NUTRITIVE VALUE OF SUNFLOWER SEED FOR SWINE

by

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INTRODUCTION

Dramatic changes have taken place in the swine industry within the last decade. Genetic improvement has resulted in a leaner, faster gaining, more efficient type of hog being produced today. Considerable research has been conducted to reevaluate the protein (amino acid) requirements, energy needs, energy-protein relationships, and vitamin and mineral requirements as they effect growth and body composition.

Research is also being conducted to evaluate the potential of new feeds available to the pork producer. New varieties of cereal grains and new crops are continually being developed. In many instances the principal use of these crops is in livestock feeding. Recent years have demonstrated that genetically superior feedstuffs can be produced. Corn hybrids have been modified through the introduction of genes which affect amino acid composition. Triticale, a cross between wheat and rye, is nutritionally superior as a livestock feed to either parent. Endosperm composition of corn and sorghum grain can be genetically modified to improve its nutritive value as a feedstuff. Additionally, new crops are continaully being developed which need to be evaluated as potential livestock feeds.

These experiments were conducted to determine the nutritive value of sunflower seed for growing and finishing swine, determine its apparent digestibility and its effects on carcass fatty acid composition.

REVIEW OF LITERATURE

Limited research has been conducted to evaluate the nutritional value of sunflower seed for swine. Sunflower seed was compared with tankage as a protein supplement for fattening pigs weighing over 45 kg by Weaver (1921). The ration composed of equal parts of sunflower seed and corn compared favorable with a ration containing 10 parts corn to 1 part tankage. Both treatments were supplemented with minerals free-choice.

Sunflower seed meal is a by-product produced upon extraction of sunflower seed oil, and is available for use as a livestock feed. Cunha (1957) reported that sunflower seed meal could not be used as the only protein supplement but could be used to supply 20 to 30% of the protein supplement in the diets of growing-finishing swine. Rose, Coit and Sell (1972) reported sunflower seed meal could replace 50% of soybean meal without adversely affecting hens performance, but 100% replacement adversely affected egg production and feed efficiency. Seerley et al. (1974) working with expeller processed (heated to 127 C) sunflower seed meal reported depressed gains with 50 or 100% replacement of soybean meal with sunflower seed meal in diets of growing swine. Replacing 25% protein with sunflower seed meal did not reduce gains but increased feed per unit of gain. Addition of 0.3% L-lysine monohydrochloride to sunflower seed meal diets improved gains and feed per unit of gain.

Sunflower seed is a rather unique feedstuff in that it contains a high fat content (33%) and a high fiber content (15%). The substitution of sunflower seed for common swine feedstuffs increases the fat, protein and fiber content of the diet while the calorie:protein ratio remained relatively constant. Numerous experiements have shown increased caloric content of swine diets result in decreased daily feed consumption and improved efficiency of gain (Noland and Scott, 1960; Clawson et al., 1962; Kuryvial, Bowland and Berg 1962; Lowrey et al., 1962; Wagner et al., 1963; Greeley, Meade and Hanson 1964a; Greeley et al., 1964b; Hale, Johnson and Warren 1968; Allee et al., 1971c; Allee and Hines, 1972; Allee et al., 1972). Increases in backfat thickness and intramuscular fat on diets containing added fat have been reported by (Noland and Scott, 1960; Wagner et al., 1963; Greeley et al., 1964b; Allee et al., 1971c; Allee et al., 1972). Fatty acid composition of backfat and intramuscular fat may also be altered by dietary fat source and quantity (Mason and Sewell, 1967; Jurgens et al., 1970; Brooks, 1971). Additions of fat to diets generally increase ether extract digestibility while having no effect on protein digestibility (Clawson et al., 1962; Lowrey et al., 1962; Greeley et al., 1964a; Boenker, Tribble and Pfander 1969).

The importance of a constant calorie:protein ratio has been demonstrated by Clawson et al. (1962), Allee, Baker and Leveille (1971b) and Allee and Hines (1972).

