Journal of Animal and Veterinary Advances 5 (11): 1014-1021, 2006

Utilization of Cull Peas, Dry Beans and Bakery Wastes for Feeding Swine

[1]E.W. Hawkins, [2]D.K. Lunt, [3]L.E. Orme and [1]N.P. Johnston
[1]Department of Nutrition, Dietetics and Food Science, Brigham Young University, Provo, UT 84602
[2]Texas A and M University Agricultural Research Center, McGregor, TX 76657
[3]Emeritus status, Department of Animal Science, Brigham Young University, Provo, UT 84602

Abstract: Fifty-six cross bred weaned pigs were allotted to seven different nutritional treatments. The purpose of this experiment was to compare various nontraditional byproduct, cull or waste feeds with conventional or commercial swine rations for rate of growth, efficiency of growth and carcass traits. One treatment was terminated after 38 days because of impaired protein digestion resulting from the presence of a dietary inhibitor. It was concluded that cull peas or extruded cull beans may be used in diets fed to growing pigs as a supplemental protein source without significantly diminishing efficiency or rate of growth. Bakery wastes resulted in less efficient gains ($p<0.05$), a lighter harvest weight and longer days to market weight. Therefore, bakery waste may be used as a component of the diet as an energy source but supplemental protein would be required to achieve growth performance and feed efficiency similar to that of pigs on the other dietary treatments in the present study. No significant differences due to diets were found for carcass composition, color of lean or color of fat. Cost of the feed in the commercial diet in the present study was more than twice that of the diets which contained nontraditional feedstuffs. This study shows it is not only cost effective, but profitable to use certain cull, waste or byproduct feeds as a component of diets for growing pigs.

Key words: Swine, beans, peas, protein

INTRODUCTION

The decision as to how to best utilize cull dry peas and beans following harvest is one which farmers have to face. Some breakage or waste normally occurs during harvest or processing. Nutritionally, dry cull peas and beans are excellent sources of protein and energy. The value of broken dry peas and beans is greatest when used for animal feed and is very competitive in price as compared to other protein sources. With increased emphasis upon efficiency and cost of production, cull peas and beans could play a valuable role in reducing feed costs. Feed grains and protein supplements vary in price depending upon yields, international trade, numbers of livestock, etc. In recent years, soybeans have been used to make biodiesel. Demand for soy-based biodiesel is expected to grow in the future. This new market for soybeans will make protein feeds derived from soybeans more expensive. Alternative sources of protein, such as dry cull peas and beans, may become increasingly important as feedstuffs for swine. Questions have arisen, however, as to the palatability of dry cull peas and beans when fed to swine as well as the effect these feeds may have on feedlot performance and carcass characteristics, especially color and firmness of fat. Bakery waste is also available in some areas. The high starch and sugar content of bakery waste makes this a possible source of energy and the cost is often quite reasonable.

Objectives: The objectives of this study were as follows:

- To compare the rate and efficiency of growth in pigs from weaning to market weight when fed a complete commercial diet or diets which included either cull peas or beans, or bakery waste,
- To compare various carcass traits and carcass composition of market weight swine fed on theses diets and
- To compare the relative feed costs of the treatment diets.

MATERIALS AND METHODS

Experimental design: The purpose of this experiment was to compare swine rations using various cull feeds with conventional or commercial swine rations for comparison of growth and carcass traits. The pigs in this experiment all came from the same genetic pool, namely the Brigham

Corresponding Author: E.W. Hawkins, Department of Nutrition, Dietetics and Food Science, Brigham Young University, Provo, UT 84602

Young University swine unit and thus were similar in frame and muscle structure. Average initial weight was 17.70 kg. Fifty-six cross bred weaned pigs were randomly allotted to the various treatment groups. Three barrows and one gilt were used per treatment. Each treatment was replicated. Treatments are shown in Table 1 and composition of diets is given in Table 2. Nutritional composition of components of the diets is illustrated in Table 3[1] while Table 4 lists the daily nutrient requirements for growing and finishing swine[2].

