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# The influence of dietary field peas (*Pisum sativum* L.) on pig performance, carcass quality, and the palatability of pork[1,2]

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**ABSTRACT:** An experiment was conducted to test the hypothesis that field peas may replace soybean meal in diets fed to growing and finishing pigs without negatively influencing pig performance, carcass quality, or pork palatability. Forty-eight pigs (initial average BW 22.7 ± 1.21 kg) were allotted to 1 of 3 treatments with 2 pigs per pen. There were 8 replications per treatment, 4 with barrows and 4 with gilts. The treatments were control, medium field peas, and maximum field peas. Pigs were fed grower diets for 35 d, early finisher diets for 35 d, and late finisher diets for 45 d. Pigs receiving the control treatment were fed corn-soybean meal diets. All diets fed to pigs receiving the medium field peas treatment contained 36% field peas and varying amounts of corn; soybean meal was also included in the grower and the early finisher diets fed to pigs on this treatment. In contrast, no soybean meal was included in diets fed to pigs on the maximum field peas treatment, and field peas were included at concentrations of 66, 48, and 36% in the grower, early finisher, and late finisher diets, respectively. Pig performance was monitored within each phase and for the entire experimental period. At the conclusion of the experiment, carcass composition, carcass quality, and the palatability of pork chops and pork patties were measured. Results showed that there were no effects of dietary treatments on ADFI, ADG, or G:F. Likewise, there were no differences in carcass composition among the treatment groups, but gilts had larger ($P = 0.001$) and deeper ($P = 0.003$) LM, less backfat ($P = 0.007$), and a greater ($P = 0.002$) lean meat percentage than barrows. The pH and marbling of the LM, and the 10th rib backfat were not influenced by treatment, but there was a trend ($P = 0.10$) for more marbling in barrows than in gilts. The subjective color scores ($P = 0.003$) and the objective color score ($P = 0.06$) indicated that dietary field peas made the LM darker and more desirable. Pork chops from pigs fed field peas also had less ($P = 0.02$) moisture loss compared with chops from pigs fed the control diet. Treatment or sex did not influence palatability of pork chops or pork patties. In conclusion, field peas may replace all of the soybean meal in diets fed to growing and finishing pigs without negatively influencing pig performance, carcass composition, carcass quality, or pork palatability.

**Key words:** carcass, composition, field pea, palatability, pig, pork, quality



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## INTRODUCTION

Production of field peas (*Pisum sativum* L.) is rapidly increasing in the upper Midwest, and greater quantities of field peas are available for livestock feeding (NASS, 2006). In the United States, field peas have traditionally been fed mainly to ruminant animals, but they are now also commonly included in diets fed to swine. Previous research has demonstrated that field peas may be included in diets fed to nursery pigs at 18% and to growing-finishing pigs by at least 36% without negatively affecting pig performance or carcass composition (Stein et al., 2004). At an inclusion rate of 36%, field peas replace all the soybean meal in the late finisher diet, but soybean meal is needed in the grower and the early finisher diets to meet the pig's requirement for AA. To replace all the soybean meal in these diets, higher inclusion rates of field peas are needed. However, effects of higher dietary inclusion rates of field peas on pig performance and carcass

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quality have not been studied. Likewise, the influence of dietary field peas on palatability of pork has not been investigated.

Therefore, the objective of the present experiment was to test the hypothesis that field peas may completely replace soybean meal in diets fed to growing and finishing swine without negatively influencing pig performance, carcass quality, or the palatability of pork.

## MATERIALS AND METHODS

### *Animals and Housing*

The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee at South Dakota State University. Forty-eight growing pigs originating from the matings of SP-1 boars to line 401 females (Ausgene Intl. Inc., Gridley, IL) were blocked by BW and sex and randomly allotted to 1 of 3 experimental groups. The average initial BW of the pigs was 22.7 ± 1.21 kg. Four of the replications were started on the same day, and the remaining 4 replications were started 3 wk later to reduce variation among replications with respect to initial BW.

The pigs were housed in an environmentally controlled building with the ambient temperature maintained between 18 and 22°C. Treatments were randomized within the building, and the experiment was conducted from September to December 2004. There were 2 pigs per pen and 8 replicate pens per treatment group (4 pens with barrows and 4 pens with gilts). Pens were 1.2 × 2.4 m and had fully-slatted concrete floors. A 2-hole feeder and a nipple drinker were installed in each pen.

### *Diets, Feeding, and Live Data Recording*

Commercial sources of corn, soybean meal, and field peas were obtained for the experiment (Table 1). Field peas (Toledo) were grown and harvested in South Dakota in 2004. Toledo is a green-seeded, smooth, white-flowered variety of spring field peas.

