Formulating diets to reproducing and growing pigs using field peas

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Summary

Pigs tolerate field peas well and the palatability of diets containing field peas is not different from diets containing only corn and soybean meal. Recent research with US-grown field peas indicates that field peas may be included in diets fed to nursery pigs from two weeks post-weaning at an inclusion level of 15 to 20%. At this concentration, no negative effects on pig performance have been reported. It is possible that higher inclusion levels may be used, but research to confirm this hypothesis remains to be conducted.

In diets fed to growing and finishing pigs, field peas may be included at levels sufficient to replace all of the protein supplied by soybean meal in the diets. The inclusion of field peas does not influence feed intake, average daily gain, or the gain to feed ratio. Lower carcass drip losses and a more desirable color of the longissimus muscle have been reported for pigs fed diets containing field peas, but other carcass characteristics have not been influenced by field peas in the diets. Likewise, the palatability of pork chops and ground pork patties are not changed by the inclusion of field peas in the diets.

Limited research has been conducted in the US with field peas in diets fed to sows. However, based on data from studies conducted in Europe, field peas may be included in diets fed to gestating and lactating sows at levels of 20 to 30%.

Based on the current body of research, it is recommended that, if field peas are competitively priced, they may be included in diets fed to all categories of swine. The price that can be paid for field peas depends on the price of both corn and soybean meal.

Field Peas Fed to Weanling Pigs

In an experiment conducted at South Dakota State University, field peas were included in diets fed to weanling pigs in concentrations of 0, 6, 12, or 18%. Pigs were weaned at an age of 20 days and fed a common diet during the initial 2 weeks post-weaning before being offered the experimental diets. Results of the experiment showed no negative effects of field peas on feed intake, daily gain, or the gain:feed ratio (Table 1). These data concur with results of research conducted at North Dakota State University (Landblom and Poland, 1998). Research conducted using Canadian-grown field peas indicated that the inclusion of 30% field peas in diets fed to weanling pigs resulted in a reduced gain:feed ratio during the initial 2 weeks after weaning but not during the remaining nursery period (Owusu-Asiedu et al., 2002). Based on these results, it is recommended that field peas should not be included in diets fed to weanling pigs during the initial 2 weeks post-weaning, but after this period, 15 to 20% field peas may be included in the diets without negatively affecting pig performance. If the field peas are extruded or micronized, it may be possible to include higher concentrations without any impact on pig performance (Landblom, 2002; Owusu-Asiedu et al., 2002).

Field Peas Fed to Growing Finishing Pigs

Field peas grown in the US have been included in diets fed to growing-finishing pigs (22 - 110 kg) at a level of 36 - 45% without any negative impact on pig performance, dressing percentage, or carcass composition (Landblom, 2002; Stein et al., 2004). In a more recent experiment, field peas were included in the grower period (25 - 50 kg) at 66%, in the early finisher period (50 - 85 kg) at 48%, and during the late finishing period

(85 - 125 kg) at 36% (Stein et al., 2006). At these inclusion levels, all soybean meal in the diets was replaced by field peas. The performance of pigs fed these diets were compared to the performance of pigs fed a corn-soybean meal-based control diet or diets containing corn, soybean meal, and 36% field peas in all three phases. Results of this experiment showed that pig performance was not influenced by the inclusion of field peas in the diets. This was true for all of the three phases (data not shown) and overall for the entire experiment (Table 2). Likewise, no negative effects of the field peas were observed on carcass composition, carcass quality, or the palatability of pork chops or ground pork patties from pigs fed these diets. These results are in close agreement with data from Petersen and Spencer (2006) that also showed that field peas can be included in corn based diets fed to growing-finishing pigs at quantities sufficient to replace all the soybean meal without affecting pig performance. It is, therefore, concluded that field peas may be included in corn-based diets fed to growing-finishing pigs at levels necessary to provide all the amino acids needed by the pigs.

