EFFECTS OF METHOD OF PREPARATION AND PHYSICAL FORM ON FEEDING VALUE OF SORGHUM GRAIN FOR GROWING-FINISHING SWINE

by

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INTRODUCTION

According to the report released by U.S.D.A. in the year 1964, the total sorghum grain production in the United States was 583 million bushels in 1963.

In the central and southern Great Plains, sorghum grain has become increasingly important as a feed grain the past few years. It plays an important economic role in agriculture. Reductions in wheat acreage have forced farmers to produce some other crop to stabilize their income. Except along the northern border where corn is profitably grown, sorghum grain is the principal grain which is grown in most of parts of Kansas for feeding livestock.

Chemically, sorghum grain resembles corn in composition and in feeding value. Like corn, it contains about 70 percent of nitrogen free extract which is nearly all starch, and it is low in fiber and rich in total digestible nutrients. It has somewhat more protein and less fat when compared to corn. The same as corn, it is also deficient in certain minerals and amino acids.

Sorghum grain is excellent for swine and has nearly the same feeding value as corn. Numerous experiments have shown that the chief varieties of sorghum grain produce the same gain as corn and their feeding values are about 90 to 95 percent of that of corn. Recent reports have gone to the extent of saying that the sorghum grain may be 99 percent as efficient as corn when properly supplemented in the ration. So swine producers may use sorghum grain more and more in feeding their pigs.

The experiment was conducted to attempt to measure how preparation and physical form might increase feed efficiency, rate of gain, and also how they

might affect the palatability of the sorghum grain during the growing-finishing period of pigs.

REVIEW OF LITERATURE

As the use of sorghum grain has increased, there has been a series of research reports on its feeding value as compared to the feeding value of other grains. In the past few years, only a few controlled experiments have been designed to study the effects of sorghum grain processing upon the performance of swine during the growing-finishing period. With the increased use of sorghum grain by livestock feeders, there has been an increased interest in more scientific data with regard to preparation and feeding value.

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 to fattening pigs. Their tests showed that only two or three percent of the grain passed through the pigs undigested, when fed as whole grain. The pigs were reported to chew the whole grain more thoroughly when self-fed than they did when it was hand fed twice daily. The pigs fed whole Kafir gained 1.75 lb. daily and required 3.24 lb. of grain and 0.38 lb. of supplement per pound gain. Those fed ground Kafir gained 1.68 lb. daily and required 3.24 lb. of grain and 0.37 lb. of supplement per pound gain.

The Texas Agricultural Experiment Station (1931) again compared the feeding value of sorghum grain affected by the physical preparation. The average daily gain was the same in both lots. Pigs fed whole Kafir required 3.07 lb. of grain and 0.62 lb. of supplement while those fed ground grain required 3.10 lb. of grain and 0.57 lb. of supplement per pound gain. Thirty-nine pairs of pigs were fed. Eleven were reported to have consumed

more ground grain than whole grain.

Aubel (1934) studied the relative palatability of different varieties of sorghum grains when fed to swine. The varieties of sorghum grains namely Wheatland, Red Kafir, Pink Kafir, Blackhull, Atlas, Grohoma, Kalo, Sumac and Club were used. No other feed was given except a daily allowance of tankage. The results indicated that Red Kafir was the most palatable of all the varieties tested when fed in ground form.

Baker and Reinmiller (1936) fed Wheatland sorghum grain free-choice to growing fattening pigs. The sorghum grain was fed whole or coarsely ground through a burr-type mill. The pigs fed whole grain ate 0.33 lb. per pig per day more than those fed ground grain. But the later made 0.10 lb. more rapid gains per head per day. They required 3.11 lb. of grain and 0.58 lb. of supplement per pound gain while the whole grain fed pigs required 3.52 lb. of grain and 0.60 lb. of supplement per pound gain. At the conclusion of the trial, pigs fed ground grain were heavier and fatter than those fed whole grain.

Baker et al. (1937) compared White Kafir and Sooner sorghum grain free-choice, ground or whole, to five lots of growing-finishing pigs. They reported the gains of all five lots were quite satisfactory, and with one exception quite uniform at 1.62 lb. per head per day. The exception was a gain of 1.80 lb. per day for pigs fed ground Kafir. According to this trial grinding the sorghum grain did not increase its feed efficiency, as the ground sorghum grain and supplement were only 96 percent as efficient as whole sorghum grain and supplement.

Baker et al. (1939) again fed sorghum grain of Kalo variety. The grain was fed either whole or ground free-choice to growing-fattening pigs. The

pigs eating whole grain gained 0.11 lb. per pig per day less than those eating ground grain. Pigs ate 0.08 lb. per head per day more of the ground grain than of the whole grain and they utilized feed much more efficiently. They required 3.56 lb. of grain and 0.53 lb. of supplement while those eating whole grain needed 3.76 lb. of grain and 0.51 lb. of supplement per pound gain. On comparison of their three years experimental data, they concluded the value of grinding sorghum grain was not clear. The data showed in two comparisons that whole sorghum grain was approximately 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. The sorghum grain fed in all these trials was fully as palatable as shelled corn. Carcass grades acceptable in every way showed no advantage for the pigs in any one lot over the pigs in the other lots when pigs fed either whole or ground sorghum grain. Neither were there any appreciable differences in the dressing yield.