It has been shown that as the calorie:protein ratio widens, daily gains may be reduced on rations deficient or marginal in protein.

Several experiments have shown that increasing the fiber content of swine rations, with various fiberous feedstuffs, results in decreased daily gain and decreased efficiency of gain (Bohman, Hunter and McCormick 1955; Hochstetler et al., 1959; Pond, Lowrey and Maner 1962; Baird, McCampbell and Allison 1970). Decreased nutrient digestibility was also reported by (Lloyd and Crampton, 1955; Pond et al., 1962; Boenker et al., 1969) with increased dietary fiber.

EXPERIMENTAL PROCEDURE

General

In the growth trial, pigs were housed in an environmently controlled nursery with 5 pigs in a 1.83 x 3.35 meter concrete slotted floor pen. Feed and water were supplied ad libitum. Initial and final weights were recorded and daily gain, feed efficiency and daily intake were determined at the end of the 21 day trial.

In the digestion trial, pigs were housed individually in metabolism cages allowing for separate collection of feces and urine. Daily feed intake was constant for each replication and was fed in two equal portions. Fresh water was supplied at each feeding. A pre-test period of at least 5 days preceded each collection period. A ferric oxide marker was fed at the beginning and end of each collection period. Feces were collected daily and stored in a freezer. The entire fecal collection was dried in a forced air oven, weighed and ground in a Wiley mill equipped with a 40-mesh screen. Urine was collected in plastic containers to which 20 ml of concentrated HCl had been added. Each daily collection was diluted to a constant volume of 2 liters and 100 ml aliquot taken. Accumulated aliquots were stored in a refrigerator until analyzed. Representative sunflower seed, feed, fecal and urine samples were analyzed in duplicate for nitrogen as outlined by A.O.A.C. (1970). Sunflower seed, feed and

fecal samples were analyzed in duplicate for dry matter, ether extract and energy as outlined by A.O.A.C. (1970).

In the finishing trial, pigs were housed in a modified open front building enclosed with polyethelene with supplemental heat provided by catalytic heaters. Five pigs were confined in 1.83 x 4.56 meter pens on concrete slotted floors. Feed and water were supplied ad libitum. Initial, final, and biweekly weights were recorded, daily gain, feed efficiency and daily intake were recorded, daily gain, feed efficiency and daily intake were determined biweekly and at the time pigs reached market weight at approximately 100 kilograms. Seven pigs per treatment were slaughtered at approximately 100 kilograms. Backfat and longissimus dorsi samples were taken and analyzed for fatty acid composition and total lipids.

A randomized complete block design was used in all experiments. Analysis of variance (Snedecor and Cochran, 1971) and Duncans New Multiple Range Test (Steel and Torrie, 1969) were used to test for statistical significance.

All diets were formulated to meet NRC (1968) requirements for the growing or finishing pig, and were fed in pellet form.

Sunflower seeds (table 1) were added on an isolysine basis, with 10 parts sunflower seeds replacing 8 parts corn and 2 parts soybean meal.

Trial 1. A growth trial was conducted using 60 Yorkshire barrows and gilts averaging 21.9 kilograms. Pigs were allotted according to weight, sex and sire to

TABLE 1 PROXIMATE, AMINO ACID ANALYSIS AND FATTY ACID COMPOSITION OF SUNFLOWER SEED

Proximate analysis[a] %	
Dry Matter	92.44
Ether Extract	33.96
Crude Fiber	14.97
Ash	4.45
Protein	19.39
Calcium	0.15
Phosphorus	0.50

Fatty Acid Composition[b] %	
Myrixtic (C 14)	0.08
Palmitic (C 16)	6.96
Palmitoleic (C 16:1)	0.23
Stearic (C 18)	5.14
Oleic (C 18:1)	13.71
Linoleic (C 18:2)	72.93
Higher	0.91
Saturated	12.18
Unsaturated	86.87

Amino Acid Analysis[a] %	
Alanine	0.84
Valine	0.92
Glycine	1.11
Isoleucine	0.70
Leucine	1.27
Proline	0.83
Threonine	0.63
Serine	0.70
Methionine	0.30
OH-Proline	0.07
Phenylalanine	0.86
Aspartic Acid	1.72
Glutamic Acid	3.76
Tyrosine	0.47
Lysine	0.77
Histidine	0.49
Arginine	1.34
Tryptophan	0.32
Cystine	0.17

[a]Values expressed as a percent of the sample. Dry matter of sample was 92.44 percent.

