PREPARATION OF MILO AND WHEAT

FOR GROWING-FINISHING SWINE

By

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CHAPTER I

INTRODUCTION

Milo is considered the traditional swine feed in Oklahoma, but recently wheat has been competitively priced with other cereal grains and used as a feed for swine. This has created the need for more information on the effect of substituting wheat for milo in growing-finishing swine rations.

The influence of different processing methods of milo and wheat rations for swine on performance and feed utilization have not been fully established. Research involving fineness of grind and effects of dry rolling, pelleting and reconstitution is needed in order to most efficiently utilize milo and wheat in growing-finishing swine rations.

Previously, researchers and swine producers in this state have indicated decreased rate of gain and/or decreased feed utilization when feeding milo and wheat to swine as compared to corn. Since these grains are of economic importance in Oklahoma and feed cost is approximately 75% of the cost of producing swine, improvement in the feeding value of these cereal grains is important.

The purpose of this study was to evaluate processing methods of milo and wheat fed to growing-finishing swine as related to daily gain, feed utilization and feed intake.

CHAPTER II

REVIEW OF LITERATURE

Feeding Value of Milo and Wheat for Swine

Hillier et al. (1954), Peo and Hudman (1958) and Jensen et al. (1959) reported that growing-finishing swine fed milo diets tended to gain slower and require more feed per pound of gain than pigs fed corn diets. Jensen et al. (1959) also suggested that, when substituted on an equal weight basis in diets having soybean meal as the supplementary protein, milo had a higher feeding value than did wheat, oats or barley.

Recent research by Gill et al. (1966) reported that growing-finishing swine fed Gaines wheat diets tended to gain slower and require more feed per pound of gain than pigs fed corn diets. Cromwell et al. (1969) utilizing 27 Yorkshire pigs found that growing pigs fed 16% and finishing pigs fed 13% crude protein, corn-soybean diets gained faster and required less feed per unit of gain than pigs fed corn-soybean meal diets substituted with either 50% or all wheat. Their daily gains and feed conversion ratios for the corn, 50% corn-50% wheat and wheat diets were: 1.94, 3.16; 1.88, 3.40; and 1.86, 3.35, respectively. The data suggested that wheat had approximately 95% of the feeding value of corn in diets for growing-finishing swine.

Jensen et al. (1965, 1967, 1969) found that milo and wheat rations, appropriately supplemented with protein and/or lysine, have each produced gain and feed conversion ratios similar to that of a 12% protein

corn-soybean meal diet. Hillier et al. (1955, 1956, 1957) found that adding soybean meal as a source of protein and/or lysine to a milo ration without a protein or amino acid supplement increased daily gain and feed efficiency of growing-finishing swine. Hale and Lyman (1961) increased daily gain and feed efficiency of growing-finishing swine by adding cottonseed meal and/or lysine to milo rations.

Luce et al. (1969) in a study involving 324 pigs concluded that hard red winter wheat tended to support gains similar to those of milo especially when equal amounts of supplemental protein were used. However, significantly more feed was required per pound of gain when wheat replaced all the milo. When only 50% of the milo was replaced with wheat, feed utilization was not appreciably affected. Daily gains and feed conversion ratios for the milo, 50% milo-50% wheat, wheat, 50% milo-50% wheat with additional protein supplement and wheat with additional protein supplement diets were: 1.68, 3.15; 1.68, 3.17; 1.61, 3.28; 1.76, 3.16; and 1.69, 3.28, respectively.

Danielson and Grabouski (1970) found that growing-finishing swine fed milo or wheat diets tended to gain faster and slower, respectively, than pigs fed corn diets. They also reported that a substitution of 33.3% or 66.7% of the milo portion of the diet with wheat did not apparently affect rate of gain. Pigs fed the all wheat diet had the lowest average daily gain. The feed efficiencies and average daily gains for the corn, milo, 66.7% milo-33.3% wheat, 33.3% milo-66.7% wheat and wheat diets were: 3.40, 1.93; 3.60, 2.04; 3.73, 1.93; 3.57, 2.03; and 3.46, 1.88, respectively. These data indicate that wheat and/or milo can be substituted in a balanced corn-soybean, growing-finishing swine diet. Results of this study are in agreement with

experiments by Jensen et al. (1959, 1967), Cromwell et al. (1969) and Luce et al. (1969).

The data available suggests that the feeding value of milo or wheat for swine is inferior to corn. Reports of chemical analyses on feeds by the National Academy of Science (1968) showed wheat and milo to be generally equal or superior to corn in crude protein and amino acid content. However, the nutrient composition, especially amino acid content, must be taken into consideration when formulating optimum wheat and milo rations for growing-finishing swine. It should be mentioned that in most studies milo and wheat have approximately 90 to 95% of the feeding value of corn.

A lower observed feeding value of milo and wheat could be the result of a lower protein or energy digestibility. At the present, most growing-finishing swine rations contain 75-80% cereal grains. The availability of starch, the chief energy source in these grains, is especially important since starch comprises approximately 70-75% of milo and wheat.

One method of improving starch availability and energy utilization of milo and wheat, thereby improving feed efficiency, is grain processing.

Processing Methods

In the last few years, research work has been conducted to reappraise the feeding value of grains for growing-finishing swine. Most of this work has involved grain processing, using rate of gain and feed efficiency as the criteria of evaluation. The latest studies have centered around the use of wheat in swine rations and reconstitution of

cereal grains for pigs.

The methods of processing considered in this report are grinding, dry rolling, pelleting and high moisture reconstitution. The available research data comparing methods of processing have been summarized to allow an evaluation of the different methods for swine.

Grinding and Dry Rolling

The literature contains little detailed information on these two methods of processing milo and wheat for swine. Research workers generally state that rations are fed in the whole, ground (may indicate as coarsely or finely ground), or meal form, but they fail to report particle sizes and/or processing methods.

Coarse grinding has been commonly used as a control method to which other processing methods are compared. There is a large variation in grain designated as coarsely or finely ground, but they generally are produced by using hammer mills with screens that vary from 0.1875 to 0.5 inch and 0.125 to 0.25 inch, respectively.

For grains that are likely to be incompletely digested, grinding frequently yields benefits that justify the cost of grinding. In fact, the evidence suggests that all of the commonly used grains should be ground for best utilization (Becker et al., 1963). Crushing, grinding or rolling appears to be equally effective when the process has prepared the grain to the same degree of fineness.

Baker and Reinmiller (1939) and Loeffel (1957) compared coarsely ground and whole milo rations for growing-finishing swine. They reported similar gains with a lower feed conversion value for the coarsely ground ration. Aubel (1955, 1956) and Hillier and Martin (1959) showed

that moderately fine or coarsely ground milo and dry rolled milo improved rate of gain and feed efficiency when compared to whole milo rations.

Robison (1939) indicated that it was profitable to grind wheat for pigs that are hand-fed but not for those that are self-fed, unless the price of hogs is high or the cost of grinding is low. However, it should be noted that daily gain and feed efficiency were improved for both methods of feeding when the wheat was ground.