Pigs were fed grower diets (0.95% Lys, as-fed basis) during the initial 35 d of the experiment, early finisher diets (0.8% Lys) during the following 35 d, and late finisher diets (0.65% Lys) during the final 45 d of the experiment. Within each phase, pigs were fed control diets, medium field pea diets, or maximum field pea diets (Tables 2 and 3). The control diets were based on corn and soybean meal in all 3 phases. The medium field pea diets were formulated by mixing 36% field peas and varying quantities of corn; soybean meal was also included in the grower and early finisher diets for this treatment group but not in the late finisher diet. Maximum field pea diets were formulated by mixing corn and field peas to meet the pig's requirement for AA without using any soybean meal. Inclusion rates of field peas for the maximum field pea diets were 66, 48, and 36% in the grower, early finisher, and late finisher diets, respectively. The late finisher diet fed to the maximum field pea treatment group was identical to the late finisher diet fed to pigs assigned to the medium field pea diets because 36% field peas was enough to replace all of the soybean meal in this diet.

All diets were formulated according to the Illinois Ideal Protein for growing and finishing pigs (Baker, 1997). Inclusion of crystalline Lys was reduced and inclusion of crystalline Met, Thr, and Trp was increased as the concentration of field peas in the diets was increased because pea protein contains more Lys but less Met, Thr, and Trp than soybean protein. Inclusions of minerals and vitamins were calculated to meet or exceed the current requirement estimates for growing and finishing pigs (NRC, 1998). Pigs were allowed to consume their diets on an ad libitum basis throughout the experiment, and water was available at all times.

Individual pig BW were recorded at the beginning of the experiment and at the end of each of the 3 phases. Daily feed allotments were recorded, and feed that was left in the feeders was weighed at the end of each phase. At the conclusion of the experiment, data for feed disappearance for each pen were summarized and the ADFI within each phase and treatment group was calculated. Data for pig BW gains were also summarized, and ADG and G:F were calculated for each pen and subsequently summarized within each phase and treatment group.

**Table 1.** Analyzed nutrient composition of field peas, corn, and soybean meal (as-fed basis)

| Nutrient, % | Field peas | Corn | Soybean meal |
|---|---|---|---|
| DM | 87.72 | 88.52 | 89.26 |
| CP | 20.00 | 7.66 | 44.30 |
| ADF | 9.19 | 2.55 | 8.71 |
| NDF | 13.00 | 9.09 | 11.30 |
| Ca | 0.07 | 0.01 | 0.55 |
| P | 0.44 | 0.24 | 0.56 |
| Indispensable AA | | | |
| Arg | 1.96 | 0.37 | 3.33 |
| His | 0.53 | 0.21 | 1.19 |
| Ile | 0.96 | 0.27 | 2.13 |
| Leu | 1.69 | 0.87 | 3.68 |
| Lys | 1.69 | 0.24 | 2.96 |
| Met | 0.25 | 0.20 | 0.76 |
| Phe | 1.09 | 0.35 | 2.29 |
| Thr | 1.18 | 0.38 | 2.79 |
| Trp | 0.18 | 0.05 | 0.57 |
| Val | 1.06 | 0.36 | 2.22 |
| Dispensable AA | | | |
| Ala | 0.98 | 0.54 | 2.04 |
| Asp | 2.79 | 0.65 | 5.86 |
| Cys | 0.24 | 0.14 | 0.53 |
| Glu | 3.99 | 1.35 | 9.24 |
| Gly | 1.00 | 0.29 | 2.06 |
| Pro | 0.90 | 0.58 | 2.30 |
| Ser | 0.67 | 0.21 | 1.52 |
| Tyr | 0.77 | 0.30 | 1.72 |

**Table 2.** Ingredient composition of diets (as-fed basis)

| Phase: | Grower | | | Early finisher | | | Late finisher | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatment: | Control | Medium peas | Maximum peas | Control | Medium peas | Maximum peas | Control | Medium peas | Maximum peas |
| Ingredient, % | | | | | | | | | |
| Corn | 73.64 | 49.51 | 31.2 | 80.77 | 56.71 | 49.57 | 86.95 | 61.97 | 61.97 |
| Field peas | — | 36.0 | 66.0 | — | 36.0 | 48.0 | — | 36.0 | 36.0 |
| Soybean meal | 24.0 | 12.0 | — | 17.0 | 5.0 | — | 11.0 | — | — |
| Limestone | 1.0 | 1.0 | 1.05 | 1.0 | 1.0 | 1.0 | 0.95 | 0.95 | 0.95 |
| Monocalcium phosphate | 0.65 | 0.70 | 0.75 | 0.55 | 0.55 | 0.60 | 0.40 | 0.40 | 0.40 |
| L-Lysine·HCl | 0.11 | 0.04 | 0.05 | 0.10 | 0.03 | 0.03 | 0.12 | — | — |
| DL-Methionine | 0.02 | 0.11 | 0.21 | — | 0.06 | 0.10 | — | 0.04 | 0.04 |
| L-Threonine | — | 0.04 | 0.11 | — | 0.04 | 0.07 | — | 0.03 | 0.03 |
| L-Tryptophan | — | 0.02 | 0.05 | — | 0.03 | 0.05 | — | 0.03 | 0.03 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Vitamin premix[1] | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Micromineral premix[2] | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

