Effects of Field Pea Supplementation on Digestibility and Rumen Volatile Fatty Acid Concentration of Diets Containing High and Low Quality Forages

Hannah L. Greenwell
Jana L. Gramkow
Melissa L. Jolly-Breithaupt
Jim C. MacDonald
Karla H. Jenkins

Summary with Implications

Five ruminally cannulated steers were used to evaluate the effects of supplementation (no supplement, field peas, or dry rolled corn; 0.43% BW) with high and low quality forages on diet digestibility and rumen volatile fatty acid concentrations. The inclusion of field peas increased dry matter intake and organic matter digestibility over dry rolled corn and unsupplemented steers. Propionate proportions were less for field peas and control treatments than dry rolled corn, while acetate proportions increased in field peas, and control treatments as compared to dry rolled corn. As a result, acetate to propionate ratio was reduced when dry rolled corn was supplemented. Inclusion of field peas alters the volatile fatty acid concentrations, increases dry matter intake, and improves organic matter digestibility when supplemented to forage fed steers.

Introduction

With recent increases in availability of field peas as a livestock feed, a renewed interest has developed in their use in beef production. More in-depth determination of digestion kinetics would improve the prediction of the value of field peas as both a grazing supplement and a component in finishing diets. Previous research has shown that feeding field peas in beef cattle diets up to 30% of the diet (DM basis) produces similar results to starch grains, such as corn. Corn has a negative impact on the digestion of fiber due to the starch content. However, corn supplementation also alters the proportion of acetate to propionate favoring propionate. The impacts of field pea supplementation on volatile fatty acid (VFA) concentration are not well established. Therefore, one objective of this study was to determine how field pea supplementation alters VFA concentrations and diet digestibility relative to corn when supplemented to high and low quality forages.

Procedure

Five ruminally fistulated steers (Initial BW = 444 ± 44 lb) were utilized in a 5 × 6 Latin rectangle metabolism study to evaluate the effects of supplementation on total tract digestibility of diets containing either high or low quality forages. Treatments were set up as a 2 × 3 factorial (forage quality × supplement type). The first factor was high quality forage (HQ; 50% alfalfa, 50% sorghum silage, DM basis) or low quality forage (LQ; 50% brome grass hay, 50% wheat straw, DM basis). The second factor was one of three supplements: Unsupplemented control (CON), Dry-rolled Corn (DRC), or Ground Field Peas (FP). Those steers being supplemented DRC were dosed with a urea solution to ensure that they were not deficient in rumen degradable protein in comparison to those being supplemented with FP. Both FP and DRC supplements were coated in molasses to increase palatability. Forage was offered *ad* libitum through the entire study and steers were supplemented at 0.43% of BW (DM basis). The non-supplemented cattle on the LQ forage received an adequate supply of RDP in their diet. Steers were weighed at the beginning of each period to adjust supplement amount accordingly. Supplement was fed at 0800 hours, steers were given two hours to consume supplement. Any supplement not consumed was inserted into the rumen cannula. Forage was then fed at 1000 hours. Periods lasted 14 days with a 9 day adaptation period and 4 day collection period. Animals were housed in individual slatted floor stalls. Steers were ruminally dosed continuously with 5 g of TiO_2 twice daily at 0800 and 1600 hours. During collection, rumen fluid samples and fecal grab samples were taken at four time points including 0700, 1100, 1500, and 1900 hours.

Hourly fecal samples were composited by day by steer on a wet basis, freeze dried, and ground. Daily composites were ground and composited on a week basis by steer and analyzed for NDF, ADF, OM, and percent titanium. Feed ingredients samples were taken each period, dried, ground, and analyzed for NDF, ADF, OM, and CP.

In an effort to analyze supplement effect on fiber digestibility, in-situ bag procedures were used. Both HQ and LQ were weighed into the bags that were then sealed and incubated in the rumen for 24 hours. Bags were removed, rinsed, washed with NDF solution in an Ankom Fiber Analyzer, dried, and weighed back to determine remaining NDF after incubation.

All data were analyzed using the MIXED procedure of SAS and probabilities were considered significant if $P \leq 0.10$. Steer was the experimental unit with supplement type, forage type and their interaction as fixed effects. Steer and collection period were random effects.