Koch and Deyoe (1964) conducted a preference and performance study with milo and found pigs definitely preferred whole grain or dry rolled pelleted grain (with no preference between the two) over dry rolled, steam rolled, steam conditioned and rolled and fine ground milo rations. The average daily gain of pigs consuming various preparations of milo did not differ significantly. The amount of grain required to produce 100 pounds of gain differed among the three groups on grain plus supplement free choice; however, supplement intakes were very similar for the groups. Pigs fed a complete pelleted ration were more efficient gainers than those receiving a complete meal ration.

Pelleting

Many reports have compared meal and pelleted forms of corn and barley for growing-finishing swine. Generally, results of pelleting corn rations vary between stations and experiments at the same station from no beneficial effect on growth rate or feed efficiency to significant effects for both. Feed efficiency appears to be improved more consistently and to a greater degree than does growth rate. Pelleting barley rations appears to more consistently result in an improved rate

of gain and feed efficiency over meal rations.

At the present, pelleting milo or wheat for growing-finishing swine will give about the same beneficial results as expected for corn. Generally, pelleting tends to increase average daily gain and feed efficiency when compared to the same ration in ground or meal form (Kock and Deyoe, 1964; England et al., 1965; Jensen et al., 1967; Jensen et al., 1969; and Clawson and Alsmeyer, 1970).

England et al. (1965) stated that the cause of improved gains and feed efficiency was assumed to be the increased average daily feed consumption due to the greater ration density of the pelleted diets. However, it should be noted that comparisons of pelleted and meal corn rations have shown growth rate and feed efficiency advantages for the pelleted ration without greater apparent daily feed intake. Kock and Deyoe (1964) showed similar results for complete pelleted and meal milo rations.

Dinusson and Bolin (1958) evaluated the performance of pigs on a barley ration in: (1) meal form, (2) pelleted, (3) pelleted and reground to meal form, (4) pelleted and crumbled and (5) ground and pelleted 3 times. They found that:

(1) Pigs receiving pelleted diets gained faster on less feed over those fed the same ration in meal form. This is in agreement with works by Dinusson et al. (1953, 1955) and Larsen and Oldfield (1960).

(2) Crumbling or pelleting 3 times had no advantage over single pelleting.

(3) Pelleting and regrinding did not appreciably improve rate of gain or feed efficiency.

The practical application from this study showed that unless pellets hold their shape, the advantages for pelleting are not obtained.

Thomas and Flower (1956) stated that the benefits from pelleting cereal grains are: (1) less wastage, (2) greater palatability, (3) increased density and (4) less labor.

High Moisture Reconstitution

This is a relatively new area of swine research, and only preliminary trials have been reported in the literature.

Reconstitution involves the addition of water to dry grain and allowing the mixture to undergo fermentation in air-tight storage. This grain is usually allowed to ferment 21 days or more; then it is either ground or rolled and mixed into the complete ration. It may be necessary to store the fermented grain in a cool environment to prevent development of mold (Diggs and Baker, 1968).

High moisture grain can also be obtained by early harvesting or harvesting grain before maturity. In either case, the moisture content is typically around 30%; the grain must be processed before or after storage and must be stored in oxygen free conditions.

Diggs and Baker (1968) reported that growing-finishing pigs receiving high moisture rolled milo (30% moisture), air dry rolled milo (14% moisture) or air dry ground corn (13% moisture) did not differ significantly in rate of gain. However, pigs receiving the high moisture milo required significantly less feed per pound of gain than did the pigs receiving the other two rations. Feed efficiencies adjusted to 14% moisture for wet milo, dry milo and corn were 3.62, 4.18 and 4.06 pounds of feed per pound of gain, respectively.

Martin and Woodward (1969) reported results from a preliminary study on pigs receiving high moisture harvested corn and milo rations and pigs receiving dry harvested corn and milo rations. Growing pigs were used on the milo study, but growing-finishing pigs were used on the corn study. The grains contained 25 to 30% moisture at time of harvesting and were ground and ensiled in concrete pit silos. Rate of gain, feed efficiency and NE_{m+p} of pigs fed the high moisture corn ration was improved over the dry harvested corn ration. The high moisture harvested milo ration and the dry harvested milo ration had equal NE_{m+p} values and essentially no difference in daily gain or feed efficiency.

Durrance and Hollis (1969) conducted a preliminary trial to determine if high moisture grain sorghum would give satisfactory gains and feed conversions for growing-finishing swine in Florida. Fifteen crossbred pigs were fed high moisture (28%) grain sorghum ad libitum plus a 40% protein supplement ad libitum in self feeders. The pigs readily consumed the grain sorghum and the daily gain was 1.76 pounds. The feed conversion was 4.69 pounds of total feed per pound of gain. Converted to 14% moisture, feed efficiency was 4.05 pounds total feed per pound of gain.

Previous work on high moisture grain processing for cattle at Texas, Kansas and Oklahoma Agricultural Experiment Stations have been rather thoroughly summarized by Newsom (1968) and White (1969). Trials comparing high moisture milo to dry milo generally yielded the following results:

(1) High moisture milo produced a consistent improvement in feed efficiency which was apparently due to improved digestibility

(2) High moisture milo produced no significant differences in rate

of gain.

(3) High moisture milo produced a greater increase in feed efficiency when fed to fattening cattle than when fed to growing cattle.

(4) High moisture milo must be ground or rolled before or after storage to obtain maximum utilization. There seems to be some advantage for rolling as compared to grinding and also to processing after storage as compared to before storage.

CHAPTER III

MATERIALS AND METHODS

General

Five trials were conducted to determine the effect of grain processing methods on the feeding value of milo and/or wheat for growing-finishing swine. Trials I and II were conducted to study the influence of fineness of grind of wheat and milo rations. Trial III involved pelleting milo, 50% milo-50% wheat and wheat rations. Trials IV and V were designed to evaluate high moisture reconstitution of milo.

Trial I

Trial I began in November, 1968, at the Fort Reno Experiment Station to study different particle size of grind and dry rolling of wheat for growing-finishing swine. The wheat used in the trial was a hard red winter variety grown at Fort Reno.

Allotment

One hundred forty-four purebred Beltsville and Duroc gilts, averaging 45.6 pounds, were selected from the swine breeding herd, Project H808. Twelve females, six Beltsvilles and six Durocs, were allotted at random within breed, litter and weight to each pen. The study included three replications of four treatments involving 12 pens in Barn A at the Fort Reno Experiment Station. A randomized block

design was utilized as shown in Table I.

TABLE I

TRIAL I: EXPERIMENTAL DESIGN SHOWING NUMBER OF ANIMALS PER PEN FOR EACH TREATMENT[a]

	Processed Wheat				
Blocks	Fine Grind	Medium Grind	Coarse Grind	Dry Roll	Total
1	12^{1}	12	12	12	48
2	12^{3}	12^{2}	12	12^{1}	48
3	$\underline{12}^{2}$	$\underline{12}^{4}$	$\underline{12}^{2}$	$\underline{12}^{1}$	48
Total	36	36	36	36	144

[a]Superscripts indicate the number of pigs removed from test from each pen due to injuries, sickness, or death.

