EFFECTS OF SORGHUM GRAIN PROCESSING UPON SWINE PERFORMANCE AND PREFERENCE DURING THE GROWING FINISHING PERIOD

by

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INTRODUCTION

Sorghum grain has become increasingly important as a feed grain in the past few years. In the U.S. it has increased from 243 million bushels in 1955 to a peak of 838 million bushels in 1962.

In Kansas agriculture, it plays an important economic role. Reductions in wheat acreage have forced farmers to produce some other crop to stabilize their incomes. Except along the northern border where corn can be profitably grown, sorghum grain has become the principal grain grown for livestock feeding in most of Kansas.

Sorghum grain has been shown to be an excellent feed for livestock. Properly used it does not differ greatly from shelled corn. It has about the same net energy and total digestible nutrient content and somewhat more digestible protein but less fat than corn. It is lacking in vitamin A value. It has approximately the same mineral deficiencies as corn.

Swine like sorghum grain. Generally they will eat as much or more sorghum grain as they will corn. In some instances, they make as rapid gain as those fed corn. In various trials the feeding value of sorghum grain for growing finishing pigs has ranged from about 85 to 95 percent with an average of approximately 90 percent of corn. Recent reports even show that it may be up to 99 percent as valuable as corn.

Because of increased use by livestock feeders, there has been an increased interest in more scientific data with regard to preparation and feeding value. The small size of the grain makes preparation very important since there is a tendency for these small hard grains to pass through the digestive tract of the pigs without being completely digested.

Two experiments were conducted to attempt to measure how much physical preparations might increase feed efficiency and also how they might affect the palatability of the sorghum grain.

REVIEW OF LITERATURE

Few controlled experiments have been designed to study the effects of sorghum grain processing upon the preference and the performance of swine during the growing finishing period. In general, such trials have tried to determine both data at the same time. Groups of pigs thus were not in an environment where they could express preference for one preparation over another. They were in separate pens and were fed separate preparations.

Preference

The Texas Agricultural Experiment Station (1930 and 1931) fed growing finishing pigs free choice tankage and sorghum grain. The grain was fed either whole or ground. The test was conducted for 90 days in dry lot on concrete floor. Pigs were grouped in pairs. In each pair one pig received whole sorghum grain and one pig received ground sorghum grain in addition to tankage. Thirty-nine pairs of pigs were fed. Eleven were reported to have consumed more ground sorghum grain than whole sorghum grain.

Baker et al. (1936) fed Wheatland sorghum grain to growing fattening pigs in two forms: whole and ground. Those on whole sorghum grain ate .33 pounds per pig per day more than those fed ground sorghum grain. The following year, he fed another group of pigs whole and ground Kafir and Sooner sorghum grain. This time, however, those on the ground form ate more grain: .57 pounds per pig per day more for Kafir, .34 pounds per pig per day more for Sooner. In 1939 he again fed ground and whole sorghum grain of Kalo variety. He found that pigs ate .08 pounds per pig per day more of the ground sorghum grain.

Loeffel (1957), summarizing eleven published and unpublished reports from experiments done at the Lincoln and the North Platte, Nebraska Experimental Stations, reported that whole grain on the average appeared to be more palatable than coarsely ground sorghum grain. The grains used were White Kafir, Wheatland, Sooner Milo, and Coes. The pigs fed the whole sorghum grain ate .15 pounds per head per day more than those fed ground sorghum grain. Slightly more supplement was consumed daily per pig (.80 pound versus .78 pound) where the sorghum grain was fed ground. He also reported that a finely ground feed was less economical than a coarsely ground feed in a trial in which White Kafir sorghum grain was ground to two degrees of fineness. The coarsely ground grain had a modulus of fineness of 4.02; that of the fine ground grain was 3.48. Pigs eating coarsely ground grain ate .08 pound per pig per day more. The same protein supplement was used in both lots.

Wilson (1950 and 1951) studied the value of sorghum grain ground and whole as compared to corn for growing fattening pigs in dry lot. He found in one experiment the pigs ate .14 pound per pig per day more when fed whole sorghum grain compared to ground sorghum grain. In another, however, he reported they ate .86 pound per pig per day more of ground sorghum grain.

Aubel (1961) found whole sorghum grain was more palatable to the pigs than ground sorghum grain. A difference of .34 pound per head per day was found.

Pooling all these data together it would seem that whole sorghum grain was more palatable than ground grain.

Kansas State University reports comparing whole sorghum grain to grain processed by methods other than grinding are quite extensive.

Aubel (1956) conducted a test in which shelled corn was compared to sorghum grain fed in the following preparations: whole, dry rolled, steam rolled, and dry rolled plus five percent molasses added. Pigs ate the dry rolled sorghum grain in largest amounts. They consumed the steam rolled sorghum grain in smallest amounts. The average daily consumption per pig of whole sorghum grain was .48 pound less than dry rolled grain, .32 pound more than steam rolled sorghum grain.

Aubel (1958) compared shelled corn, hybrid sorghum grain, and open pollinated sorghum grain. Sorghum grain was fed either whole or dry rolled. In the case of open pollinated sorghum grain the growing finishing pigs ate .14 pound per head per day more of dry rolled sorghum grain. In the case of the hybrid grain, however, they ate .10 pound per pig per day more of whole sorghum grain. The hybrid grain was reported of poor quality, dirty and not too plump.

Aubel (1959) compared shelled corn and hybrid sorghum grain. The grain fed free choice in each lot was processed in various ways. The preparations were: whole, steam rolled, steam rolled with five percent molasses added, and steam conditioned rolled. Considering the physical form only, he found that the pigs fed steam rolled sorghum grain ate the least grain per day. Those fed whole sorghum grain ate the most grain: .04 pound per head per day more grain than those fed steam conditioned rolled sorghum grain, .20 pound per head per day more grain than those fed steam rolled sorghum grain.

Aubel (1960) used five lots of growing fattening pigs to compare the value of corn with sorghum grain fed free choice. The sorghum grain was fed either whole, dry rolled, steam rolled, or steam conditioned rolled. The conditioning was for four hours. The lowest average daily consumption per pig was with whole sorghum grain (4.85 pounds). The highest consumption was

with steam conditioned rolled sorghum grain (5.46 pounds). The others were 5.05 pounds for dry rolled grain, 5.33 pounds for steam rolled grain.

Aubel (1961) again studied the value of sorghum grain as affected by the different physical preparations. Six treatments were used: whole, steam rolled, fine ground, fine ground and pelleted, dry rolled, and steam conditioned rolled. In the fine grinding, a 1/8 inch hammermill screen was used. In the pelleting, a 1/4 inch x 1 1/2 inch non tapered pellet die was used. In the dry rolling a 0.020 inch roll spacing on a fine corrugated roll mill was used. The steam rolled grain was steamed to a temperature of 92°C. and rolled with a roll spacing of 0.005 inches. The steam conditioned rolled grain was conditioned or binned for six hours before the rolling took place. The temperature immediately before rolling had fallen to 60°C.