Each pig was individually weighed and identified and given a ten-day post weaning period when all pigs were

Table 1: List of treatmentsa

Treatment	Diet
1	Non-extruded beans + barley and wheat base
2	Extruded beans + barley and wheat base
3	Peas + barley and wheat base
4	Soybean meal + barley and wheat base
5	Commercial supplement + barley and wheat base
6	Commercial complete feed diet
7	Pie waste + 36% protein supplement

[a]Composition of diets is given in Table 2

Table 2: Composition of diets

Ingredient, %	Trt 1	Trt 3	Trt 3	Trt 4	Trt 5	Trt 6	Trt 7
Barley	30.83	30.83	24.30	39.97	39.70	-	-
Wheat	30.83	30.83	24.30	39.97	39.70	-	-
Soybean meal	-	-	-	16.05	-	-	-
Peas	-	-	46.70	-	-	-	-
Whole raw beans	34.20	-	-	-	-	-	-
Extruded beans	-	34.20	-	-	-	-	-
Soybean oil	1.70	1.70	1.86	1.86	-	-	-
Vitamin premix	0.50	0.50	0.50	0.50	-	-	-
Salt	0.50	0.50	0.50	0.50	-	-	-
Calcite	0.66	0.66	0.86	1.17	-	-	-
Dicalcium phosphate	0.68	0.68	0.90	0.50	-	-	-
Methionine	0.10	0.10	0.08	0.15	-	-	-
Commercial supplement	-	-	-	-	20.60	-	50.00
Commercial diet	-	-	-	-	-	100.00	-
Bakery waste	-	-	-	-	-	-	50.00

Table 3: Average composition of feedstuffs

Nutrients	Soybean meal, %	Whole soybeans, %	Dry beans, %
Crude protein	45.0	38.0	23.0
Crude fat	1.3	18.0	1.4
Crude fiber	5.8	5.0	4.2
Nitrogen free extract	31.4	29.9	57.3
Minerals	6.1	6.0	4.2
Lysine	2.8	2.4	1.5
Methionine and cystine	1.3	1.1	0.5
Tryptophan	0.6	0.5	0.2
Threonine	1.7	1.5	1.1
Isoleucine	2.5	2.3	1.4
Valine	2.4	2.0	1.3
Digestible energy, Kcal kg^{-1}	3300	3600	3000

Table 4: Daily nutrient requirements[a] and amino acids for growing and finishing swine

	Liveweight Class (Kg)[b]		
Nutrient Requirements, %	5-10	20-35	60-100
Crude protein, g	132	272	462
Arginine	-	0.20[c]	-
Histidine	0.27	0.18	-
Isoleucine	0.76	0.50	0.35
Leucine	0.90	0.60	-
Methionine[d]	0.80	0.50	-
Phenylalanine[e]	-	0.50	-
Threonine	0.70	0.45	-
Tryptophan	0.18	0.13	0.09[c]
Valine	0.65	0.50	-
Lysine	1.20	0.70	0.50

[a]Each requirement is expressed as a percentage of the diet. Requirements are based on protein and digestible energy level requirements shown in tables. [b]Total air dry feed requirements (in g) for the liveweight class are respectively as follows: 600, 1250, 1750, 2500 and 3300. [c]This level is adequate; the minimum has not been established. [d]Cystine can satisfy 40% of the requirement for methionine. [e]Tyrosine can satisfy 30% of the requirement for phenylalanine

fed the same starter ration, at the end of which each pig was weighed and placed in its respective test group. Two sizes of open front pens were used. The smaller pens measured 6.2×3.0 meters whereas the larger pens were 12.2×3.1 meters. Each pen had concrete floors and automatic waterers. Feed was offered *ad libitum* morning and evening and records were kept on the amount of feed consumed by each pen on a daily basis. Each pig was weighed at 28-day intervals until they reached 90 kg. Following this, pigs were weighed at weekly intervals. The pigs were weighed off test at approximately 95 kg liveweight, except for the bakery waste group which was terminated at 80 kg. Twenty-four h later, a shrunk live weight was taken for each pig.

Harvest procedure: Pigs were harvested at the Brigham Young University Meat Laboratory. Carcasses were chilled at 2 degrees C in a cooler overnight. Carcass measurements including cutout were obtained from chilled carcasses.

Quality and yield grading: Each carcass was graded using the United States Department of Agriculture Grading Standards for fat thickness over the first rib, last rib and last lumbar vertebrae; carcass length and degree of muscling; and color scores.

