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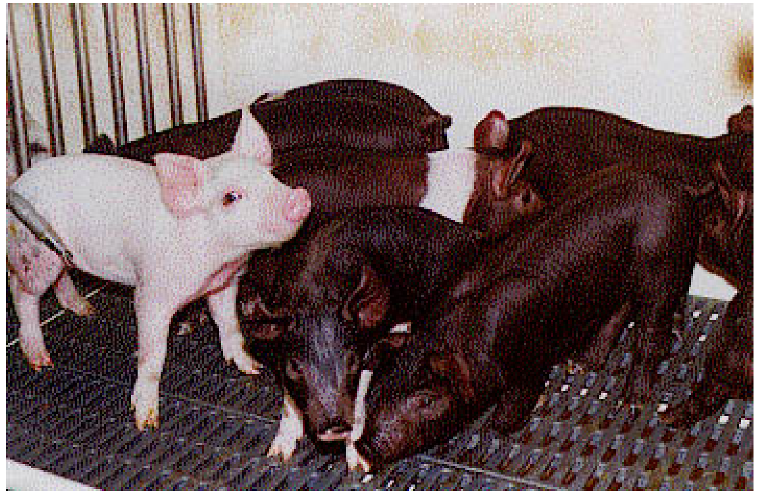
NUTRITIONAL VALUE OF RAW AND EXTRUDED FIELD PEA IN STARTER DIETS OF SEGREGATED EARLY WEANED PIGS



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ABSTRACT

An evaluation of nutrient-dense pig starter diets for segregated early weaned (SEW) pigs was conducted by replacing corn and soybean meal (SBM) with 30 and 50% raw or extruded field pea in a baseline experiment (Expt. 1), and 20 and 40% raw or extruded field pea in a modified experiment (Expt. 2). Light weight pigs (those weighing 11 pounds) allotted to treatments in experiment one responded poorly to raw field pea, therefore, an additional supporting experiment was conducted to determine when pigs averaging 11 pounds and 14 days of age could effectively begin consuming SEW diets containing 20% extruded field pea.

Using a two-phase starter diet (Table 1), pigs fed the corn/SBM control diet performed better than pigs fed diets containing 30 and 50% peas. Within pea diets, pig response was similar between the diets containing 30 and 50% peas. Although no difference was found between the performance of pigs fed either raw or extruded pea, there was a trend toward better performance when 30% extruded pea was fed. Pig performance decreased as the level of extruded peas in the diet increased whereas the opposite was true for the raw peas.

In the second experiment, pigs averaging 16 pounds at weaning and fed a 4-phase starter diet performed better

when fed the corn/SBM control. The control pigs grew faster and were more efficient than the average of pigs fed pea starters. Within pea diets, pigs fed extruded pea tended to grow faster and consume more feed than pigs fed raw pea. Pigs fed 20% extruded pea had numerically similar ADG and ADFI when compared to the control, but feed efficiency and feed cost/pound of gain favored the control. Feeding 40% raw pea yielded the poorest pig performance.

Management methods for using field pea diets in light weaning weight pigs, fed 4-phase diets, were evaluated in experiment 3. Pigs fed the control diet and the diet containing 20% extruded pea two weeks following weaning tended to perform similarly. Likewise, feed costs per pound of gain between these two groups were similar. Although not significantly different, pigs fed the diet containing 20% extruded pea immediately after weaning tended to grow slower, with poorer feed conversion efficiency, and greater cost per pound of gain than pigs fed the control diet.

Based on the results of these experiments replacing corn and SBM with raw and extruded field pea, these feedstuffs can play a role in weanling pig diets, but the levels used must be restricted. Small pigs weighing less than 11 pounds at weaning should not be fed raw pea. Pigs weighing at least 16 pounds can be fed raw pea, but the level should be less than 20%. Canadian research suggests a maximum of 15%. In the case of extruded pea, weanling pig performance was improved relative to raw pea, but its use must also be restricted. When competitively priced in "least-cost" or "best-cost" formulations, no more than 20% extruded pea can be recommended.