[b]Values expressed as a percent of total lipid.

four treatment groups (table 2): (A) control, (B) 20% sunflower seed, (C) 40% sunflower seed and (D) 60% sunflower seed. The control ration was a 16.5% protein corn-soybean meal diet containing a calculated lysine content of 0.81 percent. The trial consisted of 5 pigs per pen, was replicated three times, and lasted 21 days.

Trial 2. A digestion study was conducted using 12 Yorkshire and Duroc barrows weighing an average of 17 kilograms. Three groups of four littermates were allotted to the four dietary treatments as in trial 1. Treatments within groups were randomly assigned and fed for one test period of 5 days, after which treatments were reallotted for a second period to provide a second replication. Daily intake was 1100 g for period one and 1300 g for period two.

Trial 3. A finishing trial was conducted using 30 Yorkshire barrows and gilts averaging 61.8 kilograms. Pigs were allotted according to weight, sex and sire to three treatment groups (table 3): (A) control, (B) 25% sunflower seed, (C) 50% sunflower seed. The control ration was a 14% protein corn-soybean meal diet containing a calculated lysine content of 0.63 percent. The trial consisted of 5 pigs per pen, was replicated and lasted until the pigs weighed approximately 100 kg at which time 7 pigs per treatment were slaughtered. Backfat measurements were taken at the first and last rib, and last lumbar vertebra. Samples of adipose tissue were taken from the

TABLE 2 COMPOSITION OF DIETS (TRIALS 1 AND 2)

Ingredients	Diets			
		Sunflower Seed		
	Control	20%	40%	60%
Corn	73.8	58.0	42.1	26.2
Sunflower Seed	0.0	20.0	40.0	60.0
Soybean Meal	22.2	18.2	14.2	10.2
Dicalcium Phosphate	1.5	1.3	1.0	0.9
Limestone	1.0	1.0	1.2	1.2
Salt	0.5	0.5	0.5	0.5
Vitamin, trace mineral and antibiotic premix	1.0	1.0	1.0	1.0
	100.00	100.00	100.00	100.00
Analysis (Determined)				
Dry Matter, %	85.7	90.5	89.1	90.3
Protein, %	16.7	17.9	18.1	19.5
Ether Extract, %	1.6	7.0	12.1	14.9
Gross Energy, cal/gm[b]	3832	4447	4715	5047
Analysis (Calculated)				
Lysine, %	0.81	0.81	0.82	0.81
Fiber, %	2.8	5.3	8.0	10.1
Calcium, %	0.80	0.81	0.82	0.80
Phosphorus, %	0.60	0.60	0.59	0.60

[a]Supplied as 4400 IU Vitamin A; 330 IU Vitamin D_3; 0.03 mg Vitamin B_{12}; 96.8 mg Choline Chloride; 29 mg Niacin; 9.7 mg Riboflavin; 19.6 mg d-pantothenic acid; 4840 IU Vitamin E; 110 mg chlortetracycline and sulfamethazine and 55 mg penicillin per kg of diet. Trace mineral addition to complete diet in ppm: Zinc -- 100, Iron -- 50, Manganese -- 27.5, Copper -- 5.5, Iodine -- 0.75, Cobalt -- 0.5.

[b]Values may be slightly lower than actual content due to absorption of fat by paper bags used in storage.

