Effects of Field Pea Inclusion on Intake and Digestion in Beef Steers Fed Medium Concentrate Diets

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The supplementation of medium concentrate diets for beef cattle with field peas decreases ruminal CP digestibility and increases escape protein supply. The increment of escape protein can be explained by the decrease in effective degradation of soybean hulls and field peas with increasing field pea level in the diet. Field pea supplementation at 30% of a 55% concentrate diet increased the flow of apparent feed protein to the small intestine when fed to beef steers. Field peas is an acceptable nutrient source for beef steers fed medium concentrate diets.

Introduction

In backgrounding systems gains of 1.5 to 2.5 pounds per head per day are expected (Lardy, 1998). Protein and energy requirements for such gains are achieved by feeding mixtures of grains and forages. Field peas, that contain approx 25% CP and 47% starch, can be used as a protein and energy source. Poland and Landblom, (1996) and Anderson (1999) reported that dry matter intake was not affected when field peas replaced cereal grains in growing diets. Moreover, improved feed efficiency was detected when field peas replaced barley and soybean meal in growing diets (Okine, 2001). Digestion characteristic of cattle consuming growing diets that include field peas remains poorly quantified. In addition, level of field pea inclusion into grower diets is not well defined. Therefore, objectives of this study were to evaluate the influence of field pea supplementation on intake and digestive characteristics in beef steers fed medium concentrate diets.

Materials and Methods

Four beef steers (703.4 ± 41 kg initial BW) with cannulas in the rumen and proximal duodenum were used in a 4 x 4 Latin square. Steers were handled and cared for according to procedures approved by the North Dakota State University Institutional Animal Care and use Committee. Composition of experimental diets is shown in Table 1, which included .25% chromic oxide added as a digesta marker. Diets were prepared at approximately weekly intervals and stored in concrete feed bays. Diets consisted of 45% grass hay (6.8% CP) and 55% concentrate mixture. Treatments consisted of: 1) control, no peas; 2) 15% peas; 3) 30% peas; and 4) 45% peas in the total diet (Table 1), with peas replacing wheat middlings, soybean hulls, and barley malt sprouts in the concentrate mixture. Steers were fed ad libitum at 0700 and 1900 daily and were allowed free access to water. Experimental period consisted of a 9-d diet adjustment period followed by a 5-d collection period. During collections, fecal output was measured using fecal bags. Fecal bags were emptied and weighed twice daily at 12-h intervals. Duodenal samples were taken twice daily from all steers as follow: d 2, 0630 and 1230; d 3, 0800 and 1400; d 4 0930 and 1530; and d 5, 1100 and 1700. Individual samples consisted of approximately 200 mL of duodenal contents and 10% (wet basis) of daily fecal output. Samples from each steer and within each collection period were composited for analysis. In situ bags were incubated in the rumen on d 10 through 13. Grass hay (2 mm; 5 g) was placed in dacron bags and ruminally incubated for 98, 72, 36, 24, 14, 9, 5, 2, and 0 h, and field pea and soybean hulls for 72, 48, 36, 24, 14, 9, 5, 2, and 0 h. All bags were removed at 0 h and rinsed with a hose to removed large particulate matter. In situ bags were then rinsed in a top-loading washing machine (General Electric, Louisville, KY) using the delicate cycle. The machine was filled with 45 L cold water. The bags were agitated for 1 minute, drained, and spun for 2 minutes. This cycle was repeated five times. Bags were dried in a forced-air oven (The Grive Corporation, Round Lake, IL; 50°C) and stored at room temperature until analysis. Samples were subject to all or part of the following analysis DM, ash, chromium, CP, ADF, NDF, and purines. Microbial organic matter and N (MN) leaving the abomasum were calculated using purines as microbial markers (Zinn and Owens, 1986). Data were analyzed as a 4 x 4 Latin square using Mixed procedures of SAS (Littell et al., 1998). Fixed effects were field pea level and period, and the random effect was steer. Orthogonal contrasts were conducted for linear, quadratic, and cubic effects of dietary level of field pea (SAS, 1990).

Results

Organic matter intake (% BW) decreased (*P* < .10) with increasing field pea level (Table 2). However, OM digestibility was not affected (*P* > .10) by field pea level. Non-microbial CP flow to small intestine quadratically increased (*P* > .10) with level of field pea which was a result of the linear decreased (*P* < .10) observed for apparent and true ruminal digestibility. Since most of the non-microbial CP is escape protein, escape protein increased with increasing filed pea level. Intake of NDF and ADF linearly decreased (P >.05) with field pea level as a result of the decrease of DMI and diet NDF and NDF dilution. However, NDF and NDF digestibilities were not affected (*P* > .10) by field pea level. Rates of DM, NDF, and ADF ruminal disappearance are summarized in Table 3. Forage DM, NDF, and ADF, and soybean hulls NDF rate of ruminal disappearance linearly decreased (*P* < .10) with field pea level. Field pea DM rate of ruminal disappearance quadratically increased (*P* < .05) with field pea level. Table 4 shows the in situ CP kinetic parameters, the forage CP degradation rate quadratically increase (*P* < .05) with field pea level with a peak at 15% field pea. However, effective degradation was not alter (P > .10) by field pea level. Effective CP degradation of Soybean hulls and field peas quadratically decrease (P < .10) with field pea level.

Discussion

The supplementation of medium concentrate diets for beef cattle with field peas decreases ruminal CP digestibility and increases escape protein supply. In agreement with the in situ data, the increment of escape protein can be explained by the decrease in effective degradation of soybean hulls and field peas with increasing field pea level in the diet.