INTRODUCTION

North Dakota is a state experiencing many changes in the agricultural sector, especially with freedom to farm provisions in the new farm bill. While wheat is the most economically important crop grown, emerging alternative crops are being grown more frequently for use in livestock systems and crop rotations. In crop rotations, alternative crops can aid crop disease control and compliment residual soil nutrient levels. The field pea is one such emerging alternative crop.

Pea grain has indirectly been valued for its nutrient composition as a human food since initial cultivation several thousand years ago.

Field pea contains on the average 23% protein, 3,420 kcal/kg of digestible energy, 1.3% fat, 5.5% crude fiber and 1.6% lysine. They are, however, a poor source of the sulphur-containing amino acids: methionine and cystine (Wiseman and Cole, 1988). In addition, antinutritional factors (trypsin and chymotrypsin inhibitors, lectins and tannins) in raw field pea limit the quantity that can be fed to pigs, particularly the SEW pig.

Protease inhibitors are proteins with specific antitrypsin and antichymotrypsin activity, which decrease the digestibility of protein and cause pancreatic hypertrophy (Griffiths, 1984). Trypsin inhibiting activity of raw pea was reported by Valdebouze and co-workers (1980) to be from 5-20 times less than that reported for raw soybeans.

Heat treatment appears to be a viable option for deactivation of the trypsin and chymotrypsin that interfere with protein digestion. Heat processing at high temperatures, such as can be obtained with extrusion (250 - 290 F), can deactivate protease inhibitors (van Zuilichem and van der Poel, 1989). The extent of destruction is a function of temperature, duration of heating, particle size, moisture and variety (Liener, 1983).

The objective of this investigation was to determine the substitution value of raw or extruded field pea when replacing corn and soybean meal in SEW pig starter diets.

PROCEDURE

Three experiments were conducted in this evaluation of raw and extruded field pea. The first was a preliminary study that evaluated 0, 30 and 50% raw and extruded pea diets to establish a pig acceptance and performance baseline. The second study was similar, but was changed to a 4-phase feeding program for pigs averaging 16 pounds at weaning, and the raw and extruded pea levels were reduced 10% from 30 and 50% to 20 and 40%.

A third study focused on feeding management for young, light weaning weight pigs, by comparing a corn/SBM diet to a 20% extruded pea diet that was fed either immediately after weaning or delayed for two weeks to determine which method would give early weaned pigs the most favorable initial start after weaning.

Raw peas were extruded by Maertens Manufacturing Company, Center, North Dakota, using an Insta-Pro ® extruder. Before extrusion, pea was ground through a number four screen, and 5% sunflower oil added to reduce starch expansion. Extrusion temperature of the peas used in these experiments averaged 275F ± 15F. After extrusion, the extruded pea material was re-ground through a 1/8 inch screen using a New Holland grinder/mixer and incorporated into the nutrient dense 2-phase and 4-phase starter diets shown in Tables 1 and 2.

Data was analyzed using GLM procedures of SAS (SAS, 1988).

Experiment 1

One-hundred-five,14.5 day-old pigs (averaging 10.8 lbs.) were randomly allotted to receive 0, 30 and 50% raw or extruded field pea in a 29 day preliminary study. There were three pens per treatment and seven pigs per pen. At weaning the pigs were vaccinated with a 3-way multivalent vaccine and moved to an environmentally-controlled, segregated, early weaning facility and fed the meal-type 2-phase starter diets shown in Table 1. Phase-1 diets were fed for 14 days, followed by Phase-2 diets for the remaining 15 days. Pigs and feed were weighed at weekly intervals and feed and water were provided on an ad libitum basis. Raw or extruded field pea was added to the basal diet at the expense of corn, SBM and fish meal. Dietary protein and lysine concentrations were equivalent across diets within each phase. Synthetic methionine was added to provide a minimum of .96 and .61% methionine-cystine in Phase 1 and 2 diets. All other amino acids were provided by dietary ingredients with no consideration given to their ratio to lysine.