[1]The vitamin premix provided the following quantities of vitamins per kilogram of complete diet: vitamin A, 6,594 IU as vitamin A acetate; vitamin $D_3$, 989 IU as D-activated animal sterol; vitamin E, 33 IU as alpha tocopherol acetate; vitamin $K_3$, 2.6 mg as menadione dimethylpyrimidinol bisulphite; thiamin, 2.0 mg as thiamine mononitrate; riboflavin, 5.9 mg; Pyridoxine, 2.0 mg as pyridoxine hydrochloride; vitamin $B_{12}$, 0.026 mg; D-pantothenic acid, 20 mg as calcium pantothenate; niacin, 33 mg; folic acid, 0.66 mg; and biotin, 0.1 mg.

[2]The micro mineral premix provided the following quantities of minerals per kilogram of complete diet: Cu, 25 mg as copper sulfate; Fe, 120 mg as iron sulfate; I, 0.30 mg as potassium iodate; Mn, 25 mg as manganese sulfate; Se, 0.30 mg as sodium selenite; and Zn, 125 mg as zinc oxide.

### *Carcass Evaluations*

Pigs were harvested on 2 different days in the same order as they were started on the experiment, and all replications were fed for the same number of days. At the conclusion of the experiment, pigs were deprived of feed overnight. The following morning, pigs were loaded on a 1-compartment trailer and transported approximately 3 km to the South Dakota State University Meat Science Laboratory, where they were harvested within 4 h after arrival. Within each kill day, the kill order was randomized among treatments. The average live BW at slaughter was 123 ± 8.6 kg.

Pigs were stunned by electrocution, exsanguinated, and then scalded for 4 to 5 min. Carcass sides were placed in the chiller approximately 45 min after stunning. The 24-h pH was measured at the 10th rib directly in the LM at 22 to 26 h after exsanguination using a pH star (Model 5000, SFK Technology, Herlev, Denmark) equipped with a puncture-type combination

**Table 3.** Analyzed nutrient composition of experimental diets (as-fed basis)[1]

| Phase: | Grower | | | Early finisher | | | Late finisher | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatment: | Control | Medium peas | Maximum peas | Control | Medium peas | Maximum peas | Control | Medium peas | Maximum peas |
| Item | | | | | | | | | |
| ME, kcal/kg | 3,326 | 3,287 | 3,248 | 3,334 | 3,261 | 3,233 | 3,342 | 3,272 | 3,272 |
| CP, % | 15.90 | 15.90 | 16.40 | 13.70 | 13.60 | 14.30 | 12.90 | 12.70 | 12.70 |
| ADF, % | 4.63 | 4.42 | 4.52 | 3.91 | 4.61 | 4.86 | 3.11 | 4.96 | 4.96 |
| NDF, % | 10.40 | 9.03 | 9.27 | 7.75 | 9.40 | 9.52 | 8.49 | 10.90 | 10.90 |
| Ca, % | 0.60 | 0.60 | 0.60 | 0.55 | 0.55 | 0.55 | 0.50 | 0.50 | 0.50 |
| P, % | 0.50 | 0.50 | 0.50 | 0.45 | 0.45 | 0.45 | 0.40 | 0.40 | 0.40 |
| AA, % | | | | | | | | | |
| Arg | 1.08 | 1.11 | 1.10 | 0.91 | 1.10 | 1.08 | 0.72 | 0.93 | 0.93 |
| His | 0.45 | 0.46 | 0.46 | 0.40 | 0.36 | 0.38 | 0.34 | 0.33 | 0.33 |
| Ile | 0.72 | 0.73 | 0.73 | 0.62 | 0.58 | 0.60 | 0.51 | 0.51 | 0.51 |
| Leu | 1.59 | 1.62 | 1.63 | 1.48 | 1.25 | 1.31 | 1.40 | 1.22 | 1.22 |
| Lys | 0.95 | 1.02 | 0.95 | 0.88 | 0.93 | 0.89 | 0.70 | 0.73 | 0.73 |
| Met | 0.36 | 0.35 | 0.36 | 0.30 | 0.29 | 0.34 | 0.27 | 0.26 | 0.26 |
| Met + Cys | 0.60 | 0.58 | 0.59 | 0.51 | 0.48 | 0.53 | 0.47 | 0.44 | 0.44 |
| Phe | 0.83 | 0.86 | 0.85 | 0.73 | 0.69 | 0.70 | 0.63 | 0.63 | 0.63 |
| Thr | 0.91 | 0.95 | 0.95 | 0.83 | 0.75 | 0.76 | 0.69 | 0.66 | 0.66 |
| Trp | 0.14 | 0.14 | 0.14 | 0.13 | 0.12 | 0.14 | 0.11 | 0.12 | 0.12 |
| Val | 0.82 | 0.83 | 0.82 | 0.70 | 0.68 | 0.70 | 0.62 | 0.62 | 0.62 |