TABLE 3 COMPOSITION OF DIETS (TRIAL 3)

Ingredients	Diets		
		Sunflower Seed	
	Control	25%	50%
Corn	81.7	61.9	41.9
Sunflower seed	0.0	25.0	50.0
Soybean meal	15.0	10.0	5.0
Dicalcium Phosphate	1.0	0.8	0.6
Limestone	0.8	0.8	1.0
Salt	0.5	0.5	0.5
Vitamin, trace mineral and antibiotic premix	1.0	1.0	1.0
	100.00	100.00	100.00
Analysis (calculated)			
Protein, %	14.0	14.8	15.7
Lysine, %	0.63	0.63	0.63
Ether Extract, %	3.3	11.0	18.7
Fiber, %	2.5	5.6	8.6
Calcium, %	0.59	0.58	0.61
Phosphorus, %	0.49	0.50	0.50

[a]Supplied per kg of diet: 3300 IU Vitamin A, 330 IU Vitamin D_3, 0.01 mg Vitamin B_{12}, 97 mg Choline Chloride, 29 mg Niacin, 9.7 mg Riboflavin, 19.6 mg d-pantothenic acid, 4840 IU Vitamin E. Added to complete diet: Tylosin -- 20 g, Zinc -- 50 ppm, Iron -- 25 ppm, Manganese -- 13.75 ppm, Copper -- 2.75 ppm, Iodine -- 0.37 ppm, Cobalt -- 0.25 ppm.

outer layer of backfat over the shoulder for fatty acid analysis. Longissimus dorsi samples were taken from the 10th to 14th ribs. Backfat and longissimus dorsi samples were taken after carcasses had chilled, and were frozen until analyzed. Total lipid of the longissimus dorsi was determined by using the Soxlet Method of lipid extraction as outlined by A.O.A.C. (1970). Fatty acid composition was determined by gas-liquid chromatography. Extraction and methylation of backfat tissue for fatty acid analysis were performed by a modification of the methods of Sink et al. (1964) and Howard (1969). Extraction and methylation of longissimus dorsi tissues were performed by a modification of the methods of Books (1967) and Howard (1969). Fat and longissimus dorsi lipid methyl esters were injected into a Beckman GC-4 gas chromatograph equipped with a hydrogen flame detector heated to 270 C. The column was a 2.44 meter by 0.32 cm stainless steel tubing, which was packed with 7.5% diethylene glycol succinate coated on 70-80 mesh chromosorb G, DMCS treated and acid washed. Determinations were made isothermally at 180 C with a nitrogen gas flow of 10 psi. Peak areas for myristic (C 14:0), palmitic (C 16:0), palmitoleic (C 16:1), stearic (C 18:0), oleic (C 18:1), linoleic (C 18:2), and higher methylated fatty acids were determined by triangulation (peak areas = height x width at one-half the height). The percentage of each fatty acid was determined from the peak areas.

RESULTS AND DISCUSSION

Trial 1. The addition of sunflower seed to the diet of growing pigs resulted in a linear ($P<.05$) decrease in feed intake as the level of sunflower seeds in the diet increased (table 4). Replacement of corn and soybean meal with sunflower seeds increased the caloric density of the diet and therefore decreased feed consumption. Energy intake was similar for all treatment groups. It is well established that feed intake decreases as calorie content of the diet increases (Noland and Scott 1960; Clawson et al., 1962; Kuryvial et al., 1962; Lowrey et al., 1962; Wagner et al., 1963; Greeley et al., 1964a; Greeley et al., 1964b; Allee and Hines, 1972). Decreased intake was also reported with increasing levels of protein in the diet by Greeley et al., (1964a), Greeley et al. (1964b) and Wagner et al.(1963).