In that experiment, pigs ate the most of whole grain (4.75 pounds per head per day). Those fed the steam conditioned rolled grain consumed about the same quantity (4.74 pounds). The lowest consumption was with the fine ground and pelleted (3.52 pounds per head per day). The other average daily consumptions per head were in descending order, steam rolled (4.63 pounds), fine ground (4.41 pounds), and dry rolled (3.84 pounds).

Jensen et al. (1959) fed sorghum grain in a complete ration in either meal or pellet form. They found in one trial that the pigs ate more meal form (.49 pounds more), and in two other trials they ate more pellet form (.29 pounds more in one test, .72 pounds more in another test).

No conclusion can be reached when one attempts, from the literature, to determine the preference of pigs for either whole sorghum grain, fine ground, dry rolled, steam rolled, or steam conditioned rolled sorghum grain. Aubel's results were not consistent.

Performance

The Texas Agricultural Experiment Station (1930) reported that when sorghum grain was fed free choice and self fed, it did not pay to grind the sorghum grain for fattening pigs. Their tests showed that only two to three percent of the grain passed through the pigs when sorghum grain was fed whole. Observations showed that pigs in these tests made 14 trips in a period of 15 hours to the grain compartment of the self feeder. The pigs were reported to chew the whole grain more thoroughly than they did when they were hand fed twice daily. The pigs fed whole Kafir gained 1.75 pounds daily and required 3.24 pounds of grain and .38 pounds of supplement per pound gain. Those fed ground Kafir gained 1.68 pounds daily and required 3.24 pounds of grain and .37 pounds of supplement per pound gain. Pigs in those tests were fed in pairs: one received whole grain; the other, ground grain.

The Texas Agricultural Experiment Station (1931) again compared the feeding value of sorghum grain as affected by the physical preparation. The average daily gain was the same in both lots. Whole Kafir fed pigs required 3.07 pounds of grain and .62 pounds of supplement while those fed ground grain required 3.10 pounds of grain and .57 pounds of supplement per pound gain.

Baker and Reinmiller (1936) fed Wheatland sorghum free choice to growing fattening pigs. The sorghum grain was fed whole or coarsely ground through a burr-type mill. The pigs fed whole sorghum grain ate more feed than those fed ground grain. But the latter made more rapid gains (.10 pound more per head per day). At the conclusion of the trial they were heavier and fatter. They required 3.11 pounds of grain and .58 pounds of supplement per pound gain while the whole sorghum grain fed pigs required 3.52 pounds of grain and .60 pounds of supplement per pound gain.

Baker and Reimmiller (1937) fed White Kafir and Sooner sorghum grain free choice, ground or whole, to five lots of growing finishing pigs. The gains of all five lots were quite satisfactory, and with one exception quite uniform 1.62 ± .01 pounds per head per day. The exception was 1.80 pounds per day for pigs fed ground Kafir. Grinding the sorghum did not increase its efficiency in this trial, as the ground sorghum grain and supplement were only 96 percent as efficient as whole sorghum and supplement. Carcass grades acceptable in every way showed no advantage for the pigs in any one lot over the pigs in the other lots. Neither were there any appreciable differences in the dressing yield.

Baker and Reimmiller (1939) fed whole and ground Kalo sorghum grain free choice to growing fattening pigs. The pigs eating whole grain were slower in gain, .11 pound per day per head less than pigs eating ground grain. Pigs eating ground grain utilized feed much more efficiently. They required 3.56 pounds of grain and .53 pounds of supplement while those eating whole grain needed 3.76 pounds of grain and .51 pounds of supplement per pound of gain. However, after pooling all their 3-year data, Baker et al. concluded that the value of grinding was questionable. In two comparisons whole sorghum grain averaged 97 percent as efficient as ground sorghum grain, and in one comparison whole Kafir was 98 percent and whole Early Kalo 96 percent as efficient as the corresponding ground grain. In the one case in which grinding showed a material advantage the sorghum grain used had been stored for several months before feeding and was dry and apparently hard. The sorghums fed in all these trials were fully as palatable as shelled corn and the pigs fed either whole or ground sorghum grain produced carcasses apparently the equal of those from cornfed pigs in yield, finish, firmness and grade.

Wilson (1950 and 1951) fed sorghum grain free choice to growing fattening pigs. In the first experiment the pigs fed whole sorghum grain gained .05 pounds more per head per day. However, they gained .04 pounds less per head per day in the second trial. The total amount of feed per pig per pound gain in the first test was approximately the same although there was a difference of .03 pounds less grain eaten by the whole grain fed pigs. However, there was a difference of .13 pounds in feed requirement per pound gain in the second trial. The best feed conversion was for pigs fed whole grain.

Aubel (1954) fed free choice whole sorghum grain, ground sorghum grain, and shelled corn to growing finishing pigs. He reported pigs being fattened on ground sorghum grain made 12 percent greater average daily gain while pigs on whole sorghum grain produced 8 percent greater gain than pigs fed shelled corn. Pigs receiving sorghum grain in either form required less protein supplement and more grain per hundred pounds of gain.

Loeffel (1957) reported five trials of feeding free choice growing fattening pigs whole and coarsely ground sorghum grain. The varieties used were Wheatland, Sooner, White Kafir, and Coes. The average daily gain of the two groups, whole and ground sorghum grain fed pigs, were quite similar. In four trials the advantage in rate of gain was in favor of the pigs fed ground grain. In the fifth trial, there was a substantial increase in daily gain where the whole sorghum grain was fed. This explains why the two averages were so nearly the same.

From the standpoint of feed required per pound gain, an average of 3.69 pounds of whole sorghum grain was required as compared with 3.61 pounds of ground grain. In three cases less grain was required with the whole sorghum grain, and in two instances the opposite was true. The amount of supplement required per pound gain was practically identical in all cases.

In producing one pound of gain, 4.17 pounds of total feed was required where the whole sorghum grain was fed and 4.08 pounds where the coarsely ground grain was used. On this basis the coarsely ground sorghum grain was 2% more efficient than the whole grain. Since the cost of grinding generally exceeds this, there was no economic advantage in favor of grinding.

Loeffel (1957) conducted a trial designed to determine how finely grains should be ground. White Kafir sorghum grain was fed free choice coarsely ground (modulus of fineness 4.02) and finely ground (modulus of fineness 3.48). Pigs on coarse ground grain gained .05 pound per head per day more. They required 4.56 pounds of grain and .30 pounds of supplement per pound gain. Those fed finely ground grain required more feed per pound gain: 4.64 pounds of grain and .27 pounds of supplement.

Aubel (1961) reported both average daily gain and feed conversion in favor of ground grain fed pigs. Those animals gained .05 pounds per head per day faster, required .51 less pounds of grain but .02 more pounds of supplement per pound of gain than pigs fed whole grain.

One would assume that according to the above data it usually did not pay to grind sorghum grain when considering both average daily gain and feed conversion. The same can apparently be said for other methods of preparation also.

Aubel (1958) compared whole and dry rolled open pollinated and hybrid sorghum grain fed free choice. The open pollinated grain was of excellent quality, clean, high in protein and plump. The hybrid grain was inferior in every aspect. Pigs on open pollinated sorghum grain made similar gains with both preparations. Pigs on hybrid sorghum grain gained faster with dry rolled grain (.05 pounds per head per day). Those pigs required less feed per pound of gain (.20 pound less grain and .03 pound less supplement)

when fed dry rolled grain. The pigs eating open pollinated sorghum grain required the same amount of supplement per pound gain but .08 pounds less grain per pound gain when fed whole grain.