Carcass cutting procedure: Each carcass was separated into halves prior to moving into the chiller. After hanging in a 2 C cooler overnight, carcass halves were then handled as follows: carcasses were weighed 12-18 h after slaughter with the leaf fat removed. Carcass length was measured from the anterior point of the aitch bone to the anterior edge of the first rib, holding the tape as close to the thoracic vertebrae as possible. Three measurements of backfat were taken (including the skin) opposite the first rib, last rib and last lumbar vertebrae. These three measurements were then averaged. Loin eye area was measured by cutting between the tenth and eleventh ribs, perpendicular to the back and measuring only the *longissimus dorsi* (L.D.) muscle. This was accomplished by tracing the L.D. muscle from the untrimmed loin using acetate paper and subsequently using a compensating polar planimeter. The shoulder was cut perpendicular to the back and between the second and third ribs. Front feet were removed 2.54 cm above the knee joint. Neck bones were removed as close as possible to the sternum, ribs and chine. The jowl was removed by cutting parallel to the shoulder separation cut. The brisket flap and the clear plate were removed. The rough loin (loin-fat back) was separated from the rough belly (belly or side end-spareribs) to the tenderloin on the sirloin end and as close to the backbone as possible following the natural curvature of the backbone. Removal of the fatback was done by leaving no more than 0.64 cm backfat remaining on the loin after removal of the fat. Spareribs were removed from the belly by cutting up towards the ribs leaving exposed ribs. The ham was removed by cutting between the second and third sacral vertebrae and perpendicular to the femur. Hind feet were removed by cutting approximately 2.54 cm below the hock. The ham was trimmed by removal of tail and flank and approximately 1/3 of skin leaving approximately 0.3-0.6 cm of fat cover.

Two 2.54 cm thick chops were taken dorsally to the tenth rib and saved for organoleptic evaluation, as well as for texture, firmness and color evaluation of muscle. A sample of backfat was also obtained for further analysis. The percent ham and loin was calculated using the weights of ham and loin and dividing by the cold carcass weight. Percentage of lean cuts was calculated by weighing the trimmed shoulder (picnic and Boston butt), loin and ham and dividing by cold carcass weight.

Carcass quality evaluation: National Pork Producers Council[3] shows the procedure used to evaluate market hogs. Marbling, firmness and color scores were used following the guidelines published by NPPC.

Visual, texture and fatback evaluations: Visual, texture and fatback evaluations were accomplished using the two loin chops. A section of backfat was also obtained for each carcass and frozen until further analysis. Two loin chops and fatback from each carcass were frozen at-20 C with visual differences distinguishable in color and texture of muscle of fat recorded.

Statistical analysis: Statistical analyses were performed utilizing students' T test, the F test, Analysis of Variance and Duncan Multiple Range Test[4].

RESULTS

Efficiency and rate of growth: Pigs were harvested when reaching average weights of 91.2 to 101.2 kg except the hogs fed bakery wastes; these pigs were harvested at an average live weight of 79.8 kg because of they were growing slowly and were becoming very fat. Table 5 lists the weights for the various 28-day weigh periods along with the final or off feed weight and the days on feed. The pigs fed the non-extruded beans actually lost weight the first 28 days and by the 38th day were extremely emaciated and had dry and rough hair coats and squealed constantly. Their stools were very loose and either light

Table 5: Twenty-eight day liveweight

Treatments		Day 0	1st Month	2nd month	3rd month	4th month	5th month	Over all
Non-extruded beans	Average	16.93[a]	16.74					
	Maximum		18.56					
	Minimum		11.77					
Extruded beans	Average	18.11[a]	25.96	41.16	62.87	91.68	-	91.68[a]
	Maximum		31.75	49.87	69.84	99.77	-	
	Minimum		20.41	26.76	53.51	83.37	-	
Peas	Average	17.97[a]	27.55	46.20	64.97	91.22	-	91.22[a]
	Maximum		32.65	55.33	75.74	104.31	-	
	Minimum		20.41	38.10	57.60	81.63	-	
Soybean meal	Average	18.60[a]	26.70	48.59	75.51	98.47	-	98.47[a]
	Maximum		31.75	56.24	80.73	106.58	-	
	Minimum		23.13	40.82	63.13	86. 17	-	
Commercial	Average	18.21[a]	26.36	44.84	69.11	91.27	-	91.27[a]
Supplement	Maximum		31.75	52.15	78.00	104.31	-	
	Minimum		19.95	35.37	57.14	77.10	-	
Commercial	Average	18.90[a]	25.91	47.51	67.41	93.26	-	93.26[a]
Complete	Maximum		32.65	57.60	81.63	106.58	-	
Diet	Minimum		19.50	37.19	54.42	81.63	-	
Bakery waste	Average	15.16[a]	25.74	42.80	57.01	66.09	79.82	79.82[b]
	Maximum		33.56	47.62	66.21	71.83	92.52	
	Minimum		20.41	37.19	50.79	54.42	61.68	