Wilson (1950, 1951) studied the value of sorghum grain ground and whole for growing-fattening pigs in dry lot. In the experiment the pigs fed whole sorghum grain gained 0.05 lb. and ate 0.14 lb. per pig per day more than those fed ground grain. However, in the second experiment, he reported they ate 0.86 lb. per pig per day more of ground sorghum grain. The total amount of feed per pig per pound gain in the first experiment was approximately the same. There was a difference of 0.13 lb. in feed required per pound gain in the second trial. The best feed conversion was for pigs fed whole sorghum grain.

Aubel (1954) fed free-choice whole sorghum grain, ground sorghum grain and shelled corn to growing-finishing pigs. He found pigs being fattened on

ground sorghum grain made 12 percent greater average daily gain and pigs on whole sorghum grain produced 8 percent greater gain than those fed shelled corn. He concluded that pigs receiving either whole or ground sorghum grain required less protein supplement but more grain per hundred pounds of gain than those fed corn.

Loeffel (1957) reported that whole grain on the average appeared to be more palatable than coarsely ground grain. The grains used were White Kafir, Wheatland, Sooner Milo, and Coes in five trials of feeding free-choice to growing-fattening pigs. Those fed whole sorghum grain ate 0.15 lb. per head per day more than those fed ground sorghum grain. Slightly more supplement was consumed daily per pig (0.80 lb. vs. 0.78 lb.) where the sorghum grain was fed ground. In the first four trials, the advantage in rate of gain was in favor of the pigs fed ground sorghum grain. However, in the fifth trial, there was a substantial increase in daily gain where the whole sorghum grain was fed. An average 3.69 lb. of whole sorghum grain was required per pound of gain while 3.61 lb. feed per pound gain of ground sorghum grain was required. In producing one pound of gain, 4.17 lb. of total feed was required where the whole sorghum grain was fed and 4.08 lb. where the coarsely ground grain was required. Pigs eating coarsely ground grain ate 0.08 lb. per head per day more than the whole grain. The same protein supplement was used in both lots, and the amount of supplement required per pound gain was practically identical in all cases. He pointed out there was no economic advantage from grinding sorghum grain.

Loeffel (1957) fed pigs White Kafir sorghum grain ground to two degrees of fineness. The coarsely ground grain had a modulus of fineness of 4.02, and the fine ground grain was 3.48. Both rations were fed free-choice with

the same protein supplement. The results indicated that pigs fed coarsely ground grain ate 0.08 lb. of feed and gained 0.05 lb. per pig per day more than those fed fine ground grain. They required 4.56 lb. grain and 0.30 lb. supplement per pound gain while those fed fine ground grain required 4.64 lb. of grain and 0.27 lb. of supplement.

Aubel (1958) compared corn with both open-pollinated and hybrid sorghum grain, with the sorghum grains prepared for feeding in different ways. Five lots of pigs were self-fed free-choice in dry lot. In this experiment, all lots received a protein supplement, and lot 1 whole hybrid sorghum grain, lot 2 rolled hybrid sorghum grain, lot 3 whole open-pollinated grain, lot 4 rolled open-pollinated grain and lot 5 shelled corn. The open-pollinated grain was of excellent quality, clean, high protein and good plump grain. The hybrid grain was inferior in every aspect. Pigs receiving the open-pollinated grain made the largest daily gain of 1.36 lb. and 1.37 lb. for lots 3 and 4, respectively. However, pigs fed rolled hybrid sorghum grain gained faster and required less feed per pound of gain (0.20 lb. less grain and 0.03 lb. less supplement) than those fed whole hybrid grain. The pigs eating open-pollinated grain required the same amount of supplement per pound gain, but 0.08 lb. less grain per pound gain when fed whole grain. All factors considered, the sorghum grains, both open-pollinated and hybrid grain showed up well.

Aubel (1959) reported that five lots of pigs were self-fed free-choice in dry lot. All received a mixed animal and plant protein supplement. The sorghum grain ration for each lot was prepared in the following manner: whole, steam rolled, steam rolled added 5% molasses, steam conditioned rolled and shelled corn. (The sorghum grain was steamed at 90 pounds pressure at 180° F.) Pigs fed steam rolled grain with 5% molasses ate the most feed per

day (5.58 lb. grain and 0.76 lb. supplement) and made the largest gain (1.40 lb.), but did not convert their feed the most economically. Results of gains made by pigs on other rations were as follows: whole grain 1.27 lb., steam conditioned rolled 1.23 lb., and steam rolled 1.12 lb. gain per pig per day. Pigs fed steam rolled grain required 4.03 lb. of grain and 0.60 lb. of supplement per pound of gain which was the highest. Feed per pound of gain by pigs fed other rations were as follows; steam conditioned rolled grain 3.95 lb. of grain and 0.61 lb. of supplement, steam rolled added 5% molasses 3.97 lb. of grain and 0.54 lb. of supplement, and whole grain 3.54 lb. of grain and 0.52 lb. of supplement.