Implications

Field pea supplementation at 30% of a 55% concentrate diet increased the flow of apparent feed protein to the small intestine when fed to beef steers. Field peas is an acceptable nutrient source for beef steers fed medium concentrate diets.

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Publications Of This Research

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Table 1. Composition of diets consumed by beef steers.

	Field Pea Level (%)			
Item	0	15	30	45
Ingredient composition (%)				
Grass Hay	45.0	45.0	45.0	45.0
Field Pea	0.00	15.0	30.0	45.0
CSB	5.0	5.0	5.0	5.0
Wheat Middlings	20.0	13.4	6.7	0.0
Soybean Hulls	13.4	9.0	4.5	0.0
Barley Malt Sprouts	10.0	6.7	3.3	0.0
Supplement[a]	6.35	5.65	5.25	4.75
Chromic oxide	0.25	0.25	0.25	0.25
Analyzed composition (%)				
Ash	10.5	10.7	10.6	10.4
CP	12.6	12.9	12.9	13.0
NDF	58.9	57.2	56.7	53.1
ADF	33.2	32.0	30.9	28.8

[a] Supplement ingredients included ground corn, limestone, salt, soybean meal, trace mineral salt, vitamin A-D, vatamin E, and CSB.

Table 2. Effect of level of field pea on characteristics of digestion of OM and CP in beef steers.

Item	Field Pea (%)				SEM	P-value	Contrast[a]		
	0	15	30	45			L	Q	C
OMI, (% BW)	1.97	1.74	1.80	1.70	0.08	.09	.05	NS	.15
Organic matter digestion (% intake)									
Apparent ruminal	58.3	57.9	53.9	57.3	2.54	.59	NS	NS	NS
True ruminal	67.3	67.0	62.5	67.0	1.74	.11	NS	.18	.06
Postruminal	10.8	6.2	13.7	12.7	2.71	.19	NS	NS	.09
Total tract	69.4	64.5	67.8	68.9	1.77	.25	NS	.10	NS
Crude protein flow									
Duodenal, (g/d)									
Total	1,549	1,533	1,826	1,617	128.1	.30	NS	NS	.15
Microbial	808	737	618	537	97.6	.43	.11	NS	NS
Non-microbial	872	873	1,156	924	79.3	.01	.05	.09	NS
Crude protein digestion (% intake)									
Apparent ruminal	17.5	12.0	0.6	6.5	4.31	.10	.06	NS	NS
True ruminal	53.5	48.7	37.8	46.2	3.83	.07	.07	.13	.13
Postruminal	51.6	47.9	59.9	54.9	4.02	.29	NS	NS	.13
Total tract	68.8	59.6	60.9	61.5	2.70	.16	.15	.10	NS
Microbial efficiency[b]	14.6	13.6	12.9	11.0	1.69	.64	NS	NS	NS

[a]Probabilities for contrasts: linear(L), quadratic (Q), and Cubic (C); NS = P>0.20.
[b]Grams microbial N per kg OM truly fermented.

Table 3. Effect of level of field pea on rate of DM, NDF and ADF ruminal disappearance (%/h) of grass hay, soybean hulls, and field peas in beef steers.

	Field Pea (%)						Contrast[a]		
Item	0	15	30	45	SEM	P-value	L	Q	C
Forage									
DM	4.4	4.3	3.2	2.8	0.42	0.05	0.02	NS	NS
NDF	4.3	4.0	2.6	2.8	0.55	0.07	0.02	NS	NS
ADF	4.4	4.3	2.6	2.8	0.50	0.05	0.02	NS	0.12
Soybean hulls									
DM	5.6	5.5	4.0	3.4	0.93	0.19	0.05	NS	NS
NDF	6.1	6.4	3.3	4.2	1.40	0.10	0.04	NS	.11
ADF	4.4	4.1	3.7	2.6	0.78	0.36	.11	NS	NS
Field peas									
DM	5.0	8.4	5.5	4.9	0.55	.03	NS	0.02	0.13

[a]Probabilities for contrasts: linear(L), quadratic (Q), and Cubic (C); NS = *P*>0.20.

Table 4. Effect of level of field pea on CP kinetic parameters of grass hay, soybean hulls, and field peas in beef steers

	Field Pea (%)						Contrast[a]		
Item	0	15	30	45	SEM	P-value	L	Q	C
Forage									
Soluble, %	4.9	3.3	7.9	2.3	2.90	0.40	NS	NS	0.18
Slowly degradable, %	69.4	68.4	68.0	76.3	3.39	0.31	NS	NS	NS
Degradation Rate, %/h	4.1	4.7	2.7	2.2	0.28	0.01	0.01	0.04	NS
Effective degradability, %	73.8	71.6	75.9	78.6	2.87	0.20	0.11	NS	NS
Soybean hulls									
Soluble, %	13.9	15.0	14.0	12.3	2.42	0.89	NS	NS	NS
Slowly degradable, %	81.3	79.8	75.1	82.2	3.37	0.44	NS	NS	NS
Degradation Rate, %/h	7.0	7.5	7.6	5.7	0.58	0.21	NS	0.10	NS
Effective degradability, %	95.2	94.8	89.1	94.5	1.72	0.09	NS	0.10	0.13
Field peas DM									
Soluble, %	17.6	15.0	14.0	12.3	2.07	0.41	0.11	NS	NS
Slowly degradable, %	78.3	79.8	75.1	82.2	3.89	0.51	NS	NS	NS
Degradation Rate, %/h	6.7	7.5	7.6	5.7	0.70	0.22	NS	0.80	NS
Effective degradability, %	96.0	94.8	89.1	94.5	2.12	0.09	NS	0.09	0.15

[a]Probabilities for contrasts: linear(L), quadratic (Q), and Cubic (C); NS = *P*>0.20.