[1]Values for ME, Ca, and P were calculated (NRC, 1998) rather than analyzed.

pH electrode (LoT406-M6-DXK-S7/25, Mettler-Toledo, GmbH, Urdorf, Switzerland). The pH probe was calibrated at the beginning of each measuring day using pH 4.6 and 7.0 buffers. The left side of each carcass was ribbed between the 10th and 11th ribs at 24-h postmortem, and the LM area, LM depth, and fat thickness were measured at the 10th rib using standard procedures (NPB, 2000). The lean meat percentage for each pig was also calculated (NPB, 2000).

Subjective color and marbling scores were obtained after a 10-min bloom time according to the National Pork Producers Council Quality Standards (NPPC, 1999). Values for L* color of the LM were measured using a Minolta Chroma Meter CR-310 (Minolta Corp., Ramsey, NJ) at $D_{65}$ illuminant calibrated to a white plate. An area just cranial to the 10th rib was skinned to obtain L*, a*, and b* color values for the second layer of fat, counting from the skin inward.

Forty-eight hours postmortem, the LM was removed without fat from the left side of each carcass. Beginning at the 11th rib and continuing toward the caudal end, a 2.5-cm-thick chop was removed from the LM. The chop was weighed to the nearest 0.01 g, placed on a white Styrofoam tray, and retail-wrapped (Koch Supplies, Kansas City, MO). It was then placed at an approximate 30-degree angle in a 1.4°C cooler. After 48 h, the chop was removed from the package and weighed again to the nearest 0.01 g. Drip loss was determined as the percentage disappearance of initial weight.

After removal of the chop that was used for drip loss measurement, the remainder of the LM, from the 11th rib location to the caudal end, was weighed to the nearest 0.01 g, vacuum-packaged, and stored at 1.4°C. After 7 d, the LM was removed from the vacuum-package bag, placed on a table, and allowed to drip for 15 min. The LM was then weighed to the nearest 0.01g. Purge loss was determined as the percentage disappearance of the initial weight.

Also at 48-h postmortem, the 3rd through 10th rib section of the LM that had been removed from the left side of each carcass was vacuum-packaged and then aged for 10 d and subsequently stored at –20°C. After a 4-wk storage, two 2.54-cm-thick chops were removed from the caudal end of each LM and allowed to thaw for 24 h at 1.4°C. The chops were then cooked at 190°C for 13.5 min in an impingement oven (Lincoln Foodservice Products Inc., Ft. Wayne, IN). The chops were weighed raw (before cooking) and again after cooking to the nearest 0.01 g. Cooking loss was determined and expressed as a percentage of initial raw weight. The chops were then allowed to cool for approximately 4 h until they reached a temperature of 18 to 20°C, and three 1.27-cm-diam. cores were taken from each chop (6 cores per LM) parallel to the muscle fiber orientation. Peak shear force was measured, once for each core, using a Warner-Bratzler shear force machine (G-R Electric Manufacturing Company, Manhattan, KS).

### *Evaluation of Pork Palatability*

A 7-member, trained sensory panel evaluated the palatability of pork LM chops and ground pork patties according to published guidelines (AMSA, 1995). Pork LM chops (2.54-cm thick) were cooked on a clamshell-style grill (Model G12385IL, Foreman Champion & Burger, Columbia, MO) to an internal temperature of 71°C. They were then cut into $1.3 \times 2.5$-cm cubes using a template and placed into a Styrofoam bowl with holes in the bottom to allow the meat juice to drain away from the sample. The samples were stored in a 50°C warming oven until served. The panelists were placed in segregated sensory booths with red lights. Each panelist then received samples identified by code and evaluated the chops for tenderness, juiciness, pork flavor intensity, and off-flavors.

To evaluate ground pork palatability, pork sirloins were ground, and approximately 110 g were formed into patties using a Patty Press (Hamburger Press, Tupperware, Orlando, FL) and cooked to an internal temperature of 71°C. Cooked patties were sliced into 6 pie-shaped portions and placed into Styrofoam bowls with holes in the bottom to allow the meat juice to drain away from the sample. The samples were stored in a 50°C warming oven until served. The panelists evaluated the patties for texture, juiciness, pork flavor intensity, and off-flavors under conditions similar to those described for the evaluation of pork chop palatability.

