Effects of Feeding Iowa-Grown Field Peas on Finishing Pig Performance

A.S. Leaflet R2359

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Summary and Implications

The objective of this study was to investigate an alternative feedstuff, Iowa-grown field peas, for finishing pigs. Field peas (winter, spring, and summer types) grown in southeast Iowa during 2005 and 2006 were sampled and analyzed for nutrient content. Overall, the peas were 2.8% fat, 5.7% fiber, 3% ash, 19.3% protein, 1.5% lysine, 0.73% threonine 0.18% tryptophan, and 0.20% methionine. The spring peas were generally lower in fat and higher in essential amino acid content than the summer and winter peas. Finishing pigs, barrows (n = 64) were randomly assigned to pens with four pigs each. There were four replications per treatment group. Each pen was assigned one of the four diets. The four diets were: 1) winter pea 30% of the total diet (by weight), 2) summer pea 30%, 3) spring pea 30%, and 4) corn-soybean meal as the control. The three pea diets contained corn but no soybean meal. Each of the four diets had 0.64% lysine based on calculated analysis. Crystalline amino acids were added to the pea diets. The pigs started the experiment at 80 ± 2.5 kg live weight and were fed the experimental diets for 39 days. Pigs were weighed individually at the start, at 14-d intervals, and at the end of the experiment. At final weighing, backfat and loin muscle area was ultrasonically evaluated on each pig.

There was no difference in final pig weight (123 ± 3 kg) in the four treatment groups. There were no treatment effects on average daily gain (ADG) ($P = 0.22$) across dietary treatments. Average daily feed intake (ADFI) was influenced by dietary treatments ($P < 0.10$). Pigs tended to consume less corn-soybean meal and spring pea diets than the winter and summer pea diets, with ADFI of 4.0, 3.8, 3.5, and 3.4 kg/d for winter, summer, spring, and the control diets, respectively. Feed:Gain (F:G) was not different among the treatment groups. Pigs fed winter peas had greater ($P < 0.10$) backfat (BF) than pigs fed spring peas or the control diet. Pigs fed summer peas were intermediate in BF and did not differ from the other treatments. There were no differences between dietary treatments for loin muscle area (LMA), although the pigs fed spring peas had numerically smaller loin muscle areas. There were no differences in the overall fat-free lean values ($P > 0.10$). In this study, the results showed no decrease in performance of finishing pigs at the inclusion rate of 30% field peas in a corn-based diet. The 30% field pea inclusion rate was enough to replace all the soybean meal and reduce the amount of corn in the diet. In the diets containing peas, synthetic amino acids, lysine, tryptophan, and threonine were added in the pea diets to avoid deficiencies. Because of their chemical composition, agronomic characteristic, and easy on-farm feeding, field peas are a potential crop to consider for Iowa pork production. Results from this study indicate, Iowa-grown field peas at 30% rate can replace all of the soybean meal and part of the corn in diets for finishing pigs with no negative effects on performance.

Introduction

Field peas (*Pisum sativum L.*) are a valuable and versatile nutrient source for a range of livestock species in several regions of the world. Interest in growing field peas as a feedstuff for livestock is increasing in the upper Midwest. Peas are a relatively new crop in Iowa where corn and soybean meal are the primary ingredients of swine diets. The growing season, seed characteristics, and other agronomic factors influence the nutrient content of peas. Hence, it is important to understand the nutrient levels of locally grown peas before incorporating them in swine diets.

Unlike soybeans, pea seeds after harvesting can be ground and incorporated in swine diets without further processing. The nutrient profile of field peas is intermediate between corn and soybean meal with a similar digestible energy to corn. South Dakota work showed that field peas may be included in diets fed to nursery pigs at 18% of the diet and to finishing pigs at 36% of the diet. These levels are sufficient to replace most of the protein supplied by the soybean meal in the diets without affecting pig performance. Consequently, it is critical to clarify both performance and carcass quality of pigs fed field peas as the primary protein source. The objective of this study was to investigate Iowa-grown field peas as a feedstuff for finishing pigs.

Materials and Methods

Peas

Field peas (winter, spring, and summer types) grown in southeast Iowa during 2005 and 2006 were sampled and analyzed for nutrient content (Table 1). Samples were analyzed by Experiment Station Chemical Laboratories, University of Missouri-Columbia. Crude protein was done by Kjeldahl laboratory procedure.