The crude fiber content of 40 (8.0%) and 60% (10.1%) sunflower seed rations exceded the 6.57% optimum level for growth as reported by Axelsson and Eriksson (1953). Daily intake did not increase with increasing levels of crude fiber as reported by Dinnusson et al. (1961); Axelsson and Exiksson (1953); and Baird et al. (1970). The increased calorie value of the 40 and 60% sunflower seed diets probably offset the expected increase in feed intake of these high fiber diets. Similar results have been reported by Seerley, Poley and Wahlstrom (1964) in which the addition of 4 or

TABLE 4 PERFORMANCE OF GROWING PIGS[a]

Diets	Daily Gain (kg)	Feed/Gain[b]	Feed Intake (kg)	Calorie/Protein[c]
Control	0.73[d]	2.33[d]	1.70[d]	23
20% Sunflower seed	0.70[d]	2.21[e]	1.55[e]	25
40% Sunflower seed	0.65[e]	2.12[ef]	1.38[f]	26
60% Sunflower seed	0.68[d]	2.06[f]	1.40[f]	26

[a]15 pigs per treatment averaging 21.9 kg initially.

[b]Feed/gain and feed intake are pen means, 5 pigs per pen and three pens per treatment.

[c]Calculated as gross kcal per gram of protein in the diet.

[def]Means with different superscripts within a column are statistically different ($P<.05$).

8% yellow grease to a corn-oat ration resulted in an 8.5% reduction in feed intake.

Replacement of corn and soybean meal by sunflower seed had no significant effect on daily gain at the 20 and 60% level. However at the 40% level the pigs gained significantly ($P<.05$) slower. This is likely the result of the 40% group being deficient in daily protein intake, because of decreased feed intake without a sufficient increase in dietary protein.

Pigs on the 40% sunflower seed diet consumed a daily average of 250 g protein where as pigs on the control, 20 and 60% diet consumed 284, 277 and 273 g respectively. Feed required per unit of gain significantly ($P<.05$) decreased as the sunflower seed increased the calorie content of the ration. Numerous experiments have demonstrated improved feed efficiency when fat is added to the diet (Noland and Scott 1960; Clawson et al., 1962; Kuryvial et al., 1962; Lowrey et al., 1962; Wagner et al., 1963; Greeley et al., 1964; Seerley et al., 1964; Hale et al., 1968; Allee, Baker and Leveille 1971a; Allee and Hines, 1972; and Allee et al., 1972).

Trial 2. Results of the digestion trial are presented in table 5. Replacing corn and soybean meal in the diet of growing pigs with 20, 40 or 60% sunflower seed, although increasing the calorie density, protein and fiber content of the diet, had little effect on apparent digestibility of protein or nitrogen retained. Clawson et al. (1962)

TABLE 5 INFLUENCE OF LEVEL OF SUNFLOWER SEEDS ON NITROGEN RETENTION, ETHER EXTRACT AND ENERGY DIGESTIBILITY (TRIAL 2)

Item	Diets			
		Sunflower Seed		
	Control	20%	40%	60%
Daily Nitrogen, g				
Intake	37.55	37.90	39.07	41.55
Urine	8.14	9.04	10.72	11.91
Feces	5.89	6.61	6.83	7.18
Retained	23.52	22.25	21.52	22.46
% Retained	62.60[c]	58.60[d]	55.00[e]	54.20[e]
% Digested	84.30	82.60	82.50	82.70
Daily Ether Extract, g				
Intake	22.80	96.13	163.68	197.76
Feces	7.59	12.85	17.19	20.25
Digested	15.21	83.28	146.49	177.51
% Digested	66.50[c]	86.70[d]	89.60[d]	89.70[d]
Daily Energy, Kcal				
Intake	5366	6106	6354	6711
Feces	625	846	1073	1199
Digested	4741	5260	5281	5512
% Digested	88.30[c]	86.20[d]	83.10[e]	82.20[e]

[a]All values expressed on a 100% dry matter basis.

[b]Six pigs per diet averaging 17 kg initially, intake, urine and feces are averages of Periods 1 and 2.

[cde]Values with different superscripts are statistically different ($P<.05$).

reported no significant influence by either calorie: protein ratio or level of fat in the diet on apparent digestibility of protein. Similarly, Pond et al. (1962) reported no difference in apparent digestibility of protein on high protein (18%), low fiber (5.3%) or high fiber (9.5%) diets. Percent nitrogen retained decreased linearly as the level of sunflower seed increased in the diet. However, protein digestibility was not influenced by level of sunflower seed in the diet.