Feeding

The growing-finishing gilts were self-fed a 16% crude protein, wheat-soybean meal ration. The four diets were identical except for wheat preparation. The composition of the complete rations is shown in Table II. A proximate analysis of these rations showed 88.7% dry matter, 15.4% protein, 0.64% calcium and 0.47% phosphorous.

Pigs were placed in 10' x 24' feeding pens with concrete floors one week prior to the start of the test to allow for pen adjustment. After the pretrial week, pigs were changed from their normal diet to

one of the four experimental diets shown in Table II.

TABLE II

TRIAL I: RATION COMPOSITION

	Ration Number			
Ingredients, Percent	1	2	3	4
Ground wheat[a], 0.125 inch grind	82.50	--	--	--
Ground wheat[a], 0.1875 inch grind	--	82.50	--	--
Ground wheat[a], 0.25 inch grind	--	--	82.50	--
Dry rolled wheat[a], 0.003 inch tolerance	--	--	--	82.50
Soybean meal (44%)	12.85	12.85	12.85	12.85
Molasses	1.50	1.50	1.50	1.50
Dicalcium phosphate	1.05	1.05	1.05	1.05
Calcium carbonate	1.05	1.05	1.05	1.05
Trace mineralized salt	0.50	0.50	0.50	0.50
Vitamin-antibiotic mix[b]	0.55	0.55	0.55	0.55
Total	100.00	100.00	100.00	100.00
Composition	Calculated Percent			
Protein	16.0			
Calcium	0.7			
Phosphorous	0.6			

[a]The wheat contained 12.5% crude protein.

[b]Vitamin-antibiotic mix contained 10 pounds of Premix 8650-A and 1 pound of Tylan 40. This premix supplied 1000 I.U. vitamin A, 100 I.U. vitamin D, 1.1 mg. riboflavin, 10 mg. niacin, 3.5 mg. pantothenic acid, 52.5 mg. choline, 7.5 mcg. vitamin B_{12} and 20 mg. tylosin per pound of feed.

Processing

Grinding and dry rolling of wheat were performed at the Fort Reno Station Mill. The wheat was ground by using a hammer mill with a 0.125, 0.1875 or 0.25 inch screen or rolled by using 18" x 24" rollers with a 0.003 inch roller tolerance.

The processed grains were sieved and weights per bushel were taken, as shown in Table III, to characterize the ground and dry rolled wheat to particle size and density, respectively.

TABLE III

TRIAL I: PARTICLE SIZE[a] AND DENSITY[b] OF PROCESSED WHEAT

	Screen Size							
Process	4.0 mm	2.0 mm	1.0 mm	500 micron	250 micron	125 micron	<125 micron	Lb.Per Bu.
	Percent Retained on Screen							
0.125 inch grind	0	1.6	32.8	32.6	18.4	10.4	4.2	48.6
0.1875 inch grind	0	8.0	37.6	27.9	15.1	7.4	4.0	50.9
0.25 inch grind	0	17.1	40.7	22.8	10.5	6.3	2.6	52.0
Dry roll	3.1	48.7	26.8	10.6	6.6	2.8	1.4	31.5

[a]Five 100 gram samples of each grain were used.

[b]Test weights reported are an average of five determinations.

Data Obtained

Performance data was summarized for the pigs at the completion of the trial. All variables were subjected to an analysis of variance, the components of which are shown in Table IV.

TABLE IV

TRIAL I: ANALYSES OF VARIANCE

	For Feed Intake and Feed/Lb. Gain	For Average Daily Gain[a]
Source	d.f.	d.f.
Total	11	127
Replications (R)	2	2
Treatments (T)	3	3
R X T[b]	6	
Breed (B)		1
B X T		3
Residual[b]		14
Within Pen		104

[a]Variable was subjected to a hierarchial analysis of variance.

[b]Error term used to test treatments.

Days on test and weight gains were determined for the 16 pigs removed from the treatments and combined with the data from pigs finishing the trial. These totals were used to compute average daily feed intake and feed efficiency, but average daily gain was calculated only

for the pigs finishing the experiment.

Trial II

Trial II was conducted to study the effect of particle size of grind and dry rolling of milo for growing-finishing swine. The trial started in May, 1969, at the Fort Reno Experiment Station.

Allotment

One hundred ninety-two Beltsville-Duroc crossbred pigs, averaging 57.0 pounds, from the swine breeding project at Fort Reno were used in this study. Sixteen pigs, eight barrows and eight gilts, were randomly allotted within sex, litter and weight to each pen. The study included three replications of four treatments involving 12 pens in Barn A of the Fort Reno Station. A randomized block design was utilized as shown in Table V.

TABLE V

TRIAL II: EXPERIMENTAL DESIGN SHOWING NUMBER OF ANIMALS PER TREATMENT

	Processed Milo				
Blocks	Fine Grind	Medium Grind	Coarse Grind	Dry Roll	Total
1	16	16	16	16	64
2	16	16	16	16	64
3	16	16	16	16	64
Total	48	48	48	48	192

Feeding

Growing-finishing pigs were self-fed a 15% crude protein, milo-soybean meal ration. The four rations were identical except for milo preparation. Composition of the experimental rations is shown in Table VI. The milo used in these rations was commercially purchased in Enid. A proximate analysis of these rations showed 87.4% dry matter and 14.7% protein.

Pigs were fed one of the four experimental diets starting one week after being placed in the 10' x 24' feeding pens with concrete floors. This allowed pigs time to become accustomed to the new environment.

Processing

Processing methods and sampling procedures were identical to those in Trial I with wheat. All milo processing was done at the Fort Reno Mill. Fine, medium, or coarse grinding was obtained by using a hammer mill with a 0.125, 0.1875 or 0.25 inch screen, respectively. Dry rolling was performed by rolling whole milo between 18" x 24" rollers with a 0.003 inch roller tolerance.

The relative density and particle size of the processed milo fed in Trial II are shown in Table VII.

Data Obtained

Pigs were removed from the four treatments when they weighed approximately 200 pounds. Individual average daily gain and pen feed intake and feed efficiency were calculated at the completion of the trial.