[a,b]Means in the same column with different superscripts differ ($p<0.05$)

Table 6: Average daily feed consumption (kg)

Treatments	1st month	2nd month	3rd month	4th month	5th month	Overall average
Non-extruded beans	0.54					
Extruded beans	2.97	4.36	5.11	3.57	-	4.00[a]
Peas	3.29	4.76	5.27	4.31	-	4.41[a]
Soybean meal	3.42	5.24	5.43	2.46	-	4.19[a]
Supplement	3.65	4.98	5.43	2.69	-	4.19[a]
Complete diet	3.55	4.97	5.43	3.31	-	4.31[a]
Bakery waste	9.09	11.47	9.33	7.95	9.15	9.40[b]

[a]Means within a column with a different superscript differ ($p<0.05$)

brown or dark black due to excreted stomach bile. Pigs in this treatment group lay with their noses in the corner most of the time. What feed they ate was the droppings they could reach from the adjoining pens. The non-extruded bean treatment was terminated out of concern for the welfare of these pigs. No difference in rate of growth was observed for any treatment except for those pigs fed bakery wastes. The bakery waste diet was inexpensive but pig performance was reduced by this treatment.

Table 6 lists average daily consumption of all rations fed by weigh period as well as the overall average. The pigs on the extruded soybeans required slightly less feed whereas the pigs on the bakery wastes required twice the amount of feed as compared to the remaining four treatment groups ($p<0.05$). However this is as fed rather than on an equal moisture basis. The non-extruded beans treatment, fed for only one month, was extremely unpalatable, as observed by the average of only 1.18 kg feed/pig/day as compared to 6-8 kg for the other grain-fed groups. Performance of the pigs on either the extruded dry bean, pea or the extruded soybean diets were comparable to either the diets formulated with commercial supplement or the complete commercial feed. These data agree with studies conducted by Henery and Bourdon[5]. Feed efficiency throughout the study is shown in Table 7. Although not statistically tested, it appeared that pigs in the non-extruded bean treatment ate as much or more than pigs in the other treatments for the first 28 days. In actuality, they ate very little and rutted the feed all over trying to find something to eat and actually lost weight. Pigs on the bakery wastes consumed a large amount at first and then they because selective, eating the filling and leaving the dough. Pigs on the bakery wastes gained better the first month or so after which the gains were markedly reduced in comparison to the other treatments Table 8. Although numerically lower, individual animal variation precluded detecting a significant difference. For treatment number two, it was difficult extruding the beans because of lack of fat in the beans. When the extruder did work the beans came out in ropes, which were crushed with a hammer. However, the pigs were able to sift and choose ration components. Treatments three, four, five and six were quite similar in feed consumed and rate of gain. These pigs enjoyed the rations and grew very well.

The pigs fed the commercial supplement had very firm feces. Pigs on the commercial ration had more grain in their fecal material. This group had the lowest feed efficiency (3.11 kg) except for the bakery waste treatment. Half-way into the first month, the pigs in treatment

Table 7: Feed efficiency (feed to gain ratio)

Treatments		1st Month	2nd month	3rd month	4th month	5th month	Over all
Non-extruded beans	Average	2.43					
	Maximum	3.83					
	Minimum	1.53					
Extruded beans	Average	2.12	1.65	1.55	2.27		1.96[a]
	Maximum	2.10	2.02	1.81	3.27		
	Minimum	1.16	1.33	1.32	2.69		
Peas	Average	1.46	2.09	1.66	2.42		1.90[a]
	Maximum	1.90	2.57	2.14	2.61		
	Minimum	1.20	1.57	1.30	2.27		
Soybean meal	Average	1.34	1.75	1.69	2.79		1.89[a]
	Maximum	1.55	2.02	1.85	2.40		
	Minimum	1.19	1.47	1.53	2.12		
Commercial	Average	1.61	1.73	2.03	3.11		2.12[a]
Supplement	Maximum	1.85	2.63	2.47	4.54		
	Minimum	1.34	1.32	1.56	2.27		
Commercial	Average	1.35	2.07	1.71	1.29		1.60[a]
Complete	Maximum	1.57	2.63	2.14	2.57		
Diet	Minimum	1.12	1.64	1.46	1.07		
Bakery waste	Average	2.19	4.28	5.44	13.57	1.95	5.48[b]
	Maximum	2.60	6.80	9.46	18.63	2.41	
	Minimum	1.61	2.64	3.50	9.57	1.69	