### *Chemical Analysis*

Field peas, corn, and soybean meal, and all diets were analyzed for DM (procedure 4.1.06, AOAC, 2000), CP (Thiex et al., 2002), and ADF and NDF (procedure 4.6.03, AOAC, 2000). Field peas, corn, and soybean meal were also analyzed for Ca and P (procedure 4.8.03 and 3.4.11, respectively; AOAC, 2000). Amino acids were analyzed on a Thermo Quest HPLC (Thermo Separation Products Inc., San Jose, CA), using ninhydrin for postcolumn derivatization and nor-leucine as the internal standard. Samples were hydrolyzed with 6 *N* HCl for 24 h at 110°C (procedure 4.1.11, alternative III; AOAC, 1998). Methionine and Cys were determined as Met sulfone and cysteic acid after cold performic acid-oxidation overnight before hydrolysis (procedure 4.1.11, alternative I; AOAC, 1998). Tryptophan was determined after flushing the samples with nitrogenous gas and 6 *N* NaOH hydrolysis for 22 h at 110°C (procedure 45.4.04, AOAC, 1998).

### *Statistical Analysis*

Data were analyzed using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC; Littell et al., 1996). Means were separated using the LSMEANS statement and the PDIFF option. In the initial model, the effects of treatment, sex, and the interaction of treatment × sex were analyzed. However, there were

**Table 4.** Growth performance of growing-finishing pigs fed diets without or with field peas[1,2]

| Item | Treatment | | | | | Sex | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Control | Medium peas | Maximum peas | SEM | *P*-value | Barrows | Gilts | SEM | *P*-value |
| Grower period | | | | | | | | | |
| Initial weight, kg | 22.9 | 22.7 | 22.7 | 0.47 | 0.49 | 23.0 | 22.5 | 0.640 | 0.64 |
| ADFI, kg | 1.86 | 1.85 | 1.83 | 0.057 | 0.92 | 1.91 | 1.78 | 0.055 | 0.14 |
| ADG, kg | 0.80 | 0.81 | 0.81 | 0.027 | 0.89 | 0.83 | 0.79 | 0.029 | 0.34 |
| Avg. G:F ratio, kg/kg | 0.43 | 0.44 | 0.45 | 0.008 | 0.38 | 0.43 | 0.44 | 0.007 | 0.43 |
| Final weight, kg | 50.90 | 51.00 | 51.10 | 1.21 | 0.97 | 52.00 | 50.10 | 1.46 | 0.39 |
| Early finisher period | | | | | | | | | |
| ADFI, kg | 2.87 | 2.81 | 2.99 | 0.089 | 0.28 | 3.11 | 2.67 | 0.09 | 0.01 |
| ADG, kg | 0.93 | 0.96 | 1.00 | 0.034 | 0.26 | 1.01 | 0.91 | 0.035 | 0.09 |
| Avg. G:F ratio, kg/kg | 0.33 | 0.34 | 0.33 | 0.008 | 0.30 | 0.33 | 0.34 | 0.009 | 0.24 |
| Final weight, kg | 83.80 | 85.00 | 86.40 | 1.81 | 0.26 | 87.80 | 82.30 | 2.22 | 0.13 |
| Late finisher period | | | | | | | | | |
| ADFI, kg | 3.33 | 3.03 | 3.45 | 0.164 | 0.10 | 3.39 | 3.15 | 0.176 | 0.37 |
| ADG, kg | 0.89 | 0.82 | 0.86 | 0.042 | 0.56 | 0.88 | 0.83 | 0.034 | 0.33 |
| Avg. G:F ratio, kg/kg | 0.27 | 0.27 | 0.25 | 0.012 | 0.52 | 0.26 | 0.27 | 0.011 | 0.53 |
| Final weight, kg | 123.60 | 122.00 | 125.3 | 2.99 | 0.59 | 127.4 | 119.8 | 3.36 | 0.16 |
| Entire growing-finishing period | | | | | | | | | |
| Initial weight, kg | 22.9 | 22.7 | 22.7 | 0.47 | 0.49 | 23.0 | 22.5 | 0.64 | 0.64 |
| ADFI, kg | 2.74 | 2.60 | 2.82 | 0.079 | 0.12 | 2.86 | 2.59 | 0.078 | 0.05 |
| ADG, kg | 0.87 | 0.86 | 0.89 | 0.024 | 0.59 | 0.91 | 0.84 | 0.025 | 0.13 |
| Avg. G:F ratio, kg/kg | 0.32 | 0.33 | 0.32 | 0.009 | 0.38 | 0.32 | 0.33 | 0.009 | 0.39 |
| Final weight, kg | 123.60 | 122.00 | 125.3 | 2.99 | 0.59 | 127.4 | 119.8 | 3.36 | 0.16 |

[1]Data are means of 8 observations per treatment (4 with barrows and 4 with gilts).
[2]Treatment × sex interactions were analyzed but found not to be significant.

no significant interactions of sex × treatment. Therefore, the data were analyzed as a 2 × 3 factorial with 2 sexes (barrows and gilts) and 3 dietary treatments (control, medium peas, and maximum peas). The pen was the experimental unit for the analyses of the performance data, but the pig was the experimental unit for the analyses of carcass data. Data for the palatability evaluation were pooled within pen, and the pen was the experimental unit for these analyses. Sex and dietary treatment were considered fixed effects, and replicate was the random effect. An alpha-value of 0.05 was used in all analyses to assess significance.