The feed intake and feed per pound of gain were subjected to an analysis of variance as shown in Trial I (Table IV). A factorial

TABLE VI

TRIAL II: RATION COMPOSITION

Ingredients, Percent	Ration Number 1	2	3	4
Ground milo[a], 0.125 inch grind	74.60	--	--	--
Ground milo[a], 0.1875 inch grind	--	74.60	--	--
Ground milo[a], 0.25 inch grind	--	--	74.60	--
Dry rolled milo[a], 0.003 inch tolerance	--	--	--	74.60
Soybean meal (44%)	20.40	20.40	20.40	20.40
Molasses	1.50	1.50	1.50	1.50
Dicalcium phosphate	1.50	1.50	1.50	1.50
Calcium carbonate	0.80	0.80	0.80	0.80
Trace mineralized salt	0.50	0.50	0.50	0.50
Vitamin-antibiotic premix[b]	0.70	0.70	0.70	0.70
Total	100.00	100.00	100.00	100.00

Composition	Calculated Percent
Protein	15.0
Calcium	0.70
Phosphorous	0.60

[a]The milo contained 8.03% crude protein.

[b]Vitamin-antibiotic mix contained 10 pounds of premix 8650-A and 4 pounds of Tylan 10. This premix supplied 1000 I.U. vitamin A, 100 I.U. vitamin D, 1.1 mg. riboflavin, 10 mg. niacin, 3.5 mg. pantothenic acid, 52.5 mg. choline, 7.5 mcg. vitamin B_{12} and 20 mg. tylosin per pound of feed.

analysis of variance was used to analyze average daily gain. Variance components for the factorial analysis are shown in Table VIII.

TABLE VII

TRIAL II: PARTICLE SIZE[a] AND DENSITY[b] OF PROCESSED MILO

Process	Screen Size							
	4.0 mm	2.0 mm	1.0 mm	500 micron	250 micron	125 micron	<125 micron	Lb. Per Bu.
	Percent Retained on Screen							
0.125 inch grind	0	1.8	21.2	61.2	15.1	0.7	0	45.0
0.1875 inch grind	0	5.4	31.0	57.9	5.7	0	0	49.0
0.25 inch grind	0	12.2	33.3	31.7	21.5	1.3	0	50.0
Dry roll	0	15.6	48.4	21.4	7.9	4.9	1.8	40.0

[a]Four 100 gram samples of each grain were used.

[b]Test weights reported are an average of four determinations.

Duncan's New Multiple Range Test (Steel and Torrie, 1960) was used to compare treatment means whenever a significant F value was obtained.

TABLE VIII

TRIAL II: ANALYSIS OF VARIANCE

Source	d.f.
Total	191
Replications (R)	2
Treatments (T)	3
Sex (S)	1
Pigs within sex within pen (P)	7
R X T[1]	6
R X S	2
R X P	14
T X S	3
T X P	21
R X T X S	6
R X T X P	42
R X S X P	14
S X P + T X S X P[2]	28
R X T X S X P	42

[1]Error term used to test treatments and replications.

[2]Error term used to test sex and treatment x sex.

Trial III

Trial III was conducted to determine the influence of grinding or pelleting on the feeding value of milo and/or wheat for growing-finishing swine. The trial started in May, 1970, at the Fort Reno Livestock Experiment Station.

Allotment

Three hundred twenty-four Duroc, Beltsville, and crossbred pigs, averaging 52.9 pounds, from the swine breeding project at Fort Reno were used in this study. Eighteen pigs were randomly allotted within

breed, sex, litter and weight to each pen. The study included three replications of the six treatments involving 18 pens in Barn A of the Fort Reno Experiment Station. Each replication began one week apart. The experimental design used in this trial is shown in Table IX.

TABLE IX

TRIAL III: EXPERIMENTAL DESIGN SHOWING NUMBER OF ANIMALS PER PEN FOR EACH TREATMENT[a]

	Milo		Wheat		50% Milo-50% Wheat		
Blocks	Fine Grind	Pelleted	Fine Grind	Pelleted	Fine Grind	Pelleted	Total
1	18	18	18^{1}	18^{2}	18^{1}	18^{1}	108
2	18	18	18	18	18^{1}	18^{1}	108
3	18	18	18	18	18^{2}	18	108
	54	54	54	54	54	54	324

[a]Superscripts indicate the number of pigs removed from test from each pen due to injuries, sickness, or death.

Each pen contained nine barrows and nine gilts, three Durocs, three Beltsvilles and three crossbreds, to total 18 pigs per pen.

Feeding

Growing-finishing pigs were self-fed a 16% crude protein ration from eight weeks of age to 200 pounds. These rations were milo-soybean, wheat-soybean and 50% wheat-50% milo-soybean meal diets.

Each ration was fed in both ground and pelleted form. The composition of the complete rations is shown in Table X.

TABLE X

TRIAL III: RATION COMPOSITION

Ingredients, Percent	Ration Number[a] 1 and 2	3 and 4	5 and 6
Milo (8.3% crude protein)	72.25	---	38.25
Wheat (12.3% crude protein)	---	81.50	38.25
Soybean meal (44% crude protein)	22.75	13.60	18.50
Molasses (wet)	1.50	1.50	1.50
Dicalcium phosphate	1.50	1.30	1.40
Calcium carbonate	0.80	0.90	0.90
Salt	0.50	0.50	0.50
Vitamin-trace mineral premix[b]	0.50	0.50	0.50
Tylan 10	0.20	0.20	0.20
Total	100.00	100.00	100.00
Composition		Calculated Percent	
Protein	16.00	16.00	16.00
Calcium	0.70	0.70	0.70
Phosphorous	0.60	0.60	0.60

[a]Rations 1, 3 and 5 were fed in ground form. Rations 2, 4 and 6 were fed in pelleted form.

[b]Vitamin-trace mineral premix supplied 1500 I.U. vitamin A, 150 I.U. vitamin D_3, 2 mg. riboflavin, 15 mg. niacin, 10 mg. pantothenic acid, 500 mg. choline, 7.5 mcg. vitamin B_{12}, 0.22 ppm iodine, 99 ppm iron, 22 ppm manganese, 11 ppm copper and 99 ppm zinc per pound of feed.

A proximate analysis of these rations showed 87.7, 88.9 and 88.0% dry matter and 16.3, 15.4 and 16.5% protein for rations 1 and 2, 3 and 4 and 5 and 6, respectively.

Pigs were started on one of the six experimental diets one week after being placed in 10' x 24' feeding pens with concrete floors. This allowed pigs time to adjust to the new surroundings.

Processing

A fine grind was obtained on all grain by using a hammer mill with a 0.125 inch screen. The milo and wheat were ground at the Fort Reno Mill. Pelleted rations were fed as 0.1875 inch pellets and were commercially prepared by the Evergreen Mills in El Reno.

The relative density and particle size of the ground rations fed in Trial III are shown in Table XI.

TABLE XI

TRIAL III: PARTICLE SIZE[a] AND DENSITY[b] OF PROCESSED MILO AND/OR WHEAT RATIONS

	Screen Size							
0.125 inch grind	4.0 mm	2.0 mm	1.0 mm	500 micron	250 micron	125 micron	< 125 micron	Lb. Per Bu.
	Percent Retained on Screen							
Milo	0	2.0	26.8	34.5	29.5	6.5	0.8	58
Wheat	0	2.0	27.0	31.3	26.3	13.0	0.5	59
50% Milo-50% Wheat	0	2.0	28.0	32.8	25.8	10.8	0.8	58

[a]Four 100 gram samples of each ration were used.