Results

Digestibility

There were no interactions between forage quality and supplement type on digestibility. Dry matter intake (DMI), forage DMI, DM digestibility (DMD), OM intake (OMI), OM digestibility (OMD), and 24 hour in-situ NDF digestibility (NDFD) were greater with HQ forage than in LQ forage (Table 1). The FP supplement increased DMI, DMD, OMI, OMD, and NDFD compared to steers receiving DRC or CON; DRC and CON did not differ in intake, DMD, OMI or OMD. Forage DMI tended to be least for DRC while FP tended to increase forage DMI, but was similar to CON (Table 2). The in-situ 24 hour NDFD is an indicator of the associative effects on fiber digestion that might occur when

Table 1. Diet digestibility and concentration of rumen VFA's in steers due to forage quality

Forage Trt[1]	High Quality	Low Quality	SEM	*P*-value
DMI (lb)	13.50	10.37	1.07	<0.01
Forage DMI (lb)	12.13	9.00	1.07	<0.01
DMD (%)	63.09	49.09	1.65	<0.01
OMI (lb)	12.24	9.24	0.95	<0.01
OMD (%)	64.18	50.10	1.61	<0.01
NDFI (lb)	7.06	7.00	7.06	0.82
In-situ NDFD[2] (%)	38.59	33.81	0.85	<0.01
Total, mMol	124.49	126.81	9.39	0.86
Acetate, %	64.1	72.26	0.58	<0.01
Propionate, %	18.48	17.89	0.22	0.06
A:P	3.61	4.09	0.05	<0.01

[abcd] Within a row, means without a common superscript differ.
[1]High Quality Forage Diet: 50/50 blend of sorghum silage and alfalfa hay. Low Quality Forage Diet: 50/50 blend of brome grass hay and wheat straw. Water was added to the Low Quality treatment to ensure equal amount of dry matter across both forage treatments.
[2]NDF digestibility: measured at 24 hours, in-situ.

Table 2. Diet digestibility of steers due to supplement type

Supplement Trt[1]	Control	Corn	Peas	SEM	*P*-value
DMI (lb)	10.56[a]	11.72[a]	13.50[b]	1.07	0.01
Forage DMI (lb)	10.57	9.67	11.45	1.12	0.14
DMD (%)	53.05[a]	55.13[a]	60.10[b]	2.01	0.06
OMI (lb)	9.42[a]	10.60[a]	12.20[b]	1.00	<0.01
OMD (%)	53.81[a]	56.07[a]	61.54[b]	1.61	0.03
NDFI (lb)	6.81	6.59	7.62	0.68	0.14
In-situ NDFD[2] (%)	36.09[ab]	34.48[a]	38.03[b]	1.06	0.09
Total, mMol	128.56	120.12	128.27	11.55	0.84
Acetate, %	68.82[b]	66.39[a]	69.38[b]	0.72	<0.01
Propionate, %	17.96[a]	18.93[b]	17.72[a]	0.27	<0.01
A:P	3.97[b]	3.58[a]	3.99[b]	0.05	<0.01

[abcd] Within a row, means without a common superscript differ.
[1]Control received no supplement. Corn received dry rolled corn coated in molasses. Peas received ground peas coated in molasses.
[2]NDF digestibility: measured at 24 hours, in-situ.

other feedstuffs are added to the diet such as supplements. While the level of supplementation was low (0.43% BW), there was still a difference in forage NDF digestibility between the DRC and FP supplements, with FP having greater fiber digestibility over the DRC supplemented cattle.

Rumen VFA Concentrations

Forage quality of the diet altered acetate and propionate relative proportions along with the acetate to propionate ratio (A:P). Acetate relative proportions increased in the LQ while propionate relative proportions increased in the HQ. The changes in relative proportions shifted the A:P in favor of the propionate and produced lower values in the HQ diets than the LQ diets (Table 1).

Acetate and propionate proportions, as well as the A:P ratio were affected by supplement type. Acetate proportions were greatest in the CON and FP, which were similar and greater than DRC. Propionate proportions were greatest in the DRC supplemented cattle with CON and FP being similar. The A:P ratio was decreased by all supplement types with DRC and FP being similar (Table 2).

Conclusion

Supplementing FP in forage diets of both low and high quality increased DMI, DMD, OMI, OMD, and 24 hour NDFD. These alterations from the CON and DRC could be associated with the lower starch level of FP as compared to DRC. VFA concentrations with field pea supplementation remain similar to the DRC treatment as opposed to having similar results to the CON treatments. Field peas did not appear to have the same negative associative effects on digestibility as DRC, but also did not produce VFA concentrations similar to DRC. The changes in VFA concentrations for FP could potentially be explained due to the shifts in microbial populations toward starch digesting bacteria which favors the production of propionate.

Hannah Greenwell, graduate student

Jana Gramkow, graduate student

Melissa Jolly-Breithaupt, graduate student

Karla Jenkins, associate professor, animal science, Panhandle Research and Extension Center, Scottsbluff

Jim MacDonald, associate professor, animal science, Lincoln