Aubel (1959) self fed free choice sorghum grain to four lots of growing finishing pigs. The preparations, varying in each lot, were whole, steam rolled, steam rolled with 5 percent molasses added, and steam conditioned rolled. The average daily gain per pig in descending order was: steam rolled plus 5 percent molasses added (1.40 pounds), whole (1.27 pounds), steam conditioned rolled (1.23 pounds), and steam rolled (1.12 pounds). The pigs fed steam rolled plus 5 percent molasses added did not convert their feed the most efficiently even though they made the highest average daily gain. They were third in feed efficiency (3.97 pounds of grain and .54 pounds of supplement per pound gain). Pigs fed whole sorghum grain required the least feed per pound gain (3.54 pounds of grain and .52 pounds of supplement). Those fed steam rolled grain required the highest (4.03 pounds of grain and .60 pounds of supplement). Those fed steam conditioned rolled grain were second in feed conversion (3.95 pounds of grain and .61 pounds of supplement).

Aubel (1960) compared five lots of pigs self fed free choice on sorghum grain and supplement. The grain preparation varied in each lot. Processing methods used were whole, dry rolled, steam rolled, and steam conditioned rolled. The steaming was at 90 pounds pressure and at 180°F. the conditioning was for four hours. Pigs receiving the steam rolled grain gained .02 pounds per head per day faster than those receiving dry rolled grain. Those two lots were the best gainers in the experiment. The lowest average daily gain was for whole sorghum grain (.10 pounds less than that of the steam rolled grain fed pigs). Pigs fed steam conditioned rolled grain gained .02 pounds faster than those fed whole grain.

Pigs fed dry rolled grain required the least feed per pound of gain (3.56 pounds of grain and .48 pounds of supplement). Those fed steam conditioned rolled grain required the highest amount of feed per pound gain (3.83 pounds of grain and .47 pounds of supplement). Those on steam rolled grain were third in feed conversion (3.78 pounds of grain and .52 pounds of supplement). Those on whole sorghum grain were second (3.62 pounds of grain and .52 pounds of supplement).

Aubel (1961) again studied the effects of various milling processes on feed conversion and rate of gain of growing finishing pigs fed free choice sorghum grain and supplement. The preparations were whole, steam rolled, dry rolled, steam conditioned rolled, fine ground, fine ground and pelleted. The pigs on dry rolled sorghum grain made the lowest average daily gain. Those fed fine ground and pelleted sorghum grain made the next lowest gains. Both of them also had a low feed conversion figure as well as low daily feed consumption. Those receiving steam rolled, fine ground, and steam conditioned rolled grain made an excellent showing both in daily gains and in feed conversion. The steam conditioned rolled and the steam rolled grain were wasted in large quantities. It was estimated that 2300 pounds of the steam conditioned rolled grain and 300 pounds of the steam rolled grain were wasted during the feeding period. During the steaming process those two feeds were subjected to heats of 180° to 200°F. Aubel thought it was possible that this destroyed or changed the food nutrients of those feeds. The ranking in descending order with respect to average daily gain in this experiment was steam rolled, finely ground, steam conditioned rolled, whole, finely ground and pelleted, and dry rolled. The descending order in feed conversion was finely ground, finely ground and pelleted, steam rolled, dry rolled, steam conditioned rolled, and whole.

As in the case of preference, it is impossible to draw conclusions with respect to which processing method produces the best feed conversion and the highest average daily gain when comparing whole, dry rolled, steam rolled, steam conditioned rolled and fine ground sorghum grain.

Sorghum grain has also often been fed as the only grain in complete swine rations usually either as a meal or in pelleted form. Jensen et al. (1959) compared different cereal grains as a replacement for yellow corn in corn-soybean oil meal rations for growing finishing pigs in dry lot. Studying the effect of pelleting upon the utilization of sorghum grain in three trials, they reported that feeding sorghum grain in a complete pelleted ration resulted in 8 percent faster gain than when feeding it in a complete meal ration. The amount of feed required per pound gain decreased with pelleting. In the three experiments, the average daily gains per pig for meal form were 1.69, 1.74, 1.73 pounds and 1.82, 1.76, 2.00 pounds for pelleted form. The feed required per pound of gain was 3.32, 3.79, 3.34 pounds for meal form and 3.24, 3.46, 3.22 for pelleted form.

Koch (1962) compared sorghum in pellet and meal form. Complete rations were self fed to 6 groups of growing finishing pigs. Pigs eating completely pelleted rations gained somewhat faster than those fed complete, meal rations. The average daily gains per pig were 1.97, 2.12, 2.01 pounds for pelleted ration; 1.91, 1.87, 1.81 pounds for meal ration. The average feed efficiency also favored the complete pelleted ration. Part of the difference in feed conversion was due to an observable but unmeasurable difference in feed wastage. Pigs eating pelleted ration wasted very little while those eating meal rations consistently wasted an unmeasurable amount. The amount of feed required per pound gain was 3.26, 3.02, 3.03 pounds for pelleted ration; 3.62, 3.41, 3.51 pounds for meal ration.

EXPERIMENTAL PROCEDURE

Experiment I - Preference

Experiment I was conducted at the Swine Testing Station. Its purpose was to determine the effect of physical preparation of sorghum grain on swine preference during the growing finishing period.

Six barrows and five gilts consisting of 4 Poland China, 3 Crossbred, and 4 Duroc were used. The pigs weighed approximately 31 pounds, averaged twelve weeks of age, and were the runts or tail-enders from the fall, 1962, farrowing period. They were the pigs that were left after pigs were assigned to other trials. They had been vaccinated for hog cholera, erysipelas, and wormed with piperazine before being put on test.

During the test, they were housed in a concrete floored pen 15 feet wide by 30 feet long with 20 feet of the pen under roof. Ninety square feet of area under roof was, however, shut from animal use due to their small number (see Plate I on page 17).

Pigs were self fed, free choice sorghum grain and a protein supplement.

Sorghum grain fed was a hybrid sorghum grain sold in Kansas under the trade name of "Griswold". The grain was fed in six two hole wooden self feeders. Each feeder had the grain prepared differently. The preparations were as follows:

(1) Whole sorghum grain

(2) Dry rolled sorghum grain:

The grain was passed through a fine corrugated roll mill with a roll spacing of 0.020 inch.

(3) Rolled and pelleted sorghum grain:

The grain was rolled as above, then pelleted using a 3/16 inch pellet die.

(4) Steam rolled sorghum grain:

The grain was steamed to a temperature of 96°C (205°F) then rolled through a fine corrugated roll mill with a roll spacing of 0.005 inch and cooled.

(5) Steam conditioned rolled sorghum grain:

The grain was steamed as above, then binned for 6 hours to temper or condition the grain. Then it was rolled through a roll mill with a roll spacing of 0.005 inch and cooled as above. The temperature immediately before rolling had fallen to 44°C.

(6) Ground sorghum grain:

The grain was ground through a 1/4 inch hammermill screen.