Field Peas Fed to Reproducing Swine

Research conducted at North Dakota State University suggested that the inclusion of 10% field peas in diets fed to lactating sows resulted in increased litter weight gain and a tendency for reduced pig mortality during the lactation period (Landblom et al., 2001). This experiment also showed that there is no negative effect of including up to 30% field peas in diets fed to lactating sows. There are no data available from studies in which US-grown field peas have been fed to gestating sows. However, data from France suggested that the inclusion of 16% field peas in gestating diets and 24% in lactating diets had no

negative effects on sow or pig performance (Gatel et al., 1987). Data from Germany indicated that if field peas are included in diets fed to gestating and lactating sows at levels of 10 or 20%, there is no impact on sow reproductive performance. However, if the inclusion level was 30%, sow performance was reduced (von Leitgeb et al., 1994). There are no data available on the type of field peas used in the latter study or on the concentration of antinutrititional factors in the peas. If peas containing a relatively high concentration of trypsin inhibitors or other anti-nutritional factors were used, then that might explain why some negative results were obtained at the higher inclusion level of field peas. Based on the above results, it is concluded that field peas may be used in diets fed to gestating and lactating sows at an inclusion level of 20 to 30%%.

Formulating Diets with Field Peas

General Principles

Pigs have requirements for certain dietary levels of digestible indispensable amino acids and for digestible phosphorus. The dietary requirements for amino acids and phosphorus are determined by the physiological stage of the animal; i.e., the stage of growth of a growing pig or the reproductive stage of a breeding animal (NRC, 1998). When formulating diets, it is necessary to meet the requirements for all indispensable amino acids. In corn-soybean meal based diets, lysine and tryptophan are often the first limiting amino acids. If the requirements for these two amino acids are met, the requirements for all other indispensable amino acids are usually also met. Lysine and tryptophan are also the first limiting amino acids in diets based on corn and field peas. However, because of the relatively low concentrations of digestible methionine, cysteine,

and threonine in field peas, it is also necessary to pay careful attention to the concentrations of these amino acids in the diets if field peas are used, and it is often necessary to include crystalline sources of methionine, threonine, and tryptophan to formulate a diet balanced in all indispensable amino acids. In contrast, the inclusion of crystalline lysine and inorganic sources of phosphorus may be reduced because of the relatively high concentrations of these nutrients in field peas. As a rule of thumb, 3% field peas will replace approximately 2% corn and 1% soybean meal in diets fed to swine if crystalline sources of methionine, threonine, and tryptophan are included to balance the indispensable amino acids. At the same time, the inclusion level of crystalline lysine and monocalcium phosphate (or dicalcium phosphate) is reduced. In experiments where field peas were successfully included in diets fed to swine, these principles for diet formulation were followed. Poor pig performance has been reported from experiments in which field peas were used without appropriate inclusion of crystalline amino acids. However, once the indispensable amino acids in the diets were balanced, this problem was ameliorated and normal pig performance was restored.

Examples of Diets Containing Field Peas

Diets for growing pigs (i.e., 20 to 50 kg) were formulated using corn and soybean meal; corn, soybean meal, and field peas; or corn and field peas (Table 3). All diets were formulated to meet minimum requirements for digestible amino acids and digestible phosphorus (NRC, 1998). Calcium, salt, vitamins, and micro minerals were included at similar levels in all diets. It appears from Table 3 that as the concentration of field peas in the diet increases, crystalline sources of methionine, threonine, and tryptophan are needed

to meet the requirements for these amino acids, whereas the inclusion levels of crystalline lysine and of monocalcium phosphate are reduced. By following these principles, diets that contain equal concentrations of digestible indispensable amino acids and of digestible phosphorus were formulated. The diets will, therefore, result in equal pig performance.