The winter field peas were a new variety (Specter) developed by USDA-ARS Pullman, WA. There were two planting dates, mid- and late-October, at the ISU Southeast Research Farm, Crawfordsville, IA. Yield was 30 bu/A.

The mixed variety of spring-planted peas included a yellow pea (Admiral and Midas) and a green pea (Striker).

The peas were grown west of Washington, IA and were planted in May. The Midas variety yielded 19.4 bu/A. The Striker variety yielded 37.9 bu/A and 21.5 bu/A. The difference was due to manure application. The low yields for Midas were attributed to no inoculation. The research farm has reported yields as high as 50 bu/A.

The summer field pea variety (WF0097) was grown near Solon, IA. The peas were planted following wheat harvested in July. Due to hot weather and an outbreak of powdery mildew, the yield was poor (6.5 bu/A).

Diets

The four diets were: 1) winter pea 30% of the total diet (by weight), 2) summer pea 30% of the total diet (by weight), 3) spring pea 30% of the total diet (by weight), and 4) corn-soybean meal as the control. The three pea diets contained corn but no soybean meal. Each of the four diets had 0.64% lysine based on calculated analysis (Table 2). In the winter and summer pea diets crystalline lysine, tryptophan and threonine were added. In spring pea diet only crystalline tryptophan and threonine were added. The control diet had no crystalline amino acids added. All the diets were formulated to meet or exceed National Research Council nutrient recommendations for finishing pigs. Prior to mixing the diets, the grains were ground with a hammer mill using a 4.8-mm screen and presented in meal form.

Animals and Facilities

Finishing pigs, barrows (n = 64), offspring of PIC 336 terminal line bred to PIC Cambrough 227 sows all from the same farm were used in the experiment. A pen of four pigs composed an experimental unit. Pens were randomly allotted to one of the four treatment diets. Pig body weight and ancestry were equalized across the treatments. In each pen, a two-hole feeder and a nipple water drinker were installed. The pens were 1.8 m × 2.7 m with a half concrete slatted floor. There were four replicate pens per treatment group. The pigs were housed in an environmentally-controlled building at the ISU Swine Nutrition Farm, Ames, IA. Prior to the start of the experiment, all pigs were fed corn-soybean meal grower diets as a large group.

The pigs started on the experiment after attaining body weight of approximately 80 kg and were fed the experimental diet for 39 d. Pigs were weighed individually at the start, at 14-d interval, and at the end of the experiment. The feed was weighed before it was placed in the feeders. The pigs had *ad libitum* access to feed, however the feeders were adjusted regularly to minimize wastage. On the final day of the experiment, the feed that was left in the feeders was weighed and feed disappearance from each pen was calculated. Average daily feed intake (ADFI) was calculated for each pen and treatment group. ADFI = feed disappearance divided by the number of pigs per pen divided by the number of days on the experiment. Pig body gain (BG) and average daily gain (ADG) was calculated for each pen and subsequently for each treatment group. BG = start weight minus end weight. ADG = BG divided by number of days on experiment. Feed:Gain ratio (F:G) was calculated for each pen. FG = ADFI divided by ADG.

Scanning

At final weighing, each pig was scanned by a certified technician using an Aloka 500-V SSD ultrasound machine fitted with a 3.5-MHz, 12.5cm linear array transducer. A sound-transmitting guide placed on the pig's back was used to collect image measurements off-midline for BF and LMA at the tenth rib. Vegetable oil was used to provide better conductivity between the skin and the probe. The ultrasonic measurements were used to determine fat-free lean weight of the live pigs (FF lean). The FF lean weight divided by the carcass weight = FF lean percentage (FFL%).

Statistical analysis

Data were analyzed using the PROC MIXED procedure of SAS. CLASS statement was treatment and pen. The pen was the experimental unit for performance data. Data for carcass leanness evaluation was also pooled within pen. The model contained treatment, ADFI, ADG, BF, and LMA. The LSMEANS statement and the PDIFF option were used to separate the means. To test significance, an alpha value of $P < 0.10$ was used in the analyses.