The chemical analysis of the grain fed is reported in Table 1 on an as received moisture basis. The same lot of grain was used to make all preparations.

Table 1. Chemical analysis of sorghum grain preparations and protein supplement used in both preference and performance experiments.

Preparation*	% Moisture	% Protein	% Ash	% Crude fat	% Crude fiber
Whole grain	-	-	-	-	-
Dry rolled grain	13.5	7.2	1.53	-	-
Rolled & pelleted grain	12.6	7.4	1.44	3.19	1.49
Steam rolled grain	14.8	7.1	1.39	-	-
Steam conditioned rolled grain	16.2	7.65	1.72	-	-
Finely ground	-	-	-	-	-
Protein supplement	7.6	39.7	16.79	3.06	6.87
Complete ration	11.6	13.95	4.65	3.17	2.76

* All preparations made from the same lot of "Griswold" sorghum grain.

The protein supplement used in addition to the sorghum grain in the experiment was fed in a separate feeder. It was formulated as follows:

Soybean meal 44%	1164 lbs.
Meat Scrap 50%	400 lbs.
Dehydrated alfalfa 17%	250 lbs.
Bonemeal	50 lbs.
Limestone	50 lbs.
Salt	50 lbs.
Trace minerals (5% Zn)	5 lbs.
Aurofac (1.8 g Aureomycin + 1.8 mg. B_{12}/lb.)	28 lbs.
Merck 58 - A	3 lbs.
	2000 lbs.

Merck 58 - A contained 2 gm. of riboflavin; 6 gms. of niacin; 3.68 gm. of D-panthothenic acid; and 20 gms. choline chloride per pound of supplement. The chemical analysis of the protein supplement is reported in Table 1 on an "as received" moisture basis.

Water was available at all times from an automatic waterer which was heated electrically.

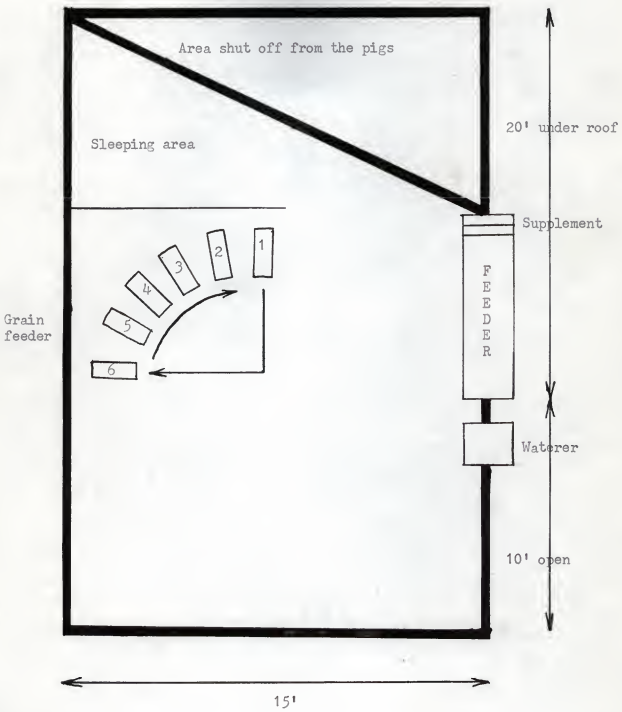
To prevent any preference due to nearness to drinking water or to supplement feeder or any other factor that might tend to instinctively draw pigs to a certain area, the grain feeders were rotated clockwise as shown in Plate I every three days. This preference test covered a period of 98 days. Feed consumption was used as the measure of preference.

Experiment II - Performance

Experiment II was conducted at the same location as experiment I.

Forty eight feeder pigs averaging 65 pounds in weight and twelve weeks of age were randomly divided as nearly as possible by weight, sex, and breed into groups of eight pigs each. The pigs like those on the preference trial had been vaccinated previously for hog cholera and erysipelas, and wormed with piperazine.

PLATE I


Area shut off from the pigs
Sleeping area
20' under roof
Supplement
F
E
E
D
E
R
Grain
feeder
1
2
3
4
5
6
Waterer
10' open
15'

Five groups of pigs consisted of three barrows and five gilts. One group consisted of four barrows and four gilts. With respect to breeds, four groups consisted of three Durocs, two Poland China's, and three Crossbreds. Two groups consisted of four Durocs, one Poland China, and three Crossbreds in one group and four Durocs, two Poland China's, and two Crossbreds in the other.

Each group of pigs was put in a pen 7 feet wide by 28 feet long with 16 feet of the pen under the roof. All lots except one were self fed free choice a protein supplement and sorghum grain prepared differently in each lot. The supplement used for all lots was the same as that used in the preference trial. The sorghum grain preparations randomly assigned to the pens were whole, dry rolled, rolled and pelleted, steam rolled, steam conditioned rolled, and a complete ration made up of 75% dry rolled sorghum grain and 25% protein supplement in meal form. The chemical analysis of all rations is listed in Table 1.

Water was always available from automatic waterers which were electrically heated. Some bedding was used during the first month of the trial due to the cold weather.

All rations were prepared in the Department of Flour and Feed Milling Industries as needed. Rations were handled in either 50 pound paper bags or 100 pound burlap sacks.

Pigs were weighed every 28 days. They were removed from test upon reaching approximately 200 pounds body weight. Average daily gain and average feed efficiency were used as criteria of performance.

The modulus of fineness and modulus of uniformity of processed sorghum grain fed free choice in the preference and the performance experiments are listed in Table 2. The steam rolled and steam conditioned rolled grain were

less fine than the dry rolled grain although they were passed through a narrower roll spacing. The reason was that these steamed grains were softened by the steam and the conditioning in the case of steam conditioned rolled sorghum grain. Thus, they passed through the rolls crushed instead of broken.

Table 2. Modulus of fineness and modulus of uniformity of processed sorghum grain used in the preference and performance experiments.

Processing method	Fineness modulus	Modulus of uniformity
Whole	4.92	9:1:0
Finely ground	2.09	0:5:5
Rolled and pelleted	3/18" pellet	-
Dry rolled	3.75	0:9:1
Steam rolled	4.71	8:2:0
Steam conditioned rolled	4.64	8:2:0
Complete ration	3.28	0:7:3

RESULTS

Experiment I - Preference

One hundred pounds of rolled grain, 98 pounds of fine ground grain, 75 pounds of steam rolled grain, 75 pounds of steam conditioned rolled grain, 100 pounds of whole grain and 100 pounds of rolled and pelleted grain were each put into the respective feeders at the start of the experiment.

During the first 28 day period the pigs showed a definite preference for rolled and pelleted sorghum grain. Five hundred pounds of grain processed by that method was added to that feeder during the first period. Next in preference was whole sorghum grain. Three hundred pounds of the whole grain was added to that feeder during the first period. No addition was made to any of the other feeders (rolled, steam rolled, ground or steam conditioned rolled).

Although the grain preparations were fed free choice with a protein supplement instead of as a complete pelleted ration, it appeared that a bias might occur because the pigs had previously been eating a pelleted starter. It was thus decided to change the experimental procedure and remove the preferred grain preparation at the end of each period until no definite preference was expressed by the pigs. All grain preparations would then be put back into the pen during the final period of the trial. It was felt that such a procedure would remove bias and give a more exact measure of preference.