Economic Considerations

Decisions on whether or not to use field peas in diets fed to swine should be based on economic considerations because pig performance and carcass quality are not influenced by the inclusion of field peas in the diets. To estimate the price of field peas that can be paid without increasing total diet costs, the costs of corn, soybean meal, monocalcium phosphate, and crystalline amino acids need to be taken into account. This is most easily accomplished by formulating diets using a least-cost formulation software package. If the costs of monocalcium phosphate and crystalline amino acids are constant, the data in Table 4 may be used to indicate when field peas are competitively priced. It appears from Table 4 that the cost of field peas can increase by $0.0.15 per bushel (27.27 kg) if the cost of soybean meal is increased by $25 per ton (907 kg). Likewise, the price that can be paid for field peas may increase by $0.20 to 0.25 per bushel (27.27 kg) if the price of corn increases by $0.25 per bushel (25.45 kg). If the costs of crystalline amino acids or of monocalcium phosphate are different from those used in the example, slightly different relationships may be obtained. Therefore, the competitiveness of field peas in diets fed to swine should be calculated for each specific situation.

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Table 1. Growth performance of weanling pigs fed diets containing field peas [a, b, c]

Field peas, %:	0	6	12	18	SEM [d]	*P*-value	
						Linear effect	Quadratic effect
Response							
Average initial weight, kg	7.81	7.81	7.79	7.79	0.68	0.98	0.99
Average finished weight, kg	19.65	20.02	19.90	19.17	1.33	0.79	0.68
Average daily gain, kg	0.423	0.436	0.433	0.407	0.025	0.64	0.44
Average daily feed intake, kg	0.66	0.66	0.70	0.64	0.05	0.91	0.54
Average gain:feed, kg/kg	0.62	0.64	0.62	0.64	0.015	0.66	0.67

[a] Data from Stein et al. (2004).

[b] Each mean represents six observations with five pigs per pen.

[c] One kilogram = 2.2 lb.

[d] SEM = standard error of the mean.

Table 2. Growth performance and carcass quality of growing-finishing pigs fed diets without or with field peas [a, b, c]

Field peas (%) [e]:	0/0/0	36/36/36	66/48/36	SEM [d]	*P*-value
Response					
Initial weight, kg	22.9	22.7	22.7	0.55	0.49
Average daily feed intake, kg	2.74	2.60	2.82	0.079	0.12
Average daily gain, kg	0.872	0.860	0.889	0.0247	0.59
Average gain:feed ratio, kg/kg	0.319	0.332	0.318	0.0087	0.38
Final weight, kg	129.0	124.1	129.2	3.18	0.59
Dressing, %	76.2	75.4	75.8	0.34	0.20
Longissimus muscle depth, cm	6.17	5.92	6.08	0.087	0.21
Longissimus muscle area, cm^2	46.1	44.5	46.3	0.860	0.36
10^{th} rib back fat, cm	2.32	2.40	2.41	0.134	0.81
Lean meat, %	51.8	51.0	51.3	0.636	0.67
Marbling score	1.07	1.07	1.04	0.089	0.97
pH, longissimus muscle	5.42	5.41	5.44	0.046	0.37
Drip loss, %	3.38	2.51	1.95	0.322	0.02
Pork chop tenderness [f]	5.50	5.57	5.47	0.253	0.92
Pork chop juiciness [g]	5.30	5.46	5.27	0.159	0.65
Pork pattie juiciness [g]	5.59	5.55	5.48	0.195	0.93

[a] Data from Stein et al. (2006).

[b] Each mean represents eight observations with two pigs per pen.

[c] One kilogram = 2.2 lb. One cm = 0.3937 inches. One cm^2 = 0.155 $inch^2$.

[d] SEM = standard error of the mean.

[e] Numbers represent the inclusion rate (%) of field peas in diets fed from 22 to 50 kg, 50 to 85 kg, and 85 to 125 kg, respectively.

[f] Tenderness score: 8 = extremely tender; 1 = extremely tough.

[g] Juiciness score: 8 = extremely juicy; 1 = extremely dry.