[b]Test weights reported are an average of four determinations.

Data Obtained

Pigs were individually removed from the six experimental treatments at approximately 200 pounds. Average daily gain, daily feed intake and feed efficiency were calculated at the completion of the trial. Days on test and weight gain were calculated for the nine pigs removed from the treatments and combined with the data from pigs finishing the study. These totals were used to compute average daily feed intake and feed efficiency. Average daily gain, average final weight and the average number of days on test were calculated only for pigs finishing the trial.

A factorial analysis of variance was used to analyze all variables. Variance components for the split-plot design are shown in Table XII. Duncan's New Multiple Range Test (Steel and Torrie, 1960) was used to compare treatment means whenever a significant F value was obtained.

Trial IV

Trial IV was conducted during the summer of 1969 at Oklahoma State University to evaluate the effect of high moisture reconstitution, grinding and dry rolling of milo for finishing swine.

Allotment

Forty-two purebred Yorkshire and Hampshire pigs, weighing approximately 120 pounds, were used in this study. These pigs were obtained from the Oklahoma State University swine herd and were randomly allotted according to breed, sex and weight to three experimental treatments. Each treatment consisted of seven pens containing two pigs each as shown in Table XIII.

TABLE XII

TRIAL III: ANALYSES OF VARIANCE

Source	For Feed Intake and Feed/Lb. Gain d.f.	For Average Daily Gain d.f.
Total	17	323
Replications (R)	2	2
Grain (G)	2	2
R X G[a]	4	4
Processing Method (P)	1	1
P X G	2	2
R X P + R X P X G[b]	6	6
Sex (S)		1
G X S		2
P X S		1
G X P X S		2
R X S + R X G X S + R X P X S + R X G X P X S[c]		12
Pigs (R X G X P X S)		288

[a]Error term used to test grain.

[b]Error term used to test processing method.

[c]Error term used to test sex.

TABLE XIII

TRIAL IV: EXPERIMENTAL DESIGN SHOWING NUMBER OF ANIMALS PER TREATMENT

	Processed Milo		
Ground	High Moisture, Rolled	Dry Rolled	Total
14[a]	14	14	42

[a]Two pens (four pigs) were removed from the treatment due to the death of one pig in the pen.

Feeding

Finishing pigs were self-fed a 16% crude protein, milo-soybean meal ration in two-pig, 6' x 7' feeding pens with concrete floors at Oklahoma State University. The experimental rations were identical except for the preparation of the milo. The milo was ground, reconstituted and rolled or dry rolled before including in the complete ration. The composition of the complete ration on a 90% dry matter basis is shown in Table XIV.

TABLE XIV

TRIAL IV: RATION COMPOSITION

Ingredient	Percent
Milo	76.88
Soybean meal (50%)	19.70
Calcium carbonate	0.50
Dicalcium phosphate	1.90
Trace mineralized salt[a]	0.50
Premix 8650A[b]	0.50
Zinc sulfate	0.02
Total	100.00

Five pounds of SP250 were added per ton of ration.

[a]Trace mineral salt supplied 12.5 ppm manganese, 10 ppm iron, 5 ppm sulfur, 1.65 ppm copper, 0.5 ppm cobart, 0.35 ppm iodine and 0.25 ppm zinc per pound of diet.

[b]Vitamin premix supplied 1000 I.U. vitamin A, 100 I.U. vitamin D_3, 1.1 mg. riboflavin, 10 mg. niacin, 3.5 mg. pantothenic acid, 52.5 mg. choline and 7.5 mcg. vitamin B_{12} per pound of feed.

All feeders were filled weekly except those containing the high moisture ration, which was fed fresh daily.

The milo used in the study was obtained from the Stillwater Milling Company in one quantity.

Processing

The reconstituted-rolled milo was prepared by adding 15 gallons of warm water to 200 pounds of air-dry, whole milo. This mixture was allowed to mix for 45 to 50 minutes in a conventional cement mixer to raise the moisture level to 30-32%. The grain was sacked in plastic airtight bags and stored for 21 days on a table to prevent damage by rodents. After 21 days the milo was removed from the bags, rolled between 12" x 18" rollers with a 0.001 inch roller tolerance, mixed, resacked and placed in a 34°F. cooler until fed.

Ground milo was prepared by using a hammer mill with a 0.1875 inch screen. Dry rolled milo was prepared by rolling the grain between 12" x 18" rollers with a 0.001 inch roller tolerance.

Relative density and particle size were not determined for the processed milo used in this trial; however, they should be similar to those obtained in Trial V (Table XVIII), since milo was processed by the same methods in both trials.

Data Obtained

Rate of gain, feed intake and feed efficiency were calculated at the completion of the trial. All variables were subjected to an analysis of variance as shown in Table XV.

TABLE XV

TRIAL IV: ANALYSES OF VARIANCE

	For Feed Intake and Feed/Lb. Gain	For Average Daily Gain
Source	d.f.	d.f.
Total	18	37
Treatment	2	2
Error[a]	16	35

[a]Error term used to test treatments.

No data were used from the four pigs (two pens) that were removed from the ground ration.

Trial V

Trial V was conducted to further study the effect of high moisture reconstitution, grinding and dry rolling of milo for growing-finishing swine. The trial started in November, 1969, at Oklahoma State University, Stillwater, Oklahoma.

Allotment

Forty-eight purebred Yorkshire and Hampshire pigs, averaging 57.8 pounds, were used in this study. These pigs were obtained from the Oklahoma State University swine barn and were randomly allotted within breed, sex and weight to three experimental treatments. Each treatment consisted of eight pens, ten Yorkshires and six Hampshires, as shown

in Table XVI. Each pen contained two pigs, a barrow and gilt of the same breed.

TABLE XVI

TRIAL V: EXPERIMENTAL DESIGN SHOWING NUMBER OF ANIMALS PER TREATMENT

Processed Milo			
Ground	High Moisture, Rolled	Dry Rolled	Total
16[a]	16	16	48

[a]One pen of Yorkshires was removed from the treatment due to the death of one pig in the pen.

Feeding

Growing-finishing pigs were self-fed a 16% crude protein, milo-soybean meal diet throughout the study. The only variable among the three treatments was the processing of the milo protion of the ration. The milo was either ground, reconstituted and rolled or dry rolled before including in the complete diet. Composition of the experimental ration is shown in Table XVII. The milo used in the study was purchased from the Stillwater Milling Company at two different times.

TABLE XVII

TRIAL V: RATION COMPOSITION[a]

Ingredient	Percent
Milo	76.98
Soybean meal (50%)	19.67
Calcium carbonate	0.50
Dicalcium phosphate	1.85
Trace mineral salt[b]	0.50
Premix 8650A[c]	0.50
Total	100.00

Five pounds of SP250 were added per ton of ration.

[a]Ration composition based on a 90% dry matter basis.