## RESULTS

### *Pig Performance*

There were no effects of dietary treatments on ADG (Table 4). This was true for all 3 phases of the experiment and for the entire experimental period. Likewise, there were no differences in ADG between barrows and gilts during either period.

The ADFI was not influenced by dietary treatments during any of the 3 phases of the experiment or for the entire experimental period. However, barrows consumed more ($P = 0.01$) feed than gilts during the early finisher phase of the experiment (3.11 vs. 2.67 kg/d). Likewise, for the entire experimental period, there was a tendency ($P = 0.05$) for a greater feed consumption for barrows than for gilts (2.86 vs. 2.59 kg/d).

The G:F ratio was not different among treatment groups during any of the experimental periods or overall for the entire experiment. Likewise, no differences between barrows and gilts were observed.

### *Carcass Evaluation*

There were no differences in the HCW or in dressing percent among treatment groups or between barrows and gilts (Table 5). Likewise, dietary treatments did not influence LM depth, the LM area, backfat thickness, or lean meat percentage. However, gilts had deeper ($P = 0.003$) and larger ($P = 0.001$) LM, less ($P = 0.007$) backfat, and a greater ($P = 0.002$) lean meat percentage than barrows.

The marbling and the LM pH were not different among treatment groups. Likewise, there was no difference in pH between barrows and gilts, but there was a trend ($P = 0.10$) for better marbling in barrrows than in gilts. Increased levels of field peas in the diets resulted in darker colored LM as indicated by increasing subjective color scores ($P = 0.003$) and a trend ($P = 0.06$) for decreasing L* values. The fat color (L*, a*, and b*) was not influenced by dietary treatment, but a trend for lower L* values ($P = 0.09$) and greater b* values ($P = 0.10$) for fat color in gilts compared with barrows were observed.

The purge loss did not differ among treatment groups, but there was a trend ($P = 0.07$) for greater purge losses in gilts compared with barrows. The drip loss was reduced ($P = 0.02$) as the concentration of field peas in the diets increased (3.39, 2.51, and 1.95% for pigs fed control, medium pea, and maximum field

**Table 5.** Effects of dietary treatments on carcass composition and quality[1]

| | Treatment | | | | | Sex | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item | Control | Medium peas | Maximum peas | SEM | *P*-value | Barrows | Gilts | SEM | *P*-value |
| HCW, kg | 92.5 | 90.3 | 93.5 | 2.41 | 0.41 | 94.8 | 89.4 | 2.76 | 0.21 |
| Dressing, % | 76.2 | 75.4 | 75.8 | 0.346 | 0.19 | 75.8 | 75.7 | 0.344 | 0.85 |
| LM depth, cm | 6.17 | 5.92 | 6.07 | 0.098 | 0.21 | 5.88 | 6.23 | 0.080 | 0.003 |
| LM area, $cm^2$ | 46.1 | 44.5 | 46.3 | 0.95 | 0.36 | 43.4 | 47.9 | 0.78 | 0.001 |
| 10th rib backfat, cm | 2.32 | 2.40 | 2.41 | 0.132 | 0.81 | 2.77 | 1.98 | 0.136 | 0.007 |
| Lean meat, % | 51.7 | 51.0 | 51.2 | 0.66 | 0.67 | 49.0 | 53.7 | 0.62 | 0.002 |
| Marbling[2] | 1.06 | 1.06 | 1.03 | 0.097 | 0.97 | 1.15 | 0.96 | 0.080 | 0.10 |
| 24-h pH, LM | 5.42 | 5.40 | 5.44 | 0.040 | 0.37 | 5.45 | 5.40 | 0.053 | 0.53 |
| Longissimus color, L* | 58.6 | 58.4 | 56.0 | 0.84 | 0.06 | 57.9 | 57.3 | 0.68 | 0.52 |
| LM color score[2] | 2.41 | 2.72 | 3.22 | 0.158 | 0.003 | 2.77 | 2.79 | 0.129 | 0.91 |
| Fat color,[3] L* | 80.0 | 80.6 | 80.3 | 0.34 | 0.51 | 80.7 | 79.9 | 0.28 | 0.09 |
| Fat color,[3] a* | 5.86 | 5.60 | 5.79 | 0.31 | 0.70 | 5.53 | 5.98 | 0.35 | 0.40 |
| Fat color,[3] b* | 5.93 | 5.90 | 5.82 | 0.237 | 0.94 | 5.61 | 6.16 | 0.201 | 0.10 |
| 48-h drip loss, % | 3.39 | 2.51 | 1.95 | 0.354 | 0.02 | 2.51 | 2.73 | 0.289 | 0.59 |
| 10-d purge loss, % | 2.18 | 1.84 | 1.82 | 0.224 | 0.44 | 1.65 | 2.23 | 0.187 | 0.07 |

[1]Data are means of 8 observations per treatment (4 with barrows and 4 with gilts).
[2]National Pork Producers Council (NPPC, 1999).
[3]Fat color scores were obtained just cranial to the 10th rib in the second layer of fat, counting from the skin inward.

pea diets, respectively). However, drip loss was not influenced by sex.