Results and Discussion

Nutrient analysis

The Iowa peas averaged 86% dry matter (Table 1). Crude fat (ether extract) content averaged 2.8%. Crude fiber content was 5 to 6% and ash was about 3%. Crude protein content averaged 19.3%, compared with 22.8% reported by the NRC. Lysine content, which is commonly the first limiting amino acid in pig diets, averaged 1.50%. According to the NRC, lysine in peas is highly digestible (84%). The peas were low in methionine (0.18%) and tryptophan (0.20%). Threonine in winter, summer, and spring peas averaged about 0.73%. The amino acid concentrations in the Iowa-grown peas were similar to values reported by the NRC. Values are reported on an as-fed basis.

Pig Performance

All pigs were in good health during the experiment period. Initial body weights did not differ between dietary treatments, as part of the experimental design. There was no difference in final weight for pigs in the four treatment groups. Likewise there were no treatment effects on ADG ($P = 0.22$) across dietary treatments (Table 3). The ADFI was influenced by dietary treatments ($P < 0.10$). Pigs tended to consume less corn-soybean meal and spring pea diets than the winter and summer pea diets, with ADFI of 4.0, 3.8, 3.5 and 3.4 kg/d for winter, summer, spring, and the control diets, respectively. The G:F and F:G ratios were not different among the treatment groups.

Carcass Evaluation

Pigs fed winter peas had greater BF than pigs fed spring peas or the control diet, and pigs fed summer peas were intermediate and did not differ from the other treatments ($P < 0.10$) (Table 4). There were no differences between dietary treatments for LMA; although the pigs fed spring peas had numerically smaller loin muscle areas. There were no differences in the overall fat-free lean values.

Discussion

The Iowa peas averaged 86% dry matter content, a level that will store well. The fat content averaged 2.8%. The NRC, reports a crude fat of 1.2% for field peas.

Crude protein averaged 19.3% compared with 22.8% reported in the NRC. This variability can be a reflection of different aspects, including genotypes, seed characteristics, and the growing season. The winter and spring pea varieties tended to have higher crude protein than summer varieties. Iowa-grown field pea lysine content averaged 1.50%, which is commonly the first limiting amino acid in pig diets. The spring varieties contained higher lysine levels than winter and summer. According to the NRC, lysine in peas is highly digestible (84%). This enhances the economic value of peas in the swine diet. Unfortunately, the peas were low in sulphur amino acids and tryptophan (Table 1). Digestibility of these amino acids is lower in peas than in soybean meal. It may be advisable to add crystalline methionine and tryptophan to swine diets containing high levels of peas. The amino acid levels in the Iowa-grown peas were similar to NRC values.

Because field peas are low in fat compared with corn and contain twice as much fiber as corn, peas are lower in energy than corn. However, the metabolizable energy value of peas is similar to soybean meal.

In this study, the results showed no decrease in performance of finishing pigs at the inclusion rate of 30% field peas in a corn-based diet. There was no adverse effect on growth rate or feed conversion among the treatment groups. The 30% field pea inclusion rate was enough to replace all the soybean meal and reduce the corn. In the diets containing peas, synthetic lysine, tryptophan and threonine were added to the pea diets to avoid deficiencies (Table 2).

Field peas are an important crop to consider for Iowa pork production, because of their nutritive value, chemical composition, and agronomic characteristics. Peas are easy to handle on-farm, only requiring basic processing before feeding. Results from this study indicate that Iowa-grown field peas fed at 30% inclusion rate can replace all soybean meal and part of corn in diets for finishing pigs without negative effects on performance. Essential amino acids should be balanced to avoid their deficiency.

Acknowledgements

The authors gratefully acknowledge the USDA-SARE program, Jim Fawcett, ISU area agronomist, the ISU Southeast Research Farm staff, the ISU Swine Nutrition Research Farm staff, A.D. Penner, and the interested farmers of southeast Iowa for assistance with the project.

Table 1. Analysis of field peas grown in SE Iowa.[1, 2]

Year	2006	2005	2006	
Season	Winter	Summer	Spring	
Color	Yellow	Yellow	Yellow/Green	
Variety	Specter	WF0097	Mixed[3]	Average
Dry matter, %	86.29	84.71	85.77	85.59
Crude fat, %	2.96	3.50	2.04	2.83
Crude fiber, %	5.98	5.94	5.20	5.71
Ash, %	2.73	3.71	2.89	3.11
Crude protein,[5] %	20.15	17.94	19.68	19.26
Lysine, %	1.51	1.43	1.54	1.49
Threonine, %	0.74	0.70	0.74	0.74
Tryptophan, %	0.18	0.18	0.19	0.18
Methionine, %	0.20	0.20	0.21	0.20

[1] Analyzed by Experimental Station Chemical Laboratories, University of Missouri, Columbia, MO.