Experiment 2

One-hundred-sixty pigs, initially averaging 16 pounds and 18 days of age, were weaned, vaccinated and randomly allotted to 0, 20 and 40% raw or extruded field pea treatments in a 28-day nursery study. There were four pen replicates per treatment with eight pigs per pen. At weaning, the pigs were handled and vaccinated the same as in experiment 1 and transferred directly to the SEW facility. The 4-phase starter program, shown in Table 2, was used to develop the pigs and evaluate the form and level of pea fed. The diets were formulated to contain constant crude protein, lysine and energy concentrations across treatments. Synthetic methionine was added to provide an average across treatments that was .8% in the first three phases and .75% in the last phase. Other amino acids were provided by dietary ingredients as in the first experiment.

Amino acid supplementation was similar to that described in experiment 1.

Experiment 3

Seventy-four pigs, averaging 11 pounds and 14 days of age, were weaned, vaccinated and transferred to the SEW facility. Treatments evaluated were: corn/SBM control, 20% extruded pea, and a treatment in which the control diet was fed for two weeks followed by the 20% extruded pea diet. A 4-phase starter program, similar to the one used in experiment 2, was fed for 35 days. Phase 1 was fed for 14 days, and the remaining three phases were fed 7 days each. Diet formulations for the control and 20% extruded pea treatments were identical to those in experiment 2, and are also shown in Table 2.

RESULTS AND DISCUSSION

Experiment 1

Feeding levels of 30% and 50% raw and extruded field pea to replace corn and soybean meal (SBM) were used in an initial investigation to establish baseline performance levels.

Using a two-phase starter diet (Table 1), pigs fed the corn/SBM control diet performed better than pigs fed diets containing peas. Within the pea diets, pig response was similar between the diets containing 30 and 50% peas, and no difference was found between the performance of pigs fed either raw or extruded pea. A field pea by processing method interaction was noted such that pig performance decreased as the level of extruded peas in the diet increased whereas the opposite was true for the raw peas.

We observed that smaller pigs, allotted in treatments with larger pigs where raw peas were fed, performed poorly, suggesting that raw pea was ill suited for small pigs weaned at 2 weeks of age and weighing less than 11 pounds. This observation led us to design two additional studies.

Experiment 2

Pigs, averaging 16 pounds at weaning, were fed the 4-phase starter diet shown in Table 2 and the data has been summarized in Table 4. When pigs consuming the corn/soybean meal diet were compared to the performance of pigs fed pea diets, the control pigs grew faster and were more efficient than the average of pigs fed the pea diets. Within pea diets, pigs consuming the extruded pea diets tended to grow faster and consume more feed than pigs fed raw peas.

Pea level was also a significant source of difference and influenced pig performance. Pigs consuming 20% pea (raw or extruded) performed better ($P<.05$) for all performance criteria measured (gain, feed intake and feed and gain efficiency) than pigs fed 40% pea diets. The response observed was primarily associated with diets containing raw pea. Increasing the level of raw pea from 20 to 40% resulted in poorer feed conversions, but when the level of extruded pea was increased from 20 to 40%, feed conversion was not affected.

Feed cost per pound of gain was lower for the control diet versus the average of the pea diets. Also, feed cost per pound of gain was lower for diets containing 20% pea versus diets containing 40% pea. Average daily gain between pigs fed the control and 20% extruded pea diets was similar, but growth for the 20% extruded pea group cost $.04 more/pound of gain, which is a function of slightly slower gain efficiency and higher cost/ton ($41.67/ton more) for extruded pea. Feed cost per pound of gain was similar between pigs consuming the corn/soybean meal control diet and the diet containing 20% raw pea. It must be noted, however, that the pigs consuming the 20% raw pea diet were approximately two pounds lighter at the end of the 28 day period.