### *Palatability*

The cook loss and the shear force were not influenced by dietary treatments or by sex (Table 6). Likewise, the trained taste panelists did not detect any differences in the palatability of pork chops among treatment groups or between sexes. This was true for the desirable traits and for the off flavors. For pork patties, pigs fed the maximum field pea diets had an increase ($P = 0.02$) in the stale taste of the patties compared with pigs fed the medium field pea diets (0.04, 0.00, and 0.11 for

**Table 6.** Effects of dietary treatments on the palatability of pork chops and pork patties

| | Treatment | | | | | Sex | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item | Control | Medium peas | Maximum peas | SEM | *P*-value | Barrows | Gilts | SEM | *P*-value |
| Cook loss,[1] % | 0.199 | 0.198 | 0.203 | 0.008 | 0.89 | 0.205 | 0.194 | 0.006 | 0.23 |
| Shear force,[1] kg | 3.54 | 3.90 | 3.86 | 0.191 | 0.35 | 3.94 | 3.60 | 0.161 | 0.19 |
| Pork chop palatability[2] | | | | | | | | | |
| Tenderness[3] | 5.50 | 5.57 | 5.47 | 0.260 | 0.94 | 5.41 | 5.62 | 0.264 | 0.60 |
| Juiciness[4] | 5.30 | 5.46 | 5.27 | 0.160 | 0.64 | 5.26 | 5.43 | 0.145 | 0.43 |
| Pork flavor intensity[5] | 5.38 | 5.26 | 5.26 | 0.130 | 0.72 | 5.26 | 5.34 | 0.128 | 0.67 |
| Metallic taste[6] | 0.04 | 0.03 | 0.07 | 0.026 | 0.51 | 0.03 | 0.07 | 0.021 | 0.17 |
| Piggy taste[6] | 0.02 | 0.02 | 0.03 | 0.016 | 0.86 | 0.03 | 0.02 | 0.012 | 0.70 |
| Rancid taste[6] | 0.01 | 0.01 | 0.03 | 0.013 | 0.43 | 0.02 | 0.01 | 0.011 | 0.67 |
| Other off flavors[6] | 0.01 | 0.02 | 0.03 | 0.014 | 0.58 | 0.03 | 0.01 | 0.012 | 0.40 |
| Total off flavors[6] | 0.08 | 0.08 | 0.16 | 0.032 | 0.12 | 0.11 | 0.12 | 0.026 | 0.71 |
| Pork patty palatability[2] | | | | | | | | | |
| Texture[7] | 5.96 | 5.82 | 5.79 | 0.163 | 0.72 | 5.79 | 5.93 | 0.133 | 0.46 |
| Juiciness[4] | 5.59 | 5.55 | 5.48 | 0.197 | 0.93 | 5.45 | 5.63 | 0.161 | 0.44 |
| Pork flavor intensity[5] | 5.11 | 5.30 | 5.25 | 0.143 | 0.61 | 5.19 | 5.25 | 0.117 | 0.72 |
| Piggy taste[6] | 0.09 | 0.07 | 0.09 | 0.030 | 0.88 | 0.11 | 0.06 | 0.024 | 0.18 |
| Rancid taste[6] | 0.07 | 0.09 | 0.02 | 0.022 | 0.10 | 0.08 | 0.04 | 0.018 | 0.09 |
| Stale taste[6] | 0.04 | 0.00 | 0.11 | 0.025 | 0.02 | 0.06 | 0.04 | 0.023 | 0.48 |
| Other off flavors[6] | 0.07 | 0.11 | 0.05 | 0.034 | 0.51 | 0.09 | 0.06 | 0.028 | 0.38 |
| Total off flavors[6] | 0.27 | 0.27 | 0.27 | 0.53 | 0.99 | 0.35 | 0.19 | 0.047 | 0.06 |

[1]Data are means of 16 observations per treatment.
[2]Data are means of 8 observations per treatment.
[3]Tenderness score: 8 = extremely tender; 1 = extremely tough.
[4]Juiciness score: 8 = extremely juicy; 1 = extremely dry.
[5]Pork intensity flavor score: 8 = extremely intense; 1 = extremely bland.
[6]Number of yes responses regarding off-flavor per 7 panel members.
[7]Texture score: 8 = extremely crumbly; 1 = extremely rubbery.

pigs fed control, medium pea, and maximum pea diets, respectively). However, there were no differences among treatment groups for any of the other measurements of pork patty palatability, and total off flavors were not different among treatments. There were no effects of sex on any of the pork patty palatability measurements except for a trend for less ($P$ = 0.09) rancid taste and less ($P$ = 0.06) total off flavors for gilts than for barrows.