[2] As-fed values.

[3] This sample was a mixture of Admiral and Midas yellow pea varieties and Striker green pea variety.

[4] Crude protein by Kjeldahl method.

Table 2. Composition of field pea-based diets fed to finishing pigs, as fed basis.

Ingredient, %	30% Winter peas[1]	Summer peas[1]	Spring peas[1]	Control[2]
Corn	67.70	67.66	67.73	83.90
Peas	30.00	30.00	30.00	0.00
Soybean meal (48% CP)	0.00	0.00	0.00	14.00
Dicalcium phosphate	0.82	0.82	0.82	0.65
Limestone	0.82	0.82	0.82	0.87
Salt	0.33	0.33	0.33	0.33
Vitamin premix[3]	0.17	0.17	0.17	0.17
Mineral premix[4]	0.08	0.08	0.08	0.08
Synthetic lysine	0.02	0.05	0.00	0.00
Synthetic tryptophan	0.035	0.035	0.03	0.00
Synthetic threonine	0.025	0.035	0.02	0.00
Calculated analysis				
Crude protein %	11.70	11.10	11.60	13.60
Lysine %	0.64	0.64	0.64	0.64
Tryptophan %	0.13	0.13	0.13	0.14
Threonine %	0.44	0.44	0.44	0.50
Met + Cyst %	0.40	0.39	0.40	0.50
Calcium %	0.54	0.54	0.54	0.54
Available. P. %	0.18	0.18	0.18	0.18
Total P. %	0.46	0.46	0.46	0.45
Met. Energy kcal/lb	1487.00	1487.00	1488.00	1516

[1]Pea diets, no soybean meal added.
[2]Corn-soybean meal.
[3]Premix supplied vitamins to meet or exceed NRC (1998) requirements.
[4]Premix supplied minerals to meet or exceed NRC (1998) requirements.

Table 3. Performance of finishing pigs fed Iowa grown winter, spring, and summer field peas compared with corn/soy-based diets.[1]

Item	Winter peas	Summer peas	Spring peas	Control[2]	SEM	P-Values
Pens	4	4	4	4		
Pigs on trial	16	16	16	16		
Days on test	39	39	39	39		
Start wt, kg	81.0	80.7	80.3	80.9	2.5	1.00
End wt, kg	126	124	119	122	3	0.63
ADFI, kg/d[3]	4.01[a]	3.80[ab]	3.52[b]	3.44[b]	0.15	0.08
ADG, g/d[3]	1161	1103	1004	1041	53	0.22
F:G[3]	290	290	285	303	7	0.31
G:F[3]	3.45	3.45	3.53	3.31	0.08	0.34

[1]Data are means of four observations per treatment (16 barrows per treatment group).
[2]Control = Corn soybean meal diet for finishing pigs.
[3]ADFI = Average daily feed intake; ADG = average daily gain; F: G = Feed-to-gain ratio; G: F = Gain-to-feed ratio.
[a,b]Values in the same row with differing superscripts differ ($P < 0.10$).

Table 4. Carcass evaluation of finishing pigs fed Iowa-grown winter, spring, and summer field peas compared with corn/soy-based diets.[1]

Item	Winter peas	Summer peas	Spring peas	Control[2]	SEM	P-Values
BF, mm[3]	22.9[a]	20.0[ab]	18.9[b]	19.3[b]	1.1	0.09
LMA, cm[2]	44.3	44.0	40.9	43.9	1.5	0.39
FF Lean, kg	47.0	47.0	44.9	46.6	1.3	0.65
FF lean, %	50.4	51.2	51.0	51.6		

[1]Data are means of four observations per treatment (16 barrows per treatment group).
[2]Control = Corn soybean meal diet for finishing pigs.
[3]BF = Back fat; LMA = Loin muscle area; FF lean = Fat free lean.
[a,b]Values in the same row with differing superscripts differ ($P < 0.10$).