[a,b]Means in the same column with different superscripts differ ($p<0.05$)

Table 8: Daily rate of gain (kg)

Treatments		1st Month	2nd month	3rd month	4th month	5th month	Over all
Non-extruded beans	Average	-.06					
	Maximum	-.14					
	Minimum	-.06					
Extruded beans	Average	0.47	0.67	0.83	0.80		0.69[a]
	Maximum	0.61	0.83	0.96	1.29		
	Minimum	0.08	0.55	0.70	0.39		
Peas	Average	0.61	0.58	0.81	0.68		0.67[a]
	Maximum	0.74	0.73	1.04	0.83		
	Minimum	0.42	0.48	0.39	0.51		
Soybean meal	Average	0.68	0.74	0.81	0.60		0.71[a]
	Maximum	0.75	0.89	0.89	0.79		
	Minimum	0.59	0.65	0.73	0.39		
Commercial	Average	0.61	0.75	0.69	0.73		0.70[a]
Supplement	Maximum	0.72	0.93	0.87	0.76		
	Minimum	0.48	0.48	0.55	0.70		
Commercial	Average	0.71	0.62	0.80	0.83		0.74[a]
Complete	Maximum	0.80	0.74	0.86	0.94		
Diet	Minimum	0.63	0.48	0.63	0.39		
Bakery waste	Average	0.52	0.48	0.80	0.43	0.43	0.53[a]
	Maximum	0.70	0.62	0.85	0.47	0.55	
	Minimum	0.44	0.32	0.75	0.40	0.22	

[a]Means in the same column with different superscripts differ ($p<0.05$)

Table 9: Bakery wastes nutritional information

Analysis	Based on 170 g sample (%)
Protein	3
Moisture	37
Fat	16
Carbohydrates	43
Ash	1

Table 10: Composition of pie and usda recommended daily allowances for humans

Serving size, 114 g	Pie	Percent of USRDA*
Calories	365	-
Protein, g	3	6.6
Vitamin A, IU	670	1.3
Vitamin C, mg	15	24.1
Vitamin B, mg	0.01	0.9
Vitamin B_2, mg	0.03	1.9
Niacin, mg	3.0	15.1
Calcium, mg	0.07	6.7
Iron, mg	1.6	8.9

*United States Recommended Daily Allowance

number seven were fed bakery wastes free choice until the third month, at which time they were given only bakery wastes. Twenty-eight days later they were again fed a 36% protein supplement free choice. Tables 9 and 10 give nutritional information for the bakery wastes. With the carbohydrate-protein imbalance or low protein of this waste product, the pigs put on fat rather than muscle. When the bakery wastes were first put in front of them they consumed a great deal, but after a few days the pigs balanced out their diet. When the pigs were restricted to bakery wastes they ate mainly the filling.

General carcass data: Carcasses were fabricated after slaughter and carcass data were analyzed. Table 11 shows the days to market, market weight, shrunk weight, hot

Table 11: Carcass cooler traits

Treatment	Days to Market	Market Wt, Kg	Shrunk Wt, Kg	Hot Carcass Wt, Kg	Cold Carcass Wt, Kg	Dressing Percent (%)
Extruded Beans	111[a]	91.68[a]	87.60[a]	67.59[a]	62.66[a]	77.25[b]
Peas	109[a]	91.22[a]	87.51[a]	68.91[a]	63.11[a]	78.75[b]
Soybean meal	101[a]	98.47[a]	93.41[a]	71.11[a]	66.56[a]	76.13[b]
Commercial supplement	110[a]	91.27[a]	87.51[a]	65.52[a]	60.29[a]	74.88[b]
Commercial diet	108[a]	93.20[a]	89.41[a]	69.52[a]	64.02[a]	77.75[b]
Bakery wastes	127[b]	79.82[a]	74.62[a]	64.05[a]	59.20[a]	85.83[a]