Apparent digestibility of ether extract increased significantly ($P<.05$) as the level of sunflower seed in the diet increased to 20% and increased only slightly from 20 to 60%. This is in agreement with the findings of Clawson et al. (1962), Lowrey et al. (1962) and Boenker et al. (1969) who showed similar increases in digestibility with additions of animal fat and Eusebio et al. (1965) with additions of refined soybean oil, stabilized edible lard and tallow and coconut oil. However, the observed increase of apparent ether extract digestibility would be expected due to greater relative proportion of metabolic fecal fat of the pigs on the control diet.

Apparent digestibility of energy significantly ($P<.05$) decreased as sunflower seed increased in the diet to 40 percent. There was no significant difference in digestibility between the 40 and 60% level. Greeley et al. (1964a) reported an increase in energy digestibility with increasing levels of stabilized tallow in low fiber diets. Additions

of sunflower seed resulted in increased levels of fiber and therefore the energy digestibility was decreased. Pond et al. (1962) reported decreased energy digestibility on high fiber, high and low protein diets as compared to low fiber, high and low protein diets.

The apparent digestibility of sunflower seed is presented in table 6. The apparent digestibility of dry matter, energy and protein of sunflower seed was determined by the indirect method of determining digestibility as outlined by Crampton and Harris (1969). That equation being:

$$\text{Digestibility of sunflower seed} = \frac{100(\text{dig. of sunflower ration} - \text{dig. of control ration})}{\%\ \text{sunflower seed in ration}} + \text{dig. of control ration}$$

Digestibility of ether extract was determined by the following equation:

$$\frac{100(\text{gEE retained on sunflower seed diet} - \text{g retained from corn-soy portion})}{(\text{g provided from sunflower seed diet} - \text{g assumed provided by corn soy portion})}$$

Example:

$$100\frac{(78.3\text{g} - 10.6)}{(88.1 - 16.7)} = 93.4\% \quad \text{(assuming EE from control diet was 63\% digestible)}$$

The digestibility coefficients determined for ether extract may be in error due to the greater relative proportion of metabolic fecal fat of pigs on the control diet.

Trial 3. Replacing corn and soybean meal with 25 or 50% sunflower seed in the diet of finishing pigs significantly ($P<.05$) reduced average daily gain (table 7).

TABLE 6 APPARENT DIGESTIBILITY OF SUNFLOWER SEED[ab]

Digestibility of:	Average	% Sunflower Seed in Diet 20	40	60
Dry matter, %	68.8 ± 4.3	66.9 ± 6.0	69.3 ± 3.5	70.3 ± 2.4
Energy, %	76.9 ± 4.4	77.5 ± 6.9	75.2 ± 2.9	78.1 ± 2.0
Protein, %	79.0 ± 5.0	75.5 ± 6.6	80.0 ± 4.6	81.5 ± 1.5
Ether Extract, %	91.4 ± 2.9	91.5 ± 4.5	91.7 ± 2.4	91.2 ± 1.9

[a]Percent digestibility determined by the indirect method and expressed on a 100% dry matter basis.

[b]Values represent mean ± SEM of six pigs per diet averaging 17 kilograms.

TABLE 7 PERFORMANCE OF FINISHING PIGS[a] (TRIAL 3)

Diets	Daily Gain (kg)	Feed Gain[b]	Feed Intake (kg)
Control	0.80[c]	3.27[c]	2.65[c]
25% Sunflower seed	0.66[d]	3.39[c]	2.22[c]
50% Sunflower seed	0.69[d]	3.39[c]	2.33[c]

[a]10 pigs per diet averaging 61.8 kg initially.

[b]F/G and feed intake are pen mean, 5 pigs per pen and two pens per treatment.

[cd]Means within a column with different superscripts are statistically different ($P<.05$).

