: 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. *Kafkas Univ Vet Fak Derg*, 20 (2): 295-300, 2014. DOI: 10.9775/kvfd.2013.10078

14. SAS: SAS/STAT Institute Inc. Cary, NC 27513, 2008.

15. Pordomingo AJ, Wallace JD, Freeman AS, Galyean ML: Supplemental corn grain for steers grazing native rangeland during summer. *J Anim Sci*, 69, 1678-1687, 1991.

16. Soto-Navarro SA, Williams GJ, Bauer ML, Lardy GP, Landblom DG, Caton JS: Effect of field pea replacement level on intake and digestion in beef teers fed byproduct-based medium concentrate diets. *J Anim Sci*, 82, 1855-1862, 2004.

17. Encinias AM, Scheaffer AN, Radunz AE, Bauer ML, Lardy GP, Caton JS: Influence of field pea supplementation on intake and performance of gestating beef cows fed grass hay diets. *Can J Anim Sci*, 80, 766 (Abstr.), 2000.

18. Poland WW, Landblom DG: Feeding value of field pea and hull-less oat in growing calf diets. *J Anim Sci*, 74 (Suppl. 1): 279 (Abstr), 1996.

19. Okine E: Feeding peas to backgrounding cattle. Western Forage/Beef Group. http://www1.agric.gov.ab.ca/$department/newslett.nsf/all/wfbg33?Open, *Accessed:* 08.01.2014, 2013.

20. Guthrie MJ, Wagner DG: Influence of protein or grain supplementation and increasing levels of soybean meal on intake, utilization and passage rate of prairie hay in beef steers and heifers. *J Anim Sci*, 66, 1529-1537, 1988.

21. Gilbery TC, Lardy GP, Soto-Navarro SA, Bauer ML, Anderson VL: Effect of field peas. Chickpeas, and lentils on rumen fermentation, digestion, microbial protein synthesis, and feedlot performance in receiving diets for beef cattle. *J Anim Sci*, 85, 3045-3053, 2007.

22. Anderson VL, Schoonmaker JP: Effect of pulse grains on performance of newly weaned steer calves. North Dakota State University Carrington Research Extension Center Beef Production Field Day Proceedings, 27:6, 2004.

23. Reed JJ, Lardy GP, Bauer ML, Gilbery, TC Caton JS: Effect of field pea level on intake, digestion, microbial efficiency, ruminal fermentation, and in situ disappearance in beef steers fed growing diets. *J Anim Sci*, 82, 2123-2130, 2004.

24. Chen JQ, Okine EK, Price MA, Khorasani GR: Feeding value of peas for backgrounding heifers. *Can J Anim Sci*, 83, 779-786, 2003. DOI: 10.4141/A03-010

25. Jenkins KH, Vasconcelos JT, Hinkle JB, Furman SA, De Mello AS Jr, Senaratne LS, Calkins CR: Evaluation of performance, carcass characteristics, and sensory attributes of beef from finishing steers fed field peas. *J Anim Sci*, 89, 1167-1172, 2011. DOI: 10.2527/jas.2009-2552

26. Carlin KM, Lardy GP, Maddock RJ, Ilse B, Anderson VL: Field pea inclusion in high grain diets for beef heifers improves beef tenderness without altering performance. *J Anim Sci*, 84 (Suppl. 1): 36 (Abstr.), 2006.