[a,b]Means within the same column with different superscripts differ ($p<0.05$)

Table 12: Carcass cutout data

Treatment	Length Cm	Backfat Cm	Loineye Area, Cm^2	Ham and Loin, %	Lean Cuts, %	Firmness[1]	Color[2]
Extruded beans	12.22	0.51	2.26	39.81	58.56	3.00	3.00
Peas	12.30	0.53	1.97	38.71	56.65	2.75	2.75
Soybean meal	12.23	0.53	2.09	39.35	57.20	2.75	2.63
Commercial supplement	12.22	0.50	2.13	42.40	57.90	2.87	3.00
Commercial diet	12.24	0.55	2.06	38.52	56.60	2.63	2.87
Bakery wastes	11.96	0.57	1.81	36.28	54.22	3.00	2.80

Means within a column with different superscripts differ ($p<0.05$)

carcass weight, cold carcass weight and dressing percent. According to USDA grading of pork, the carcass must meet the following criteria:

- Firmness of fat and lean,
- Color of the lean,
- Feathering in the ribcage,
- Belly thickness.

All pigs were acceptable for the U.S. #1 grade except for some of the pigs in the bakery wastes treatment. This could be expected because of the amount of carbohydrates given to them and the restriction of the protein supplement at different intervals during the study. Although some pigs in the bakery wastes treatment graded U.S. #2, there was no significant difference ($p>0.05$) from the other treatments.

Days to market differed significantly between groups ($p<0.05$). Pigs fed bakery wastes required more than two additional weeks on feed, even at the lower harvest weight. There were no differences in the market or shrunk carcass weights ($p>0.05$). This would suggest that cull peas or extruded beans can be used as a source of supplemental protein in swine growing and fattening diets. Pigs fed bakery wastes dressed significantly higher ($p<0.05$). This difference is explained by the pigs being significantly fatter and also because of possible lighter stomachs due to less fiber and a higher energy-dense feed. The pigs on this diet may also have had less gastrointestinal contents due to the laxative effect of the bakery wastes.

Table 12 shows comparisons of the general cutout data. Although not significantly different, ($p>0.05$) bakery wastes produced a lighter market weight pig with more fat with a tendency to have a lower percent ham and loin and/or the percent lean cuts.

Table 13: Ingredient costs

Ingredients	US $ per kg
Barley	0.10
Wheat	0.10
Soybean	0.26
Peas	0.11
Beans	0.07
Soybean oil	0.71
Premix	0.55
Salt	0.02
Calcite	0.03
Dicalcium phosphate	0.24
Methionine	4.41
Commercial supplement	0.30
Commercial complete diet	0.19

Economic evaluation of rations: Table 13 shows the cost per kilogram of all nutrients that were used in the treatments of this study. Table 13 shows the cost per kilogram of gain which agrees with previous studies where pigs on non-extruded beans restricts growth[6]. Table 14 illustrates costs of diets and profit margins for pigs fed the various treatment diets. There was a significant difference between the cost of feed for each treatment ($p<0.05$). As shown in the first column of Table 14, the cost of the commercial ration is about twice that of the other treatments. The other rations are between 250-395% more profitable than the commercial ration. Bakery wastes would be a good energy source if the supply and cost were in line. However, a protein supplement and a mineral and vitamin premix would be advisable for optimal performance if a person was feeding bakery wastes. It would probably also be advisable to include some grain in the diet. The overall profit margin for each treatment was based on the carcass weight and the carcass price. These data show a good return on investment with the inclusion of cull feeds in the diet.