Reduced gain is probably a function of feed intake, which decreased as the sunflower seed increased, although this decrease was not significant. There were no significant differences in feed efficiency due to the addition of sunflower seed. Apparently, the fat content and fiber in sunflower seed were offsetting the effects of each other.

Average slaughter weight and backfat thickness on seven pigs per treatment respectively were: control group -- 103 kg and 3.5 cm; 25% sunflower seed -- 101 kg and 3.5 cm; 50% sunflower seed -- 100 kg and 3.3 cm. The fatty acid composition of sunflower seed is presented in table 1 and that of backfat and longissimus dorsi samples in table 8.

There was a significant ($P<.05$) increase in the unsaturation of backfat and longissimus dorsi lipid samples with each increase of sunflower seed in the ration. This substantiates the results of Brooks et al. (1971) that fatty acid composition of intramuscular fat as well as backfat can be significantly altered due to dietary fatty acid composition. This is in contrast with reports of Greer et al. (1965) and Koch et al. (1968) who reported that the saturated fatty acid content of intramuscular fat appeared to remain quite constant. As the level of sunflower seed increased in the diet there was a trend for fatty acids from C 14 to C 18:1 to decrease, while C 18:2 increased in both backfat and longissimus dorsi samples. Sunflower seed lipid was analyzed to be 72%

TABLE 8 FATTY ACID COMPOSITION OF BACKFAT AND LONGISSIMUS DORSI AS EFFECTED BY LEVEL OF SUNFLOWER SEED IN THE DIET[a]

Diets	FATTY ACID, PERCENT								
	Sat.	Unsat.	C 14	C 16	C 16:1	C 18	C 18:1	C 18:2	Higher
Backfat									
Control	40.4[b]	57.9[b]	1.10[b]	23,86[b]	3.13[b]	15.43[b]	40.10[b]	14.69[b]	1.65[b]
25% Sunflower seed	31.9[c]	66.2[c]	0.88[c]	18.79[c]	1.93[c]	12.24[c]	30.25[c]	34.00[c]	1.88[c]
50% Sunflower seed	26.8[d]	70.7[d]	0.71[d]	15.76[d]	1.90[c]	10.36[d]	28.24[c]	40.52[d]	1.87[c]
Longissimus dorsi									
Control	40.8[b]	59.1[b]	1.42[b]	26.95[b]	3.32[b]	12.46[b]	46.76[b]	9.06[b]	Not
25% Sunflower seed	35.8[c]	64.2[c]	1.47[b]	23.05[c]	2.73[d]	11.29[b]	36.15[c]	25.27[c]	Determined
50% Sunflower seed	28.8[d]	71.1[d]	1.03[c]	18.60[d]	2.00[d]	9.19[c]	31.03[d]	38.11[d]	

[a]Percentages are means of 7 samples per treatment.

[bcd]Means within a column with different superscripts are statistically ($P<.05$) different.

linoleic, and this acid significantly increased with each increase of sunflower seed in the diet. This would further indicate that fatty acid composition of intramuscular fat muscle and backfat is effected by diet. The data indicate that pigs fed sunflower seed are capable of producing pork and lard high in unsaturated fats. Koch et al. (1968) reported there was no significant difference for tenderness, juiciness, flavor, overall acceptability and Warner- Bratzler shear values for loin samples between pigs fed corn and soybean meal and pigs fed 10% safflower oil, although there was a slight tendency for safflower samples to be preferred over control samples. Therefore it seems possible to produce a highly unsaturated animal product equal in consumer acceptance to normally fed pigs.

Total lipid content of longissimus dorsi were as follows: control -- 2.18%, 25% sunflower seed -- 2.37% and 50% sunflower seed -- 2.93%. These values did not differ significantly, however there was a trend toward greater intramuscular lipid content as sunflower seed increased in the diet. The increase in muscle lipid may not be as great as would normally be expected because of the increase of fiber and protein as sunflower seed increased in the diet.