Table 3. Example of diet formulations for growing pigs using field peas [a, b]

Item	Diet: NRC requirement [c]	Corn-soybean meal	Corn-soybean meal-field peas	Corn-field peas
Ingredients, %				
Corn	-	73.00	49.64	34.55
Soybean meal (48%)	-	21.40	9.00	-
Field peas	-	-	36.00	60.00
Choice white grease	-	3.00	2.90	2.93
Limestone	-	0.95	1.05	1.15
Monocalcium phosphate	-	0.92	0.65	0.50
L-lysine HCL	-	0.13	0.02	-
DL-methionine	-	-	0.07	0.14
L-threonine	-	-	0.03	0.06
L-tryptophan	-	-	0.04	0.07
Salt	-	0.40	0.40	0.40
Vitamin premix	-	0.05	0.05	0.05
Micro mineral premix	-	0.15	0.15	0.15
Energy and nutrients [d]				
Energy, kcal ME/kg	-	3,472	3,472	3,472
SID protein, %	-	13.44	13.46	13.21
Calcium, %	0.60	0.61	0.60	0.60
Phosphorus, %	-	0.55	0.48	0.44
Digestible phosphorus, %	0.23	0.23	0.23	0.23

SID arginine, %	0.33	0.94	1.08	1.16
SID histidine, %	0.26	0.39	0.38	0.36
SID isoleucine, %	0.45	0.59	0.55	0.52
SID leucine, %	0.83	1.36	1.21	1.09
SID lysine, %	0.83	0.83	0.83	0.86
SID methionine, %	0.22	0.24	0.26	0.29
SID methionine + cysteine, %	0.47	0.50	0.47	0.47
SID phenylalanine, %	0.49	0.71	0.67	0.63
SID threonine, %	0.52	0.52	0.52	0.52
SID tryptophan, %	0.15	0.16	0.15	0.15
SID valine, %	0.56	0.68	0.63	0.58

[a] Diets formulated for growing pigs (20 – 50 kg).

[b] Diets were formulated based on metabolizable contents of energy (ME), standardized ileal digestible contents of amino acids, and apparent total tract digestible contents of phosphorus in corn, soybean meal, and field peas. All data for corn and soybean meal were from NRC (1998), whereas data for field peas were from Stein et al. (2004) and Stein et al. (2006a).

[c] Data from NRC (1998).

[d] ME = metabolizable energy; 1 kg = 2.2 lb; SID = standardized ileal digestible.

Table 4. Maximum cost of field peas ($/bushel) at different costs of corn and soybean meal [a, b, c]

	Soybean meal (48%), $ per ton [d]					
Corn, $ per bushel [e]	175	200	225	250	275	300
1.50	2.5	2.60	2.75	2.90	3.05	3.20
2.00	2.95	3.10	3.20	3.40	3.50	3.65
2.50	3.35	3.50	3.60	3.80	3.95	4.05
3.00	3.80	3.95	4.10	4.20	4.35	4.50
3.50	4.25	4.40	4.50	4.65	4.80	4.95
4.00	4.70	4.80	4.95	5.10	5.25	5.35

[a] For each combination of costs for corn and soybean meal, the price indicated for field peas will result in identical diet costs for a corn-soybean meal-based diet and a corn-field pea-based diet.

[b] Diets were formulated assuming the following costs of other ingredients: choice white grease, $0.34/kg; limestone, $0.045/kg; monocalcium phosphate, $0.29/kg; L-lysine HCL, $3.08/kg; DL-methionine, $2.25/kg, L-threonine, $3.08/kg; L-tryptophan, $8.80/kg. Changes in the costs of these ingredients may change the price that can be paid for field peas.

[c] 1 bushel of field peas = 60 lb = 27.27 kg.

[d] 1 ton = 2,000 lb = 907 kg of soybean meal.

[e] 1 bushel of corn = 56 lb = 25.45kg.