Table 14: Costs and margins (US $)

Treatment	Cost of feed Per Kg*	Cost of gain Per Kg*	Total feed Cost*	Cost of feeder Pig, head	Total cost Per head**	Carcass Value	Gross profit Per head***
Extruded beans	0.1973	0.3868	28.45	20.00	48.45	88.86	40.41
Peas	0.1266	0.2405	17.62	20.00	37.62	89.42	51.80
Soybean meal	0.1928	0.3644	29.10	20.00	49.10	89.97	40.87
Comm. Supplement	0.1882	0.3990	21.15	20.00	41.15	87.16	46.01
Comm. diet	0.4826	0.7722	57.42	20.00	77.42	90.54	13.12
Bakery wastes	0.0400	0.2192	34.17	20.00	55.49	88.29	32.80

*Treatments differ ($p<0.05$). **Does not include labor or pen charges. ***Does not include non-extruded bean diet

DISCUSSION

Miller[6] reported Michigan is the number one producer of dry beans (navy beans) in the United States. Each year in Michigan many tons of off-quality and cracked beans are culled from the 60 million dollar dry bean industry. When compared to soybeans, navy beans are much lower in total protein 23% and fat 1.4% but have more carbohydrate (57% NFE). They lack the sulfur-containing amino acids to balance the methionine-cystine deficiency of corn, but have a fair amount of other essential amino acids. Like soybeans, beans contain the trypsin inhibitor, thus requiring heating to control the inhibiting action and to increase palatability. Thus, cooked cull beans used for swine in the past have served more as a replacement for grain than as a protein supplement. The comparative nutritive values of soybean meal, whole soybean and dry beans are listed in Table 3. Miller[6] also stated that dry beans were not well utilized by growing and finishing pigs. Whether the poor utilization of cull beans was due to inadequate cooking or was the result of nutritional quality of cull beans has yet to be resolved.

The nutrient requirements and amino acids for growing and finishing swine are shown in Table 4. Thomas and Kornegay[7] showed corn and extruded soybeans were comparable to soybean meal for growing and finishing swine diets. It was found that the growth rate and feed consumption was higher for the corn-soybean meal ration. Miller[6] reported the value of heated whole soybeans for swine. Until recently, such a practice was limited because it caused softness of carcass fat. With the selection of pigs with more muscle and less fat, the problem may be minimized. Henery and Bourdon[5] used tryptophan supplements of 0.15 and 0.30% to study growth and carcass composition of swine. At the 0.15% level there was little effect on the growth performance, while at the 0.30% level leaner carcasses were found as indicated by less backfat. Because of the low level of tryptophan present, the amino acid imbalance was corrected by using more soybean meal. This study stressed the importance of adequate amounts of the essential amino acids during the early phase of growth. Henery and Bourdon[5] reported the true digestabilities of the different amino acids from whole and dehulled field beans were similar. The pattern of amino acid digestibility was almost identical. The digestibility of arginine was highest of the amino acids followed by histidine.

Henery and Bourdon[6] reported that when pigs were fed 32-36% beans in the diet, efficiency and growth performance were greatly depressed, especially during the early phase of growth. Henery and Bourdon[5] also showed that when beans were reduced to 15% of the diet there was little or no effect on growth performance. However, at the beginning of the growth stage, pigs showed a lower daily gain. Beans and peas are low in methionine and lysine. They are also somewhat low in the amount of tryptophan. Diets supplemented with 0.3% DL-methionine have caused enlarged pancreases in chicks and rats, but not in pigs. Species differ in response to raw soybeans.

Yen *et al*.,[8] proposed that the trypsin inhibitor stimulates the pancreas to secrete excessive amount of the digestive enzymes, which are not totally absorbed, thus causing slower growth. Similar reactions occur in the chick. Intestinal proteolysis is inhibited because pancreatic secretions are not adequate to counteract the effect of soybean trypsin inhibitor. Pancreatic trypsin activity was significantly greater in pigs fed raw soybean than those fed either SBM or Soybean Trypsin Inhibitor (SBTI). Intestinal trypsin and chymotrypsin activities were significantly reduced by SBTI and raw soybean. Yen *et al*.,[8] also reported that in the rat and chick you get an en1argement of the pancreas which is believed to be the result of pancreas secretions. Yen *et a1*.,[8] concluded that feeding raw soybeans reduces feed intake and growth in swine. The pancreatic enzyme secretion is regulated in the duodenum. A so-called Bowmanbeuk inhibition has been isolated from the raw soybean. It has a more potent chymotrypsin-inhibiting effect than SBTI. Dietary methionine did not correct growth inhibition in the pig. The pancreas did not enlarge and continuous feeding of raw soybean did not stimulate pancreatic enzyme synthesis. It was thus suggested by Yen that growth inhibition in pigs fed raw soybean is different from that of the growing rat and chick. Yen *et a1*.,[9] reported that in the rat and chick growth inhibition was believed to result from excess loss of cystine in SBTI stimulated pancreas secretion. This is supported by the fact that SBTI increases the conversion of methionine to cystine in the pancreas and dietary methionine can counteract the inhibiting effect. In the chick, under six weeks of age, raw soybean causes an excessive pancreatic secretion and intestinal pancreatic trypsin whereas chymotrypsin activities were reduced.