During the second 28 day period, pigs began to eat some steam rolled and steam conditioned rolled sorghum grain. 325 pounds of steam rolled grain was added to that feeder. 150 pounds of steam conditioned rolled sorghum grain was added to that feeder. However, there was no addition of either ground or dry rolled grain. The animals still showed definite preference for whole sorghum for 600 pounds was added to that feeder. Whole sorghum grain was removed at the end of the second period.

In the third period, pigs had dry rolled, ground, steam rolled, and steam conditioned rolled grain to choose from. Four hundred twenty five pounds of steam rolled grain and 175 pounds of steam conditioned rolled grain was added to those respective feeders during that period. The pigs began to eat dry rolled grain also and 200 pounds was added to that feeder. They ate some ground grain but not enough to make an addition necessary. The third period was 14 days long instead of 28 days as the two previous ones.

All feeders were then put back into the pen during the fourth period. Pigs expressed an immediate preference for rolled and pelleted grain and whole grain. During this fourth period of 28 days 900 pounds of whole sorghum grain was added to that feeder, 600 pounds of rolled and pelleted grain was added to that feeder, 175 pounds of steam rolled grain was added to that feeder, and 100 pounds of dry rolled grain was added to that feeder. No addition was made to the steam conditioned rolled feeder or the ground grain feeder.

A complete summary of the additions of differently processed sorghum grain during the four periods of the experiment is shown in Table 3.

At the end of the experiment the differently processed sorghum grains had not been present in the pen for the same number of days. Rolled and pelleted grain had been present for only 56 days, whole grain for 84 days, and the others, steam rolled, dry rolled, steam conditioned rolled, and fine ground were present for 98 days. A modification in feed consumption calculation was hence necessary. Instead of the total consumption the average daily grain consumption per pig was used as a measure of preference. It was computed as follows: first the amount of feed consumed was divided by the respective number of days the feed was before the pigs, then the result was divided by the number of pigs on test or eleven. The average daily grain consumption per pig and the ranking of preference is presented in Table 4.

Table 3. Additions of sorghum grain during the four periods of the preference study.

Preparations	Grain put in at the start of the experiment lbs.	Amount in pounds of added grain				Total grain added	Grain weighed back	Total grain consumed
		1st period 28 days	2nd period 28 days	3rd period 14 days	4th period 28 days			
Rolled & palleted	100	500	removed off test	removed off test	600	1200	89	1111
Whole	100	300	600	removed off test	900	1900	148	1752
Dry rolled	100	0	0	200	100	400	72	328
Steam rolled	75	0	325	425	175	1000	86	914
Steam conditioned rolled	75	0	150	175	0	400	90	310
Fine ground	98	0	0	0	0	98	76	22

Table 4. Average daily grain consumption per pig and ranking of preference of processed sorghum grains used in the preference trial.

	Preparation					
	Whole	Ground	Rolled and pelleted	Steam rolled	Steam conditioned rolled	Dry rolled
Number of days on test	84	98	56	98	98	98
Total grain consumed lbs.	1752	22	1111	914	310	328
Average daily grain consumption per pig, lbs.	1.89	.02	1.76	0.84	.28	.30
Ranking in preference	1	6	2	3	5	4

Experiment II - Performance

Table 5 summarizes the data on the effects of sorghum grain processing upon the performance of the pigs during the growing finishing period.

One pig died in lot 2 and one died in lot 3 during the course of the experiment. Those pigs were not used in calculating gain data in the lot but their gain from the start of the trial to their death were used in calculating feed conversion. Death was not related to treatment in either case.

The pigs were taken off test individually when they reached approximately 190 to 200 pounds live weight. The average number of days on test per lot was computed by dividing the sum of the individual number of days on test by the number of individuals in the lot.

Table 5. Data on feed conversion and average daily gain per pig in the performance test.

Pen No.	1	2	3	4	5	6
Preparation	Rolled pelleted	Dry rolled	Whole	Steam rolled	Steam conditioned rolled	Complete ration (meal form)
No. of pigs	8	7*	8	8	7*	8
Average days on test per pig	87.75	90.57	89.50	87.75	84.00	84.25
Average on test wt. lbs.	66.85	67.50	66.75	66.62	67.37	66.25
Average off test wt. lbs.	190.25	200.71	198.00	193.00	202.71	200.12
Average daily gain per pig in lbs.	1.43	1.46	1.48	1.45	1.53	1.59
Feed consumed per lb. of gain						
grain	2.93	3.39	3.93	3.47	3.71	-
supplement	0.56	0.55	0.48	0.63	0.55	-
total	3.49	3.94	4.41	4.10	4.26	4.05
Average calculated crude protein level in percent	12.2	11.6	10.7	12.1	11.3	14.0

* One pig was not used in calculating gain data but was used in calculating feed conversion.

Feed was added as the pigs consumed it from the feeder. It was weighed back only when all pigs were removed from the lot. Therefore, feed conversion could not be analyzed statistically since the amount consumed was for the whole experimental period. The most efficient feed conversion was for the rolled and pelleted sorghum grain. The pigs on that treatment required 3.49 pounds of feed per pound of gain (2.93 pounds of grain and 0.56 pounds of supplement). The next most efficient feed conversion was for the dry rolled sorghum grain fed pigs. They consumed 3.94 pounds of feed per pound gain (3.39 pounds of grain and 0.55 pounds of supplement). The third most efficient feed conversion was for the complete ration, 4.05 pounds of feed were required per pound gain. Since that ration contained 25% supplement, this amounted to approximately 3.00 pounds of grain and 1.00 pounds of supplement per pound of gain. The fourth most efficient feed conversion was for the steam rolled sorghum grain. Those pigs needed 4.10 pounds of feed per pound gain (3.47 pounds of grain and 0.63 pounds of supplement). The fifth most efficient was for the steam conditioned rolled grain. Those pigs utilized 4.26 pounds of feed (3.71 pounds of grain and 0.55 pounds of supplement) per pound gain. The last and least efficient feed conversion was for the whole sorghum grain, 4.41 pounds of feed (3.93 pounds of grain, 0.48 pounds of supplement) per pound gain was required.

The pigs were weighed every twenty eight days. The final total gain and the average daily gain of each pig was computed. The analysis of variance was calculated to determine the significance of the average daily gain per pig per lot.

Because of the unequal distribution of sex within each of the six lots, in order to analyze the gains the method used was the proportional subclass number method. Data tabulated in Table 6 shows the results of the different steps of the analysis of variance. These steps were computed as follows:

The total N was the number of pigs on test or 46.

ΣX was the sum of the average daily gains of the 46 pigs.

ΣX^2 was the sum of the squares of the average daily gains of the 46 pigs.

The ration sums were the sums of the average daily gains per lot. There were 6 ration sums computed since there were six rations.

The sex sums were the sums of the average daily gains of each sex in the whole experiment. Thus there were two sex sums: male and female.

The correction term C was computed by dividing the square of the sum of the average daily gains of the 46 pigs by the number of pigs.