[b]Refer to Trial IV (Table XIV), ration composition.

[c]Refer to Trial IV (Table XIV), ration composition.

Feeders were checked daily to be sure the high moisture diet was feeding down. Only enough feed to last two to three days was placed in these feeders, but all others were filled weekly. Special precautions were taken to keep wastage at a minimum.

Each ration was sampled seven times to determine the percent dry matter, and the values obtained were 74.07%, 87.17% and 84.32% for the complete reconstituted-rolled, ground and dry rolled rations, respectively.

Processing

The same methods were used to obtain reconstituted-rolled, ground and dry rolled milo as explained in Trial IV.

The relative density and particle size of the processed milo fed in this trial are shown in Table XVIII.

TABLE XVIII

TRIAL V: PARTICLE SIZE[a] AND DENSITY[b] OF PROCESSED MILO

Process	Screen Size						
	4.0 mm	2.0 mm	1.0 mm	500 micron	250 micron	125 micron	Lb. Per Bu.
	Percent Retained on Screen						
Ground (0.1875 grind)	0	6.4	42.0	37.4	12.4	1.8	48.8
Dry rolled (0.001 inch)	0	3.4	57.6	29.6	8.8	0.6	40.6
Reconstituted-Rolled (0.001 inch)	0.45	14.8	48.3	26.3	9.35	0.8	29.2

[a]Five 100 gram samples of each grain were used.

[b]Test weights reported are an average of five determinations.

Data Obtained

Rate of gain, feed intake and feed efficiency were calculated at the completion of the trial. No data were used from the two pigs (one pen) that were removed from the ground ration.

All variables were subjected to an analysis of variance as shown in Table XIX. Duncan's New Multiple Range Test was used to compare treatment means whenever a significant F value was obtained.

TABLE XIX

TRIAL V: ANALYSES OF VARIANCE

	For Feed Intake and Feed/Lb. Gain	For Average Daily Gain
Source	d.f.	d.f.
Total	22	45
Treatment	2	2
Error[a]	20	43

[a]Error term used to test treatments.

CHAPTER IV

RESULTS AND DISCUSSION

Trial I

The results of growing-finishing gilts fed four types of processed wheat are shown in Table XX. The data was summarized after the gilts had been fed an average of 111.4 days to an average weight of 201.6 pounds.

The data suggested that the preparation methods used had little effect on average daily gain, average daily feed intake or feed per pound of gain. None of the F values were significant at the 5% level, and the comparison of treatment means revealed only small differences. Gains and feed utilization appeared not to be optimum for any of the four treatments when compared to works by Cromwell et al. (1969), Luce et al. (1969) and Danielson and Grabowski (1970). However, it should be pointed out that the experimental animals were moderately inbred gilts fed during the winter season. Differences between the Beltsville and Duroc breeds for average daily gain were not significant ($P > .05$). The average daily gain was 1.41 pounds for each breed.

It was noted that the fine grind wheat did not feed down in self feeders as readily as did the other rations. This may have reduced the amount of wastage of this diet resulting in a lowered average daily feed intake by the gilts. The average daily feed intake for gilts fed rations 1, 2, 3 and 4 were 4.63, 4.82, 4.87 and 4.73 pounds,

TABLE XX

TRIAL I: EFFECT OF WHEAT PROCESSING ON PERFORMANCE OF GROWING-FINISHING SWINE

Item	Ration Designation 1 Fine Grind (0.125 inch)	2 Medium Grind (0.1875 inch)	3 Coarse Grind (0.25 inch)	4 Dry Roll (0.003 inch)	$s_{\bar{x}}$[a]	F[b]
Pens per treatment, no.	3	3	3	3		
Pigs per pen, no.[c]	12	12	12	12		
Average initial weight, lb.	45.8	45.5	45.6	45.5		
Average final weight, lb.	200.7	202.5	201.1	202.0		
Average daily gain, lb.[d]	1.40	1.39	1.42	1.43	0.02	0.48
Average daily feed intake, lb.[d]	4.63	4.82	4.87	4.73	0.10	1.10
Feed per lb. gain, lb.[d]	3.44	3.49	3.46	3.42	0.04	0.68

[a]Standard error of treatment means.

[b]Calculated F value from analysis of variance.

[c]Sixteen pigs were removed from treatments as shown in Table I.

[d]No significant differences ($P > .05$) between treatment means.

respectively.

The average weight per bushel for the ground (fine, medium and coarse grind) and dry rolled wheat was 48.6, 50.9, 52.0 and 31.5 pounds, respectively. The density of the dry rolled wheat was reduced 35.2, 38.1 and 39.4 percent as compared to the 0.125, 0.1875 and 0.25 inch ground rations, respectively. The results did not indicate any advantages for the different processing methods employed in this trial.

Trial II

The results of 192 growing-finishing, crossbred pigs fed four types of processed milo are shown in Table XXI. The data was summarized after the pigs had been fed an average of 89.7 days to an average weight of 205.5 pounds.

The processing methods used appeared to have little effect on rate of gain. A comparison of treatment means indicated that pigs on rations 1 and 4 required significantly ($P<.05$) less feed per pound of gain than pigs on rations 2 and 3. Although a significant F value was not obtained for average daily feed intake, the results indicated that pigs on rations 1 and 4 tended to consume less feed per day than pigs fed rations 2 and 3. Pigs were fed test rations 1, 2, 3 and 4 an average of 89.5, 90.2, 90.6 and 88.4 days, respectively.

The milo diets in this trial produced results similar to those obtained by Jensen *et al.* (1969) and Luce *et al.* (1969). Danielson and Grabowski (1970) and Koch and Deyoe (1964) obtained higher and lower average daily gains, respectively, than those obtained in this trial.

Barrows gained significantly ($P<.01$) faster than gilts in this trial. The average daily gains were 1.76 and 1.60 pounds for barrows

TABLE XXI

TRIAL II: EFFECT OF MILO PROCESSING ON PERFORMANCE OF GROWING-FINISHING SWINE

Item	Ration Designation 1 Fine Grind (0.125 inch)	2 Medium Grind (0.1875 inch)	3 Coarse Grind (0.25 inch)	4 Dry Roll (0.003 inch)	$s_{\bar{x}}$[a]	F[b]
Pens per treatment, no.	3	3	3	3		
Pigs per pen, no.	16	16	16	16		
Average initial weight, lb.	56.4	56.8	57.5	57.1		
Average final weight, lb.	206.1	205.0	205.5	205.3		
Average daily gain, lb.	1.69	1.66	1.65	1.69	0.02	0.34
Average daily feed intake, lb.	5.31_1	5.55_2	5.53_2	5.25_1	0.08	4.02[c]
Feed per lb. gain, lb.[d]	3.18^1	3.37^2	3.39^2	3.13^1	0.04	10.31[c]

[a] Standard error of treatment means.

[b] Calculated F value from analysis of variance.

[c] Significant ($P<.01$).

[d] Any two treatment means without a common number differ significantly ($P<.05$).

and gilts, respectively.