## DISCUSSION

### *Pig Performance*

Results obtained for pigs on the medium pea diets confirm results from our previous research demonstrating that there are no negative effects of including 36% field peas in diets fed to growing and finishing pigs (Stein et al., 2004). Inclusion of 30% field peas in corn-based diets also was reported not to compromise pig performance (Grosjean and Gatel, 1986). However, the results obtained for the pigs fed the maximum pea diets demonstrate that even higher inclusion rates may be used and that field peas can substitute all the soybean meal in corn-based diets for growing and finishing pigs without negatively affecting performance. This was true not only for the entire experimental period but also for each of the 3 phases of the growing-finishing period including the growing phase where 66% field peas were included in the diet. These results are in close agreement with recently published data indicating that no differences in pig performance are obtained if pigs in a commercial facility are fed diets containing corn and field peas and no soybean meal (Petersen and Spencer, 2006). It appears that as long as diets are formulated to contain similar quantities of digestible indispensable AA, no negative effects of field peas are observed.

Palatability of the peas was not determined in the present experiment, but the feed intake on the pea-based diets was similar to the control diet in all phases. This observation indicates that feed intake is not influenced by the inclusion of field peas in the diets.

### *Carcass Composition and Quality*

There were no differences in the carcass composition between pigs fed corn-soybean meal-based diets and pigs fed corn-field pea-based diets. In our previous research, deeper LM were measured in pigs fed diets containing field peas compared with pigs fed corn-soybean meal-based diets (Stein et al., 2004). We did not make such an observation in the pigs used in the present experiment. The reason for this discrepancy could be that the AA concentrations in all the diets were slightly higher in the present experiment compared with the previous one.

It has been reported from European studies that the lean meat percentage is reduced and the backfat thickness is increased as the concentrations of dietary field peas are increased (Carrouee and Gatel, 1995). However, it was also demonstrated that this situation may be ameliorated by including crystalline Met and Trp in the diets (Carrouee and Gatel, 1995). In the present experiment, diets were balanced for indispensable AA and fortified with crystalline AA to meet the presumed ideal profile. This is likely the reason why the field peas did not negatively influence the carcass composition of the pigs. This observation also indicates that it is not field peas per se that are responsible for the negative effects on carcass composition that were previously reported. These negative effects are simply a reflection of AA imbalances that may be introduced with the addition of field peas to the diets if no adjustments in AA fortifications are made.

Color scores from pigs fed field peas have not previously been reported. The data from the present experiment indicate that LM from pigs fed diets containing field peas are darker and have a more desirable color than LM from pigs fed corn-soybean meal-based diets. The reason for this difference may be that field peas contain less fat than corn. As a consequence, with more field peas and less corn in the diets, there is less fat in the diet to influence the color of the meat. The drip loss from the pigs fed the field pea-containing diets was lower than for the pigs fed the control diets. We are not aware of any other studies that have reported the effect of field peas on drip loss, and we do not have an explanation for this observation. However, the combination of darker colors and lower drip losses in pigs fed diets containing field peas would indicate that field peas do induce physiological changes in the meat, but additional research is needed to determine the mechanisms underlying these changes.

### *Pork Palatability*

The palatability of pork from pigs fed diets containing field peas has not been previously reported. The data from the present experiment, however, indicate that consumers would not be able to tell the difference between pork chops and pork patties obtained from pigs fed corn-soybean meal-based diets and from pigs fed diets containing field peas. The fact that there was no difference in the shear force indicates that tenderness was not influenced by dietary treatments. The taste panel results for tenderness confirmed this. For the pork chops, there were no treatment effects on the off flavors, and although there seemed to be a small increase in the stale taste of pork patties from pigs fed the highest level of field peas, this did not influence the overall off flavors of the patties and would probably not alter a person's level of acceptance. Addition of field peas to diets fed to growing-finishing pigs did not negatively influence the palatability of pork chops or pork patties.

Data from the present experiment indicate that field peas may replace soybean meal in corn-based diets fed to growing and finishing pigs without negatively affecting pig performance provided that diets are balanced for concentrations of digestible indispensable AA. Dietary field peas do not affect the composition of the carcass of the pigs, and carcass quality is not affected or slightly improved by the inclusion of field peas in the diets. Likewise, the palatability of pork is not influenced by dietary field peas. It is recommended that producers base the usage of field peas on economic evaluations because there are no biological restrictions to the use of field peas in diets fed to growing and finishing pigs.

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