The total sum of squares was equal to the sum of the squares of the average daily gains minus the correction term.

The corrected subclasses sum of squares was equal to the difference between the sum of the quotients of the squares of the total of the average daily gains of each sex in each lot divided by the number of individuals of that sex in the lot and the correction term.

The within subclasses sum of squares was the difference between the total sum of squares and the subclasses sum of squares.

The corrected sex sum of squares was equal to the difference between the correction term and the sum of the quotients of the squares of the sex sums divided by the total number of individuals of that sex.

The corrected ration sum of squares was equal to the difference between the correction term and the sum of the quotients of the squares of the ration sums divided by the total pigs in the lot.

Table 6. Analysis of the variance of average daily gain of the pigs.

	Ration											
	1		2		3		4		5		6	
Number	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1	1.32	1.79	1.45	1.55	1.74	1.42	1.15	1.27	1.61	1.34	1.59	1.35
2	1.35	1.22	1.48	1.12	1.69	1.03	1.52	1.56	1.42	1.47	1.69	1.62
3	1.36	1.31	1.56	1.53	1.40	1.83	1.66	1.48	1.73	1.87	1.59	1.47
4		1.44		1.54		1.37		1.69		1.31	1.69	1.52
5		1.67				1.38		1.33				
Σx	4.03	7.43	4.49	5.74	4.83	7.03	4.33	7.33	4.76	5.99	6.56	6.16

Total = N: 46

$\Sigma x = 68.68$

$\Sigma x^2 = 409.29$

Ration sums: 1;11.46, 2;10.23, 3;11.86, 4;11.66, 5; 10.75, 6;12.72

Sex sums: Male 29 Female 39.68

Correction: $C = (\Sigma x)^2/n = 102.54$

Total = $x^2 - C = 306.75$

Subclasses: $\frac{(4.03)^2}{3} + \frac{(7.43)^2}{5} + \ldots + \frac{(6.16)^2}{4} - C = 0.24$

Within subclasses: $306.75 - 0.24 = 306.51$

Sex: $\frac{(29)^2}{19} + \frac{(39.68)^2}{27} - C = 0.03$

Ration: $\frac{(11.46)^2}{8} + \frac{(10.23)^2}{7} + \ldots + \frac{(12.72)^2}{8} - C = 0.11$

Interaction: $0.24 - (0.03 + 0.11) = 0.10$

Source of variation	Degree of freedom	Sum of squares	Mean squares
Sex	1	0.03	0.03
Ration	5	0.11	0.02
Ration sex interaction	5	0.10	0.02
Within subclasses	35	306.51	8.75

Insignificant at either level (5% and 1%)

The interaction sum of squares was equal to the subclasses sum of squares minus the ration sum of squares and the sex sum of squares.

The analysis of variance showed there were no significant differences at any level .05 or .01. Thus one could conclude that the ration (or grain preparation method) did not affect the average daily gain of the pig; neither did the sex, nor the ration and sex interaction.

DISCUSSION

Experiment I - Preference

The results indicated that whole sorghum grain was the best liked by the pigs. Next came rolled pelleted sorghum grain. The third liked was steam rolled sorghum grain. Difference in the palatability of the steam conditioned rolled sorghum grain and the dry rolled sorghum grain was not clear cut. The fine ground sorghum grain was the least liked.

The possible bias at the beginning of the trial seemed to be corrected by the change in procedure, removal of the rolled and pelleted grain and putting it back at the end of the experiment. The pigs which had been raised on pelleted starter ate the greatest amount from the rolled pelleted sorghum grain feeder during the first period of the experiment. When that preparation was removed and put back at the end of the experiment i.e., 42 days after being removed, they came to it at once but did not prefer it over whole grain as at the beginning.

Pelleting of a complete ration had been shown to improve the palatability of the feed. Whether pelleting sorghum grain alone would improve the palatability over that of any other processed sorghum grain had not been clearly shown. Aubel (1961) fed grain that was finely ground and pelleted instead of rolled and pelleted. That ground pelleted sorghum grain was the

least palatable as compared to whole, fine ground, dry rolled, steam rolled and steam conditioned rolled sorghum grain. Sanford (1952) compared whole, pelleted and dry rolled sorghum grain in chicken rations. He reported that the chickens ate 1.9 pounds of whole sorghum grain, 66 pounds of pelleted sorghum grain and 93 pounds of rolled sorghum grain during an eight week period. Feeding sorghum grain in complete rations, Jensen et al. (1959), reported that pigs sometimes ate more meal form and sometimes more pellet form. But a complete ration is different from free choice feeding and the bird has different anatomy than the pig. Thus those two studies may not be of value in answering the question at hand.

While the question of pelleting sorghum grain to improve the palatability had not been answered by previous reports, whole sorghum grain had been shown to be more palatable than ground sorghum grain, Texas Agricultural Experiment Station (1930, 1931), Baker (1936, 1937, 1939), Loeffel (1957), Aubel (1961). All of them reported the same conclusion in spite of the fact their testing of palatability was not done by putting all feeders in the same pen but rather in different randomized pens. There is a question as to how much the degree of grinding affects the palatability. Loeffel (1957), comparing coarse and fine ground sorghum grain, found that pigs ate less of the fine ground grain. The finer the grain was ground, the less palatable it was possibly because it was more dusty. The dust could possibly irritate the nose or esophagus of the pig.

Few studies have been reported in which the palatability of whole sorghum grain has been compared to that of either steam rolled, steam conditioned rolled, or dry rolled sorghum grain. Aubel (1959) found the descending order of palatability to be: whole, steam conditioned rolled and steam rolled. In 1960, he found that the descending order of palatability

was: steam conditioned rolled, steam rolled, dry rolled, and whole. In 1961 he found whole and steam conditioned rolled of equal palatability. Those two processings were better liked than steam rolled, fine ground and dry rolled. This present experiment indicated that whole grain and rolled pelleted grain were the best liked as compared to steam rolled, dry rolled, steam conditioned rolled, and fine ground. Which findings are correct? It is impossible to say but one should remember that results reported by other workers were from tests where pigs were not in the same environment. They were given different rations in different pens.

The palatability difference between steam conditioned rolled and dry rolled sorghum grain was not clear cut in this experiment. If one considers feed consumption as an index of palatability as is usually done, dry rolled sorghum grain was more palatable since it was consumed more (Table 4). That result would then agree with Aubel 1960 and 1961 tests. But if one considers that if an animal given a choice learns to eat the type of processing he liked faster than another type then steam conditioned rolled sorghum grain which was eaten first (Table 3) was the more palatable. One could argue here then why there was no addition of steam conditioned rolled sorghum grain in the fourth period. The reason which could be given was that since a habit could not be broken at once, the pigs which learned to eat the dry rolled grain after the steam conditioned rolled grain still ate the dry rolled grain and some had to be added. In fact it was observed they continued to eat some of these two processed grains besides the whole and rolled pelleted sorghum grain. However, the consumption was not high enough to make an addition of steam conditioned rolled necessary. What was left from other additions was enough.