Henery and Bourdon[5] reported that beans and peas are low in methionine, lysine and tryptophan. Field beans and peas can be used in feeding pigs if these amino acids are supplemented, particularly tryptophan, which appears to be the second limiting factor. Froseth *et al*.,[10] suggested that methionine supplementation of swine rations in which cull peas provide most or all of the supplemental protein is essential for optimum pig performance, especially up to 57 kilograms of body weight. Addition of both methionine and lysine to low protein diets in which all supplemental protein is supplied by cull peas is essential for optimal pig performance.

Froseth *et al*.,[11] used cull peas to replace one-half of the soybean meal in the ration. Supplemental methionine and lysine were added and compared to non-supplemented rations. Pigs fed the supplemental methionine and lysine gained faster and more efficiently than those without. The ration with the additional methionine increased rate of gain during both grower phases (19 to 34 and 34 to 56.6 kg), but had no effect during the finishing phase. The calculated dietary levels of methionine plus cystine in supplemented diets were 0.46 and 0.40% compared to: 0.31 and 0.30% in unsupplemented diets. The results of this study suggest that methionine supplementation of swine rations containing cull peas supplied adequate protein for optimum rate of gain performance, especially up to 57 kg body weight. Pigs fed the low protein diet gained less rapidly and less efficiently over the total feeding period. The addition of methionine and lysine increased comparative weight gains ($p<0.05$) and ($p<0.01$), respectively but was of questionable benefit over the entire feeding period. However, using both methionine and lysine increased feed efficiency ($p<0.05$). Addition of both methionine and lysine to the low protein diets in which all supplemental protein was supplied by cull peas was essential for optimum pig performance.

CONCLUSION

A swine producer needs to consider the cost of weaned pigs, feed costs, overhead costs, whether he mixes his own feed or has it commercially prepared, interest costs and all other factors which are unique to his operation before making a decision regarding what diet to feed. Cull peas and beans may be a profitable alternative to soybean meal in swine diets. Bakery wastes may also be used if properly balanced with adequate protein and sufficient grain.

REFFERENCES

1. Church, D.C., 1977. Livestock Feeds and Feeding, O and B Books, Corvallis, OR, pp: 328-330.
2. NRC, 1979. Nutrient requirements for swine. National Academy of Science. National Research Council, Washington, D.C.
3. National Pork Producers Council, 1982. Procedures to evaluate market hogs.
4. Ott, L., 1977. An Introduction to Statistical Methods and Data Analysis. 2nd Edition. P.W.S. Publishers, Boston, MA.
5. Henery, Y. and D. Bourdon, 1976. Utilization of legume seeds, field beans and peas by the pig. World Rev. Anim. Prod., 14: 81-87.
6. Miller, E.R., 1975. Extruded soybeans for growing-finishing swine. Res. Rep. Mich. State Univ. Agric. Exp. Stn., 289: 66-69.
7. Thomas, H.R., E.T. Kornegay, 1975. Evaluation of roasted corn and soybeans for swine. Res. Div. Rep. Va. Polytech Inst. and State Univ. Res. Div., 163: 190-192.
8. Yen, J.T., A.H. Jensen and J. Simon, 1977. Effect of dietary raw soybean and soybean trypsin inhibitor or trypsin and chymotrypsin activities in the pancreas in the small intestinal juice for growing swine. J. Nutr., pp: 107-156.
9. Yen, J.T., T. Hympwitz and A.H. Jensen, 1974. Effects of soybean of different trypsin-inhibitor activities on performance of growing swine. J. Anim. Sci., 38: 304-309.
10. Froseth, J.A., 1976. Methionine and lysine supplementation of cull pea diets for swine. Proc. West. See. Amer. Soc. Anim. Sci., pp: 27-123.
11. Froseth, J.A., 1975. Utilization of peas in swine rations. Spec. Rep. Oregon State Univ. Agric. Exp. Stn., 447: 34-44.