The average weight per bushel for the ground (fine, medium and coarse grind) and dry rolled milo was 45.0, 49.0, 50.0 and 40.0 pounds, respectively. The density of dry rolled milo was reduced 11.1, 18.4 and 20.0 percent as compared to the fine, medium and coarse ground rations, respectively. The results of this trial suggested that fine grinding or dry rolling of milo improved feed utilization as compared to medium or coarse grinding.

Trial III

The results of 324 pigs fed ground or pelleted milo, wheat or 50% milo-50% wheat diets are shown in Table XXII. The data was summarized after the pigs had been fed an average of 93.6 days to an average weight of 210.8 pounds. The pigs on the ground and pelleted diets were fed an average of 96.3 and 90.8 days, respectively.

The data indicated that the processing methods used significantly ($P<.01$) effected feed per pound of gain, daily feed intake and average daily gain.

A comparison of treatments means indicated that average daily gain and feed per pound of gain were superior ($P<.01$) for the pelleted rations than for the ground rations. This agrees with works by Koch and Deyoe, 1964; England et al., 1965; Jensen et al., 1967, 1969 and Clawson and Alsmeyer, 1970. No significant ($P>.05$) differences were found due to the grain within each processing method. Part of the improvement in performance of pigs fed the pelleted diets appears to be due to less feed wastage. Barrows gained faster than gilts within each pen, and both gained faster ($P<.01$) on pelleted than ground rations. It can be

TABLE XXII

TRIAL III: EFFECT OF PELLETING ON PERFORMANCE OF GROWING-FINISHING SWINE

Item	Ration Designation: Milo Gr. 1	Milo Pel. 2	Wheat Gr. 3	Wheat Pel. 4	50% Milo-50% Wheat Gr. 5	50% Milo-50% Wheat Pel. 6	$s_{\bar{x}}$[a]	F[b]
Pens per treatment, no.	3	3	3	3	3	3		
Pigs per pen, no.[c]	18	18	18	18	18	18		
Average initial weight, lb.	53.5	52.3	53.1	52.8	52.0	53.7		
Average final weight, lb.	210.0	211.1	209.9	211.2	207.3	215.3		
Average daily gain, lb.[e]	1.64_{1}	1.77_{2}	1.61_{1}	1.74_{2}	1.67_{1}	1.75_{2}	0.02	9.75[d]
Average daily feed intake, lb.[f]	5.73_{3}	$5.60_{2,3}$	$5.42_{1,2}$	5.29_{1}	$5.66_{2,3}$	5.34_{1}	0.08	5.76[d]
Feed per lb. gain, lb.[e]	3.51_{2}	3.17_{1}	3.42_{2}	3.07_{1}	3.50_{2}	3.12_{1}	0.04	23.92[d]

[a] Standard error of treatment means.

[b] Calculated F value from analysis of variance.

[c] Nine pigs were removed from the trial as shown in Table IX.

[d] Significant ($P < .01$).

[e] Any two means without a common number differ significantly ($P < .01$).

[f] Any two means without a common number differ significantly ($P < .05$).

seen in Table XXII that the most efficient gains were obtained by pigs on the ground or pelleted wheat diets. A comparison of feed intake means indicated that less of the pelleted ration was consumed within each grain. England et al. (1965) stated that the increase in gain and feed efficiency was assumed to be due to an increased average daily feed consumption. The average daily feed intakes were significantly ($P<.05$) higher for the ground than the pelleted 50% milo-50% wheat diets, for the ground milo than the ground wheat diet and for the pelleted milo than the wheat or 50% milo-50% wheat pelleted diets.

These results suggest that pelleting increases average daily gain and lowers average daily feed intake and feed required per pound of gain when compared to the ground diets. Wheat supports similar gains and lower feed utilization than milo. In a previous study, Luce et al. (1969) fed 15% crude protein, ground diets similar to those in this trial. They obtained similar average daily gains and consistently lower average daily feed intakes and feed efficiencies than those obtained in this trial. Both trials showed the same trend for feed intakes but wheat and milo efficiencies were reversed. Differences in these trials indicate that additional research may be needed to determine the correct level of protein, level of amino acids, or levels of each grain to feed for maximum performance.

Trial IV

The results of finishing swine fed ground, high moisture-rolled and dry rolled milo rations are shown in Table XXIII. The data were summarized after the pigs had been fed an average of 52.8 days to an average weight of 203.7 pounds.

TABLE XXIII

TRIAL IV: EFFECT OF MILO PROCESSING ON PERFORMANCE OF FINISHING SWINE

Item	Ration Designation 1 Medium Grind (0.1875 inch)	2 Reconstituted Rolled (0.001 inch)	3 Dry Roll (0.001 inch)	$s_{\bar{x}}$[a]	F[b]
Pens per treatment, no.[c]	7	7	7		
Pigs per pen, no.	2	2	2		
Average initial weight, lb.	122.9	119.4	120.4		
Average final weight, lb.	204.3	202.6	204.1		
Average daily gain, lb.[e]	1.59	1.51	1.60	0.07	0.61
Average daily feed intake, lb.[d,e]	4.90	5.03	5.48	0.25	1.84
Feed per lb. gain, lb.[d,e]	3.08	3.33	3.42	0.15	1.18

[a] Standard error of treatment means.

[b] Calculated F value from analysis of variance.

[c] Two pens were removed from treatment 1 as shown in Table XIII.

[d] Values shown were corrected to a 90% dry matter basis.

[e] No significant differences ($P > .05$) between treatment means.

The data indicated that the preparation methods used did not significantly ($P > .05$) affect average daily gain, average daily feed intake or feed per pound of gain. A comparison of treatment means indicated that daily gain for the ground or dry rolled diets tended to be superior to that obtained for the high moisture diet. A comparison of feed intake and feed efficiency means suggested that pigs fed the ground diet tended to eat less and to be more efficient than pigs fed the high moisture or dry rolled diet. The means for the high moisture diet were intermediate to the ground and dry rolled diets. This disagrees with the results of a high moisture study by Diggs and Baker (1968). They obtained significantly ($P < .05$) lower feed intake and feed efficiency means for the high moisture milo ration.

Results from this preliminary study with finishing pigs indicated no advantage for the reconstituted milo. Overall, the best performance was made by pigs fed the ground milo diet.