In conclusion one can say that on the basis of the results of this experiment whole sorghum grain was more palatable than any processed grain. Whether that palatability would be an advantage or not depends on the feed conversion and the average daily gain of pigs fed that type of preparation. Furthermore, it depends on the cost of processing. The same rule could be applied on any type of processing when compared to another type.

Experiment II - Performance

Average daily gain - The analysis of variance indicated that there was no difference in the effect of the processing of the sorghum grain with respect to the average daily gain. Such a result would be expected in view of results previously reported by other researchers.

Texas Agricultural Experiment Station (1930, 1931) reported the same average daily gain in one experiment and a different one in another (.07 difference) when comparing whole and ground sorghum grain fed free choice to growing fattening pigs. Baker (1936, 1939) and Loeffel (1957) indicated there was only .01 pound of difference in similar comparisons. Wilson (1950, 1951) found the difference very small (.04) in similar trials.

Aubel (1956) reported pigs fed whole and dry rolled sorghum grain free choice with a supplement made only .01 pound difference in average daily gain. Those on steam rolled sorghum grain made .23 pound less in average daily gain as compared to pigs fed the above processed grain. In 1958 using whole and dry rolled sorghum grain, Aubel found a difference of .01 pound in one trial, .04 in another. In 1959 comparing whole, steam rolled, and steam conditioned rolled sorghum grain fed free choice with a supplement Aubel reported a .04 pound difference between the whole and the steam conditioned rolled grain. The greater gain was for the whole grain. A difference of .13

pound was found between pigs fed whole grain and those fed steam rolled grain. In 1960 Aubel's steam rolled and dry rolled sorghum grain fed pigs had a difference of .02 pound in average daily gain with the advantage favoring steam rolled grain. Those on steam conditioned rolled and whole sorghum grain had a difference of .02 pound in average daily gain per head. They gained .10 pounds and .12 pounds respectively less per head per day than the pigs fed the first two processed grains mentioned. In Aubel's 1961 report the range of variation was .24 between the lowest and the highest average daily gain of pigs fed whole, steam rolled, fine ground, fine ground and pelleted, dry rolled, and steam conditioned rolled sorghum grain.

The present experiment had a range of variation of .16 pounds per day in average daily gain. The lowest average daily gain was 1.43 and the highest, 1.59. Yet the analysis indicated no effect of treatment on the average daily gain. Although ground grain was not used in this performance experiment, one can consider Aubel's earlier results. None of Aubel's data was analysed statistically. Although statistical analysis does not prove a point, it does help to conclude: whether the differences are real, whether they are due to something measured or due to chance. Except for two trials (1961 and 1959) where average daily gains per pig were quite different (.24 pounds and .23 pounds) Aubel's data showed small differences (.01 pounds to .13 pounds). One can thus conclude that in his experiments the average daily gains were not significantly different. Such a conclusion agrees with the findings of the experiment reported here.

Feed Conversion - The above findings point out the fact that the feed conversion per pound of gain and costs are the decisive points in the choice of a physical preparation of sorghum grain in swine feeding.

Table 7 indicated the best feed conversion was for the rolled and pelleted sorghum grain. The next best was for the dry rolled sorghum grain. The descending order of feed conversion of other processed sorghum grain was complete ration, steam rolled sorghum grain, steam conditioned rolled sorghum grain, and finally the whole sorghum grain.

If an analysis of variance could be done, some more information could be secured with respect to whether the differences in feed conversion were really due to the physical preparation or due to chance. One can, however, discuss the results to a certain extent on the basis of previously reported data.

Pelleting a ration has been shown to be a good means of increasing feed efficiency. Jensen (1959), Koch (1962) fed sorghum grain in complete rations either in pellet or meal form. They reported that pigs required less feed per pound of gain for the pelleted ration. Aubel (1955) compared free choice feeding of shelled corn and a mixed protein supplement with shelled corn and supplement in pelleted complete ration. Pigs eating pellets were more efficient. Aubel (1961) fed free choice sorghum grain and a supplement to growing fattening pigs. He found in spite of the fact that it produced the slowest gain, fine ground and pelleted sorghum grain gave the second best feed conversion when compared to whole, fine ground, steam rolled, dry rolled, and steam conditioned rolled sorghum grain. One can thus conclude pelleting of the sorghum grain does improve its feed efficiency. Whether this better feed efficiency is due to less waste, it is difficult to answer. Pigs on this experiment did waste an unmeasurable amount of dry rolled sorghum grain. Koch (1962) reported the same unmeasurable waste with complete meal rations. However, in Aubel's 1961 experiment the fine ground sorghum grain fed pigs had a better feed conversion than those fed fine ground and pelleted sorghum grain.

The second fact one must consider from the results of this experiment is the poor feed conversion of pigs fed whole sorghum grain. Texas Agricultural Experiment Station (1930, 1931) reported that 2 or 3 percent of the grain passed through the pigs when whole grain was fed. Wilson (1950, 1951) also indicated the whole hard seed was not completely utilized by the animal body. The same observation was made in this present experiment and seemed to explain the poor feed conversion of the pigs fed unprocessed grain. But when one examines Aubel's data, only Aubel's 1961 test agrees with the results of this experiment. Aubel (1956) found that whole sorghum grain fed pigs were less efficient than those on steam rolled sorghum grain but more efficient than those fed dry rolled grain. Aubel (1958) reported it required less feed per pound gain for whole open pollinated sorghum grain as compared to the dry rolled form. It was not true, however, for the hybrid sorghum grain he fed. In 1959 Aubel's pigs fed whole sorghum grain required less feed per pound gain than those fed steam rolled or steam conditioned rolled sorghum grain. In 1960, once more Aubel reported pigs fed whole sorghum grain required less feed per pound gain than those fed steam rolled and steam conditioned rolled sorghum grain, but they required more than those fed dry rolled sorghum grain.

Steam rolled and steam conditioned rolled sorghum grain can also be compared to dry rolled sorghum grain. The steaming of the grain was an attempt to soften the grain to increase the feed utilization value and to reduce the dust formed during processing. Conditioning had the same purposes. The softening of the hard grain did take place since the grain was not broken when passed through the roller mill. The modulus of fineness indicated that the steam rolled or steam conditioned rolled sorghum grain was not as fine as the dry rolled grain. Also when looked at under the

magnifying lens, those two processed grains showed a lot of surface area. Whether the surface area was the same when comparing the dry rolled and the steam rolled or steam conditioned rolled grain was not determined. It appeared that it could be the same. If it was the same and if the rule of utilization was that the more surface area the feed had, the more it could be digested and thus utilized, steam rolled and steam conditioned rolled sorghum grain should show a similar feed efficiency to that of dry rolled sorghum grain. However, the results of this experiment indicated they had less feeding value thus there was no need of steaming or conditioning. Reviewing previous works, results of this experiment agree with Aubel's 1960 test where dry rolled sorghum grain fed pigs had a better feed conversion than those fed steam rolled and steam conditioned rolled sorghum grain. However, they disagree with Aubel's 1961 test where pigs fed steam rolled and steam conditioned rolled sorghum grain showed a better feed conversion than pigs fed dry rolled sorghum grain. The best feed conversion in that test was made by pigs fed steam rolled sorghum grain.

