Effects of Field Pea Inclusion on Ruminal Fermentation and Digestion in Steers Fed High-concentrate Finishing Diets

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The objective of this study was to evaluate the effects of field pea inclusion on ruminal fermentation and digestibility in steers fed high-concentrate finishing diets. While intake increased, digestibility was not affected with increasing levels of field pea, indicating field pea to be a suitable replacement for corn in high-concentrate diets.

Summary
Four Angus steers (1,280 ± 90 pounds initial body weight) fitted with ruminal and duodenal cannulas were used in a 4 by 4 Latin square-designed experiment to test the effect of field pea inclusion in high-concentrate diets on intake, ruminal fermentation and site of digestion. Field pea replaced portions of urea, soybean meal and corn at 10%, 20% and 30% of dietary dry matter to formulate the dietary treatments. Dry matter intake (DMI) and organic matter (OM) intake increased as peas increased in the diet ($P \leq 0.05$). Field pea grain appears to be a suitable replacement for combinations of corn, soybean meal and urea in high-concentrate finishing diets.

Introduction
Field pea (*Pisum sativum*) acreage has greatly increased in North Dakota since 1998. North Dakota leads the nation in field pea production, with 590,000 acres harvested in 2006 (NASS, 2007). Field pea can be used as both a protein and energy source for cattle, containing 25% crude protein (CP) and 87% total digestible nutrients (TDN) (NRC, 1984). Thus, the feed industry is an excellent potential market for field pea. Previous research indicates DMI increases when field pea replaced corn in diets for growing steers (Reed et al., 2004). Similar feed conversion efficiency and weight gains have been reported when comparing field pea to hull-less oat (Poland and Landblom, 1996). Field pea has been included successfully in lamb finishing diets up to 45% of the diet (Loe et al., 2004). In a companion study to this experiment, no differences were found in DMI, average daily gain and gain efficiency when steers were fed high-concentrate diets containing up to 30% field pea (Larson et al., 2007). However, no research has been conducted that investigates the effect of field pea inclusion on ruminal fermentation and digestibility when included in high-concentrate diets fed to steers.

Procedures
Four ruminally and duodenally cannulated Angus steers were used in a 4 by 4 Latin square to evaluate the effects of field pea inclusion on DMI, ruminal fermentation and site of digestion. Steers were housed in an enclosed barn in individual stanchions (4 feet by 7 feet) on rubber mats. Steers were allowed free access to water and were fed a total-mixed ration twice daily at 7 a.m. and 7 p.m. Diets were offered to ensure an ad libitum intakes plus 10% refusal. The control diet on a dry matter (DM) basis consisted of 79.75% corn, 5% corn silage, 5% alfalfa, 5% concentrated separated byproduct and 5.25% supplement (Table 1). Treatments consisted of (DM basis): 1) control, containing no field pea, 2) 10 % inclusion of field pea, 3) 20% inclusion of field pea and 4) 30% inclusion of field pea. Diets were formulated to contain a minimum of 13% CP, 0.70% calcium (Ca) and 0.29% phosphorus (P). Diets also contained 25 g/T Rumensin and 10 g/T Tylan.

Table 1. Composition and analyzed dietary nutrient content of diets fed to beef steers.

	Dietary field pea, %			
Item	0	10	20	30
Ingredient, % DM[a]				
Dry-rolled corn	79.75	70.75	61.75	52.75
Rolled field pea	0	10	20	30
Corn silage	5	5	5	5
Alfalfa hay	5	5	5	5
CSB	5	5	5	5
Supplement	5.25	4.25	3.25	2.25
Analyzed dietary nutrient content, %				
DM, %	85.5	85.8	86	86.3
	---------- % of DM ----------			
OM, %	91.1	91.5	92.1	91.4
CP, %	13.2	12.5	11.9	12.5
NDF, %	18.2	18	18.8	19
ADF, %	7	7	7.4	7.5

[a] Diets were formulated to contain 25 g/T Rumensin and 10 g/T Tylan and a minimum of 13% CP, 0.70% Ca and 0.28% P.

Each period was 14 days in length, with nine days of adaptation and five days of sample collection. Individual feed and complete diets were sampled and analyzed for nutrient content. Feed refusals were measured daily. Total fecal output was measured to determine total tract digestion. Intestinal samples were taken between days 11 and 13 of collection to estimate site (ruminal vs. intestinal) of digestion. Ruminal fluid samples were collected on day 14 to determine ammonia (NH_3) , volatile fatty acids and pH.

Results

A summary of the results are found in Table 2. Dry-matter intake increased ($P \leq 0.05$) as field pea level increased in the diets. Similarly, OM intake increased as field pea level increased ($P = 0.03$); however, the treatments had no effect on total tract OM digestibility ($P = 0.64$; 74.4 ± 2.7%). Total tract CP digestion ($P = 0.31$; 60.9 ± 3.9%) was not affected by treatment ($P = 0.31$). Microbial efficiency did not differ among treatments ($P = 0.77$; 0.08 ± 0.02 g microbial N/kg OM digested ruminally).

Neutral detergent fiber ($P = 0.21$; 5.3 ± 0.1 pound/day) and acid detergent fiber (ADF) ($P = 0.27$; 2.1 ± 0.1 pound/day) intake did not differ with increasing levels of field pea. Total tract neutral detergent fiber (NDF) digestibility was not different among treatments ($P = 0.21$; 63.2 ± 3.7% digestibility). Total tract ADF digestibility tended to increase ($P = 0.10$; 49.8, 56.0, 62.3, and 65.6 ± 4.6% digestibility, respectively for 0%, 10%, 20% and 30% field pea inclusion) with increasing field pea inclusion.

Table 2. Effect of field peas on OM digestion, CP digestion, ruminal pH, total VFA and ammonia concentrations in steers.

	Dietary field pea				Treatment		Contrasts[a]		
Item	0	10	20	30	SEM	*P*-value	L	Q	C
OM digestion, % of intake									
True ruminal	31.8	33.5	37.4	36.4	7.5	0.95	0.63	0.86	0.85
Intestinal	61.4	61.7	51.6	64.2	9.1	0.76	0.97	0.51	0.43
Total tract	74.6	72	76	75	2.7	0.64	0.61	0.72	0.28
CP digestion, % of intake									
Total tract	62.2	64.9	55.8	60.8	2.9	0.31	0.38	0.72	0.11
Ruminal pH	6.3	6.3	6.3	6.2	0.05	0.24	0.06	0.82	0.67
Ruminal NH_3, m*M*	6.3	5.4	4.7	9.6	0.58	0.004	0.01	0.003	0.08
Total VFA, m*M*	117.4	113.6	118.3	129.1	3.3	0.65	0.34	0.07	0.88

[a] Contrasts were L = linear, Q = quadratic, and C = cubic.

Ruminal pH was not affected (P = 0.24; 6.28 ± 0.06) by increasing field pea inclusion. A quadratic change was measured in ruminal ammonia (P = 0.004) due to increased field pea levels. Total volatile fatty acid (VFA) tended (P = 0.07) to change quadratically with increasing levels of field pea. However, molar proportions of acetate (49.6 ± 1.4%), propionate (28.9 ± 2.4%) and butyrate (12.8 ± 2.1%) were not affected (P ≥ 0.60) by treatments.

Implications

Field pea inclusion increased DMI without affecting OM or CP digestibility or ruminal fermentation parameters. Therefore, these data suggest that field pea is a suitable substitution for corn in high-concentrate diets for finishing steers.

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