SUMMARY

Sunflower seed was evaluated as a feedstuff for growing and finishing swine. In all trials, 10% sunflower seeds replaced 8% corn and 2% soybean meal. Levels of replacement in the growth and digestion trials were 20, 40 and 60% sunflower seed. The addition of sunflower seed to the diet of growing pigs resulted in a linear ($P<.05$) decrease in feed intake. Replacement of corn and soybean meal by sunflower seed had no significant effect on daily gain at the 20 and 60% level. However, pigs fed the diet containing 40% sunflower seed gained significantly ($P<.05$) slower. Feed efficiency improved as increasing quantities of sunflower seed were added to the diet. In the digestion trial, grams of nitrogen digested and grams of nitrogen retained did not differ significantly ($P<.05$), however, percent nitrogen retained decreased ($P<.05$) linearly as the level of sunflower seed increased in the diet. Ether extract digestibility increased and energy digestibility decreased significantly ($P<.05$) as the level of sunflower seed increased in the diet. Apparent digestibility of sunflower seed was determined to be: dry matter -- 69 $\pm$ 4%, energy -- 77 $\pm$ 5%, ether extract -- 91 $\pm$ 3% and protein -- 79 $\pm$ 5%.

In the finishing trial sunflower seed replaced 25 and 50% of the control diet. Average daily gain was significantly ($P<.05$) higher for pigs fed the control diet than pigs fed either level of sunflower seed. Feed intake

decreased, though not significantly, as the level of sunflower seed increased in the diet to the 25% level. There was no significant difference in feed required per unit of gain. As the level of sunflower seed increased in the diet there was an increase in the total unsaturation of fatty acid content of both backfat and the longissimus dorsi. The most dramatic change taking place was the increase of linoleic acid from 14.7% to 34.0% to 40.5% for respectively the control, 25% and 50% sunflower seed diet for backfat samples, and from 9.0% to 25.3% to 38.1% respectively for longissimus dorsi samples. Backfat thickness did not differ significantly between treatments. There was a trend toward increasing amounts of intramuscular fat as the level of sunflower seed increased in the diet.

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NUTRITIVE VALUE OF SUNFLOWER SEED FOR SWINE

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AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

The nutritive value of sunflower seed for growing and finishing swine was evaluated in a series of three experiments. Ten parts sunflower seed replaced 8 parts corn and 2 parts soybean meal in all trials.

In the growth trial, 60 pigs averaging 22 kg were randomly assigned to diets containing 0, 20, 40 and 60% sunflower seed for a period of 21 days. As the level of sunflower seed increased in the diet, feed intake decreased significantly ($P<.05$). Daily gain decreased but reached significance only at the 40% level, and feed required per unit of gain decreased significantly at the 20 and 60% levels. In the digestion trial, 12 pigs averaging 17 kg were assigned to diets employed in trial 1. As the level of sunflower seed increased, the percent nitrogen retained decreased significantly, while the percent nitrogen digested remained constant. Ether extract digestibility increased significantly to the 20% level and remained constant thereafter, while percent gross energy digested decreased significantly to the 40% level. The apparent digestibility of sunflower seed was determined to be: dry matter -- 69 $\pm$ 4%, energy 77 $\pm$ 4%, protein -- 79 $\pm$ 5% and ether extract -- 91 $\pm$ 3%. In the finishing trial, 30 pigs weighing 62 kg were randomly assigned to diets containing 0, 25 and 50% sunflower seed. As sunflower seed increased, feed intake decreased slightly. Pigs fed the control diet gained significantly faster than

pigs fed diets containing 25 or 50% sunflower seed, while feed required per unit of gain did not differ significantly. Upon reaching slaughter weight, 7 pigs per treatment were slaughtered. Analysis of backfat and longissimus dorsi for fatty acid composition revealed a significant increase in unsaturation as the level of sunflower seed increased in the diet. There were no differences in backfat thicknesses between treatments. As the level of sunflower seeds increased in the diet there was a trend toward greater amounts of intramuscular fat in the longissimus dorsi.