Experiment 3

The results of experiments 1 and 2 defined the working limits for raw and extruded pea in the SEW pig, as being less than 20% raw and not to exceed 20% when extruded. Since small pigs (those averaging less than 11 lbs.) in experiment 1 grew poorly when offered raw pea, 20% extruded pea was considered as a comparison to the corn/SBM control. This experiment was designed to determine if these small pigs would respond better to the corn/SBM control diet immediately after weaning (2 wk.) followed by the 20% extruded pea diet for the remaining 3 weeks, or whether the 20% extruded pea could be offered immediately after weaning with good success.

The data has been summarized in Table 5. Pigs fed the control diet and the diet containing 20% extruded pea two weeks following weaning tended to perform similarly. Likewise, feed costs per pound of gain between these two groups were similar. However, pigs fed the diet containing 20% extruded pea immediately after weaning tended to grow slower, with poorer feed conversion efficiency, and greater cost per pound of gain than pigs fed the control diet.

IMPLICATION

Based on the results of these experiments replacing corn and SBM with raw and extruded field pea, these feedstuffs can play a role in weanling pig diets, but the levels used must be restricted. Small pigs weighing less than 11 pounds at weaning should not be fed raw pea. Pigs weighing at least 16 pounds can be fed raw pea, but the level should less than 20%. Canadian research suggests a maximum of 15%. In the case of extruded pea, weanling pig performance was improved relative to raw pea, but its use must also must be restricted. When competitively priced in "least-cost" or "best-cost" formulations, no more than 20% extruded pea can be recommended.

Table 1. Pig starter diets formulated with 30% and 50% raw and extruded field pea

	Phase 1	Control		30% Field Pea		50% Field Pea
		Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Ingredients, %						
Corn	43.2	47.8	19.5	32.4	9.0	21.2
Raw or Extruded Pea	---	---	30.0	30.0	50.0	50.0
Dried Whey	25.0	10.0	25.0	10.0	25.0	10.0

Soybean Meal	13.0	33.5	8.5	19.8	---	10.4
Fish Meal, 60%	10.3	---	4.0	---	4.0	---
Porcine Plasma	5.0	---	5.0	---	5.0	---
Methionine	---	---	.35	.13	.35	.25
Lysine	.15	.28	.15	.22	.1	.20
Mineral Premix	.60	.75	.65	.75	.65	.75
Dicalcium Phosphate		.95	.65	1.0	.65	1.0
Sunflower Oil	1.0	4.5	4.0	3.5	3.0	4.0
Limestone	.3	.75	.75	.75	.75	.75
Other[a]	1.49	1.49	1.49	1.49	1.49	1.49
Analysis, %:[b]						
C. Protein	22.2	20.2	22.2	20.2	22.2	20.2
Calcium	1.0	.85	1.0	.85	1.0	.85
Avail. Phos.	.53	.39	.48	.39	.48	.38
Lysine	1.7	1.4	1.7	1.4	1.7	1.4
Methionine + cys.	.90	.63	.96	.61	.90	.62
Energy kcal/lb	1.48	1.52	1.49	1.48	1.46	1.47
Cost/Pound[c]	$.228	$.147	$.288	$.147	$.287	$.150

[a]Includes 1.22% Mecadox premix, .1% vit. B complex, .075% copper sulfate, .025% zinc sulfate and .07% vitamin A,D and E. [b]Except for methionine, all other amino acids were provided by dietary ingredients with no consideration given to their

ratio to lysine.
[c]Based on costs of corn at $3.90/bu, soybean meal at $245/ton, raw pea at $153.33/ton and extruded pea at $195.36/ton.

Table 2. Pig starter diets formulated with 20% and 40% raw and extruded pea.