The cost of processing must be considered when choosing a method of physical preparation, as well as the number of days to reach 200 pounds body weight. The costs of processing per hundred pounds feed at the Department of Flour and Feed Milling Industry of Kansas State University were as follows:

Rolling	$ .10
Steam rolling	.15
Steam condition rolling	.15
Mixing (complete ration)	.10
Rolling & pelleting	.20

Added to the cost of grain, the costs of the different rations were as follows:

Table 7

Preparation	Complete ration	Whole	Rolled and pelleted	Steam rolled	Steam conditioned rolled	Dry rolled
Cost per 100 lbs; dollars						
grain		2.06	2.26	2.21	2.21	2.16
supplement		4.77	4.77	4.77	4.77	4.77
complete ration	2.91					
Feed per 100 lbs. gain						
grain		393	293	347	371	339
supplement		48	56	63	55	55
total	405	441	349	410	426	394
Feed cost per 100 lbs. gain in dollars						
grain		8.09	6.62	7.66	8.19	7.32
supplement		2.28	2.67	3.00	2.62	2.62
total	11.78	10.37	9.29	10.66	11.81	9.94
Ranking in cost (1 = lowest cost)	5	3	1	4	6	2

Whole sorghum grain	$ 2.06/cwt
Dry rolled sorghum grain	2.16/cwt
Steam rolled sorghum grain	2.21/cwt
Rolled & pelleted sorghum grain	2.26/cwt
Complete ration (25% supplement)	2.91/cwt
Supplement	4.77/cwt

Using these costs, the results indicate that one should feed rolled and pelleted sorghum grain unless he lived far away from a mill, so that the transport fee would be an additional cost. Dry rolling is the next to be recommended. Steam rolling and steam conditioned rolling should be avoided since whole sorghum grain cost less per 100 pounds of gain produced. A summary of the costs is given in Table 7.

The complete ration and the steam conditioned rolled sorghum grain fed free choice did not produce the best feed conversion figures but they did give the highest average daily gain figures. They required the fewest days to get pigs to market weight. A farmer trying to take advantage of the market price could possibly profit by using those methods of processing.

GENERAL SUMMARY

Two experiments were designed to test the preference and performance of growing finishing pigs eating sorghum grain processed in different ways and fed free choice along with a supplement. The physical preparations were whole, dry rolled, ground, steam rolled, steam conditioned rolled, and rolled and pelleted. In the performance trial, the ground sorghum grain was replaced by a complete meal sorghum grain ration containing 14% crude protein.

The following results were observed:

1. Pigs did prefer certain physical preparations more than others. With respect to physical preparations of sorghum grain, they showed they liked the unprocessed grain the best.

2. The ranking in descending order of preference as affected by the preparations was: whole, rolled and pelleted, steam rolled, steam conditioned rolled, dry rolled, and fine ground sorghum grain.
3. No significant difference was obtained in gains as affected by the six rations: whole grain, steam rolled grain, steam conditioned rolled grain, dry rolled grain, rolled and pelleted grain, and complete meal ration.
4. There was a difference in feed conversion, however, whether the difference was due to chance or treatment was not known. The experimental procedure did not permit an analysis.
5. Rolled and pelleted sorghum grain fed free choice with a supplement gave the best feed conversion. Whole grain gave the poorest feed conversion.
6. Pelleting showed an advantage compared to rolling sorghum grain. .45 pound of feed per pound gain less was required when rolled grain was pelleted.
7. Steaming did not improve feed conversion. Steam rolled sorghum grain required .16 pound more feed per pound gain than dry rolled sorghum grain.
8. Conditioning did not improve feed conversion either. Steam conditioned rolled sorghum grain required .16 pound more feed per pound gain than steam rolled sorghum grain.
9. Steaming and conditioning, however, did soften the grain as it was observed by the higher modulus of fineness although a narrower roll spacing was used as compared to dry rolling.

10. Cost wise when fed free choice with a supplement rolled and pelleted sorghum grain was the most economical. Next came the dry rolled sorghum grain. The steam rolled and the steam conditioned rolled sorghum grain costs were higher than that of whole sorghum grain.
11. The complete ration cost was the second highest. However, the rate of gain of pigs on that ration was the highest.

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EFFECTS OF SORGHUM GRAIN PROCESSING UPON SWINE PERFORMANCE AND PREFERENCE DURING THE GROWING FINISHING PERIOD

by

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Two experiments were conducted at Kansas State University to determine the effects of various sorghum grain processing methods on swine preference and performance during the growing finishing period.

Eleven feeder pigs weighing approximately 21 to 41 pounds each were put in a concrete floor pen 15 feet wide by 30 feet long with 20 feet under roof. All had been wormed and vaccinated before being assigned to the preference test.

The pigs were fed for 98 days. Six grain feeders were put in the pen and rotated clockwise every three days. The sorghum grain in each feeder varied in physical preparation. The six treatments were: whole, ground, dry rolled, rolled and pelleted, steam rolled, and steam conditioned rolled. The supplement was fed in a separate feeder. Water was always available.

The results in the first period of the experiment (28 days) required a change of procedure. Pigs ate almost entirely rolled pelleted sorghum grain during that period. Therefore, the preferred preparation was removed at the end of each period until no significant differences were observed. Then all preparations were again put before the pigs for the same period of time as the first period.

Final results indicated pigs liked whole sorghum grain the best, ground sorghum grain the least. The ranking of preference indicated by the average daily consumption and by total intake was: whole, rolled and pelleted, steam rolled, dry rolled, steam conditioned rolled, and fine ground.

In the performance experiment, 48 feeder pigs weighing an average of 65 pounds each and averaging twelve weeks of age were randomly divided by weight, sex, and breed into groups of 8 pigs each. All had been vaccinated and wormed before being put on test. Each group of pigs was placed in a pen 7 feet wide by 28 feet long with 16 feet under roof.

One lot received a complete meal ration containing 75% dry rolled sorghum grain and 25% supplement. The others were fed free choice the same supplement and sorghum grain processed in a particular way. The treatments were whole, rolled and pelleted, steam rolled, dry rolled, and steam conditioned rolled. Water was always available. The pigs were fed until they weighed approximately 200 pounds. The average daily gain and feed conversion were used as criteria of performance.

Statistical analysis indicated there was no effect of treatments on the difference in average daily gain. Complete ration fed pigs made the highest average daily gain.

Feed conversion was not analyzed statistically since the pigs were group fed. Results indicated that pigs fed free choice the supplement and rolled and pelleted sorghum grain made the best feed conversion. The poorest was made by the pigs fed free choice the supplement and whole sorghum grain. Pelleting did improve the feed efficiency of dry rolled grain possibly because of reduced waste. Steaming and conditioning both softened the grain but neither improved the feeding value of the grain. Both steam rolled and steam conditioned rolled sorghum grain made a poorer feed conversion than dry rolled grain with the steam conditioned rolled grain showing the poorest conversion.

Costwise rolled and pelleted sorghum grain was the least costly in terms of gain produced per 100 pounds of feed. Next came dry rolled grain. Feeding steam rolled and steam conditioned rolled grain cost more than feeding of whole grain. However, steam conditioned rolled sorghum grain and complete ration produced the highest average daily gain.