Trial V

The results of growing-finishing swine fed three types of processed milo are shown in Table XXIV. The performance data were summarized after the pigs had been fed an average of 91.1 days to an average weight of 211.3 pounds. Average initial weights varied from 54.6 to 61.0 pounds, but final weights were similar, varying from 210.6 to 212.3 pounds. The pigs were fed the ground, high moisture or dry rolled milo diets for 86.5, 91.4 and 95.4 days, respectively. These data indicated that the lighter weight pigs were on test longer, but carrying pigs to the same final weight resulted in non-significant ($P > .05$) differences for average daily gain. A comparison of treatment

TABLE XXIV

TRIAL V: EFFECT OF MILO PROCESSING ON PERFORMANCE OF GROWING-FINISHING SWINE

Item	Ration Designation 1 Medium Grind (0.1875 inch)	2 Reconstituted Rolled (0.001 inch)	3 Dry Roll (0.001 inch)	$s_{\bar{x}}$[a]	F[b]
Pens per treatment, no.[c]	8	8	8		
Pigs per pen, no.	2	2	2		
Average initial weight, lb.	61.0	57.9	54.6		
Average final weight, lb.	212.3	210.6	210.9		
Average daily gain, lb.	1.75_2	1.67_1	1.64_2	0.05	1.57
Average daily feed intake, lb.[d,g]	5.94_2	5.08_1	5.90_2	0.25	4.35[e]
Feed per lb. gain, lb.[d,g]	3.37_2	3.01_1	3.54_2	0.08	12.23[f]

[a] Standard error of treatment means.

[b] Calculated F value from analysis of variance.

[c] One pen was removed from treatment 1 as shown in Table XVI.

[d] Values shown were corrected to a 90% dry matter basis.

[e] Significant ($P < .05$).

[f] Significant ($P < .01$).

[g] Any two means without a common number differ significantly ($P < .05$).

means indicated that pigs on the ground milo diet tended to gain faster than pigs on the reconstituted or dry rolled milo diets. Average daily gains were 1.75, 1.67 and 1.64 pounds per day for the three diets, respectively. These gains appeared to be normal based on results from earlier trials in this report.

Significant differences were obtained for feed efficiency ($P<.01$) and average daily feed intake ($P<.05$). A comparison of treatment means indicated that pigs fed the reconstituted-rolled ration required significantly ($P<.05$) less feed per pound of gain than pigs fed the ground or dry rolled rations. Although not significant ($P>.05$) the pigs fed the ground milo diet required an average of 0.17 pounds less feed per pound of gain than pigs on the dry rolled milo diet. Also, a comparison of treatment means indicated that the daily feed consumption was significantly ($P<.05$) lower for pigs fed the reconstituted-rolled ration than for pigs fed the ground or dry rolled rations. Results of this trial are in agreement with a study by Diggs and Baker (1968). Martin and Woodward (1969) obtained similar results in a trial utilizing high moisture harvested corn. However, the results in Trial IV of this report disagree with the results of Trial V. It should be noted that Trials IV and V were conducted during the summer and winter months, respectively.

Part of the improvement in feed efficiency and daily feed intake of the reconstituted milo appears to be due to less feed wastage. Although wastage of the ground and dry rolled milo diets was kept at a minimum, little wastage was observed with the reconstituted milo diet.

The main problems associated with feeding the high moisture diet

were: (1) the feed would not feed out in the self-feeders; (2) the feed soured and had to be discarded if not consumed in three or four days; or if the bags were damaged or broken during storage and fermentation; and (3) the complete mixed ration had to be stored under refrigeration.

It should be noted that during the trial two different batches of milo were fed. Also, the milo was allowed to ferment from two to three weeks, depending upon the amount of feed on hand. These reasons help explain the cause for the lower average daily feed intake and average daily gain of the pigs fed the reconstituted milo ration. However, the improvement in feed efficiency suggested that few problems existed when feeding this ration.

Part of the increased benefit resulting from reconstitution may be due to the fluffy-like physical form which was acquired upon rolling of the moist grains. The average weight per bushel for the reconstituted, ground and dry rolled milo was 29.2, 48.8 and 40.6 pounds, respectively. The results of this trial suggested that reconstitution of milo improved feed utilization as compared to grinding or dry rolling of milo.

CHAPTER V

SUMMARY

Five feeding trials were conducted to determine the effect of grain processing methods on the feeding value of milo and/or wheat for growing-finishing swine. Trials I and II were conducted to study different particle sizes of grind for wheat and milo, respectively. Trial III involved the effect of pelleting milo, 50% milo-50% wheat and wheat rations. Trials IV and V were designed to evaluate high moisture reconstitution of milo.

Either milo and/or wheat-soybean meal rations containing 15 or 16% crude protein were used in these trials. The pigs were confinement fed on concrete floors in 10' x 24' pens at the Fort Reno Experiment Station or in two-pig, 6' x 7' feeding pens at Oklahoma State University. All pens were equipped with self-feeders and automatic waterers.

Grinding the milo or wheat to a fine, medium or coarse grind was accomplished by using a hammer mill with a 0.125, 0.1875 or 0.25 inch screen, respectively. The dry rolled grains were prepared by rolling whole grain between 12" x 18" and 18" x 24" rollers with a 0.001 or 0.003 inch roller tolerance, respectively.

The pelleted rations were produced by grinding the grains through a 0.125 inch screen, then pelleting the complete ration into a 0.1875 inch pellets.

Reconstituted milo was obtained by adding water to air-dry grain

until the moisture content was 30 to 32%. Next, the grain was stored under oxygen-free conditions for 21 days. The reconstituted grain was then rolled through a 0.001 inch roller tolerance and mixed into the complete ration and stored under refrigerated conditions until used.

Evaluation of the trials was based on the average daily gain, feed efficiency and average daily feed intake of the pigs. Gain was figured for each pig, but feed consumption and efficiency were calculated on a pen basis.

The data did not indicate any advantage for the different processing methods employed in Trial I. No significant ($P > .05$) differences in gain or feed utilization were noted among the gilts fed the ground or dry rolled wheat diets. The gains and feed utilization appeared not to be optimum for any of the treatments. In Trial II no significant ($P > .05$) differences in average daily gain were noted among pigs fed ground or dry rolled milo diets, but pigs fed a fine or dry rolled milo ration consumed less feed per day and required less ($P < .05$) feed per pound of gain than pigs fed medium or coarse ground milo diets. The pigs fed the milo diets gained faster and consumed more feed per day but had a lower feed/gain ratio than the gilts fed the wheat diets.

The data obtained from Trial III indicated that pelleting significantly ($P < .01$) improved average daily gain and feed efficiency, and wheat supported similar gains and lower feed utilization than milo. Based on previous studies, feed efficiencies for the ground diets in this trial appeared to be high.

A preliminary study, conducted to evaluate reconstituted milo for finishing swine, indicated no significant ($P > .05$) differences for average daily gain, average daily feed intake or feed per pound of

gain. Gains were higher for pigs on the dry rolled or ground milo diets than for those on the reconstituted milo diet. The feed intakes and efficiencies were the lowest for pigs on the ground milo diet followed by pigs fed reconstituted and dry rolled milo rations, respectively. However, data from Trial V indicated that reconstitution significantly improved feed efficiency ($P < .01$) and intake ($P < .05$). Gains were higher for the ground milo diet than for the reconstituted or dry rolled milo diets and were higher for all diets in Trial V than in Trial IV. The main problems associated with feeding the reconstituted milo were that the ration would not feed out in the self-feeders, and that it spoiled during storage and feeding.

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