Phases	Control				20% Raw Pea				20% Extruded Pea				40% Raw Pea				40% Extruded Pea			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Ingredients, %																				
Corn	31.0	40.5	50.4	63.0	19.1	28.4	37.7	51.0	19.1	28.4	37.7	51.0	3.8	16.2	25.3	38.0	3.8	16.2	25.3	38.0
Raw Pea	0.0	0.0	0.0	0.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	40.0	40.0	40.0	40.0	0.0	0.0	0.0	0.0
Extruded Pea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	40.0	40.0	40.0	40.0
Dried Whey	25.0	18.0	10.0	0.0	25.0	18.0	10.0	0.0	25.0	18.0	10.0	0.0	25.0	18.0	10.0	0.0	25.0	18.0	10.0	0.0
Soybean Meal	11.0	21.0	25.0	26.0	2.5	12.0	16.8	17.0	2.5	12.0	16.8	17.0	0.0	3.25	8.0	8.0	0.0	3.25	8.0	8.0
Fish Meal	10.0	5.0	4.0	3.0	10.0	5.0	4.0	3.0	10.0	5.0	4.0	3.0	6.5	5.0	4.0	4.0	6.5	5.0	4.0	4.0
Animal Plasma	10.0	4.0	0.0	0.0	10.0	4.0	0.0	0.0	10.0	4.0	0.0	0.0	10.0	4.0	0.0	0.0	10.0	4.0	0.0	0.0
Lysine	.2	.15	.29	.2	.15	.11	.22	.16	.15	.11	.22	.16	.08	.06	.18	.12	.08	.06	.18	.12
Methionine	0.0	.15	.2	.1	0.0	.26	.27	.2	0.0	.26	.27	.2	0.0	.35	.4	.35	0.0	.35	.4	.35
Mineral Premix	.9	.9	.9	1.0	.9	.9	.9	1.0	.9	.9	.9	1.0	.9	.9	.9	1.0	.9	.9	.9	1.0
Dical	0.0	.5	.65	.75	0.0	.55	.65	.75	0.0	.55	.65	.75	.3	.55	.7	.85	.3	.55	.7	.85
Limestone	0.0	0.0	.3	.3	0.0	0.0	.3	.4	0.0	0.0	.3	.4	0.0	0.0	.3	.3	0.0	0.0	.3	.3

Sunflower Oil	9.5	7.5	6.0	4.0	10.0	8.5	6.9	5.0	10.0	8.5	6.9	5.0	11.0	9.4	7.9	6.0	11.0	9.4	7.9	6.0
Other [a]																				
Analysis, %[b]																				
Crude Protein	24.2	21.1	19.2	19.3	24.3	21.0	19.4	19.3	24.3	21.0	19.4	19.3	24.6	21.1	19.5	19.3	24.6	21.1	19.5	19.3
Lysine	1.9	1.5	1.4	1.2	1.9	1.5	1.4	1.2	1.9	1.5	1.4	1.2	1.9	1.5	1.4	1.2	1.9	1.5	1.4	1.2
Tryptophan	.34	.29	.25	.25	.33	.27	.23	.23	.33	.27	.23	.23	.33	.25	.21	.21	.33	.25	.21	.21
Methionine +Cyst.	.96	.89	.82	.74	.87	.89	.79	.73	.87	.89	.79	.73	.75	.87	.81	.76	.75	.87	.81	.76
Calcium	.93	.76	.80	.75	.92	.77	.80	.79	.92	.77	.80	.79	.83	.76	.80	.78	.83	.76	.80	.78
Avial. Phos.	.55	.48	.45	.42	.54	.48	.44	.41	.54	.48	.44	.41	.54	.48	.44	.42	.50	.48	.44	.42
Energy, kcal ME/lb	1.63	1.59	1.55	1.53	1.63	1.59	1.55	1.53	1.63	1.59	1.55	1.53	1.63	1.59	1.55	1.53	1.63	1.59	1.55	1.53

[a]Includes 1.22% Mecadox premix, .05% copper sulfate, .8% zinc sulfate, .27% vit. B complex and .05% vit. A,D and E (Note: .8% zin c sulfate removed from all phase-4 diets).
[b]Except for methionine, all other amino acids were provided by dietary ingredients with no consideration given to their ratio to lysine.

Table 3. Pig performance (29-day) when 30% and 50% raw or extruded field pea replaced corn and SBOM

	Extruded Pea			Raw Pea		SE[d]
	0%	30%	50%	30%	50%	

GROWTH PERFORMANCE:						
Starting Weight, lb.	10.9	10.8	10.3	10.8	10.7	
29-Day Weight, lb.	26.0	21.0	18.1	18.1	19.4	
Gain/Head, lb.	15.1	10.2	7.8	7.25	8.7	
ADG, lbs.[ab]	.52	.35	.27	.25	.30	.025
FEEDING ECONOMICS:						
Feed/Head, lb.	28.2	22.1	20.2	19.8	22.0	
ADFI, lb.[a]	.97	.76	.69	.68	.76	.047
Gain:Feed, lb.[ab]	.54	.45	.38	.36	.39	.020
Fd Cost/Head	$4.54	$3.71	$3.50	$3.26	$3.56	.205
Fd Cost/Lb. Gain[abc]	$.30	$.37	$.46	$.46	$.41	.022

[a]Control diet differs from diets containing field peas (P<.05).
[b]Field pea level x processing method interaction (P<.05).
[c]Based on costs of corn at $3.90/bu, soybean meal at $245/ton, raw pea at $153.33/ton and extruded pea at $195.36/ton.
[d]Standard error

Table 4. Pig starter performance among 16 pound pigs fed 20%and 40% raw or extruded field pea

	Corn/SBOM	20%	40%	

	Corn/ SBOM Control					SE[e]
		Raw	Extruded	Raw	Extruded	
GROWTH PERFORMANCE:						
Starting Weight, lb.	16 .3	16.2	16.2	16.3	16.2	
28-Day Weight, lb.	37.0	35.1	36.2	30.6	34.0	
Gain/Head, lb.[ac]	20.7	18.9	20.0	14.3	17.8	1.15
ADG, lb.[ac]	.73	.68	.71	.51	.64	.041
FEEDING ECONOMICS:						
Feed/Head, lb.[bc]	35.0	32.9	36.3	28.5	33.1	1.78
ADFI, lb.[bc]	1.25	1.18	1.30	1.02	1.18	.064
G:F, lb.[acd]	.58	.58	.55	.50	.54	.015
Feed Cost/Head[bc]	$7.69	$7.14	$8.22	$6.23	$7.49	.385
Cost/Lb. of Gain[acf]	$.37	$.37	$.41	$.43	$.42	.015

[a]Control diet differs from diets containing field pea ($P<.05$).
[b]Extruded pea diets differ from raw pea diets ($P<.05$).
[c]Level of 20% field pea differs from 40% field pea ($P<.05$).
[d]Field pea x processing method interaction ($P<.05$).
[e]Standard error
[f]Based on costs of corn at $4.10/bu, soybean meal at $246/ton, raw peas at $153.33/ton and extruded pea at $195/ton.

Table 5. Pig starter performance among 11 pound weaning weight pigs receiving 20% extruded pea diets at weaning or 2 weeks post-weaning[a].

	Corn/Soy Control	Control + 20% Extruded Pea 2 weeks Post-Wean	20% Extruded Pea at Weaning	SE
GROWTH PERFORMANCE:				
Starting Weight, lb.	11.30	11.20	11.20	
35 Day Weight, lb.	35.00	36.60	32.50	
Gain/Head, lb.	23.70	25.40	21.30	1.5
ADG, lb.	.68	.73	.61	.042
FEEDING ECONOMICS:				
Feed/Head, lb.	39.80	41.90	38.20	1.5
ADFI, lb.	1.14	1.20	1.09	.043
Gain:Feed, lb.	.60	.61	.56	.022
Cost/Head	$10.25	$10.78	$10.00	.218
Cost/Pound of Gain[b]	$.4322	$.4240	$.4710	.024

[a]No treatment differences (P<.05).
[b]Ingredient costs were similar to those described in Table 4.

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