Aubel (1960) compared five lots of pigs which were self-fed free-choice on sorghum grain and protein supplement. The ration preparation varied in each lot. The processing methods used were: whole, dry rolled, steam rolled and steam conditioned rolled. (The grain was steamed at 90 pounds pressure and at 180° F.) Pigs receiving the steam rolled grain and dry rolled grain gained at approximately the same rate, 1.43 and 1.41 lb. per pig per day respectively. The poorest gain 1.33 lb. per pig per day was made by pigs fed whole grain. Those receiving steam conditioned rolled grain gained 0.02 lb. faster than those fed the whole grain ration.

Pigs fed steam conditioned rolled grain required the highest amount of feed per pound gain (3.83 lb. grain and 0.47 lb. supplement). Feed efficiency for pigs on the other treatments were as follows: steam rolled grain 3.78 lb. grain and 0.52 lb. supplement, whole grain 3.62 lb. grain and 0.52 lb. supplement, and dry rolled grain 3.56 lb. grain and 0.48 lb. supplement.

Aubel (1960) studied the effect of soaking whole sorghum grain compared with whole dry sorghum grain for finishing fall pigs in dry lot. Two lots

of pigs were self-fed free-choice sorghum grain and the same protein supplement. Pigs receiving soaked whole sorghum grain made faster daily gains but consumed about 19 lb. more grain per 100 pounds gain than those fed dry whole sorghum grain. The soaked sorghum grain apparently was more palatable than the dry, for the pigs ate one pound more per head per day. From this trial, he concluded that there was no advantage in soaking sorghum grain for pigs. Gain and feed efficiency were very much the same.

Aubel (1961) determined the effects of various milling process on feed efficiency of growing-finishing pigs. Six lots were self-fed free-choice in dry lot. The ration for each lot varied only in the method of processing the grain as follows: whole, steam rolled, fine ground, fine ground and pelleted, dry rolled and steam conditioned rolled. (The sorghum grain was steamed at 90 pounds pressure and at 180° F.) In the fine grinding, a 1/8-inch hammer mill screen was used. In the dry rolling, a 0.02 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 inch. The steam conditioned rolled grain was conditioned for 8 hours before the rolling took place. The temperature immediately before rolling had fallen to 60° C.

Pigs fed steam rolled, fine ground, and steam conditioned rolled grain made an excellent showing both in daily gains (1.60 lb.) and in feed conversion (2.95 lb. grain and 0.52 lb. supplement). Those fed dry rolled, whole and fine pelleted grain made the lowest average daily gains (1.35 lb.) and in feed conversion (3.20 lb. grain and 0.54 lb. supplement). It was estimated 2,300 pounds of the steam conditioned rolled grain and 300 pounds of the steam rolled grain were wasted during the feeding period. Aubel explained in processing the feeds in those lots, the grain was steamed and put

under heat of 180° F to 200° F. It is possible this destroyed or changed the food nutrients of these feeds or made the feeds impalatable. The ranking in descending order with respect to average daily gain of the pigs in this trial was: steam rolled, fine ground, steam conditioned rolled, whole, fine ground and pelleted, and dry rolled grain. The descending order in feed required by pigs was: fine ground, fine ground and pelleted, steam rolled, dry rolled, steam conditioned rolled and whole grain.

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 lb. and 1.82, 1.76, 2.00 lb. for pelleted form. The feed required per pound of gain was 3.32, 3.79, 3.34 lb. for meal form and 3.24, 3.46, 3.22 lb. for pelleted form.

Jensen et al. (1960) studied pelleting and lysine addition in finishing swine. The results indicated with meal rations daily gains and feed per pound of gain were respectively, control 1.11, 5.43; 0.25% added lysine 1.55, 4.73. With pelleted rations, results were, control 1.64, 4.24; 0.25% added lysine 1.80, 3.81. Pelleted sorghum grain with 0.25% supplemental lysine proved superior in stimulation of growth rate and feed efficiency for feeding swine.

Standley (1961) replicated four ration groups as follows: pelleted ground corn, pelleted ground barley, pelleted ground milo, and cracked milo.

A 37% protein supplement was added to all rations. In general, the results indicated milo and corn equal in producing pork both exceeding barley, with more economical gain for hogs fed milo or corn. There was an advantage for pelleted milo over cracked milo of 0.54 lb. less feed required to produce a pound of gain.

Koch (1962) fed sorghum grain in pellet and meal form to six lots of growing-finishing pigs. In this trial, he reported pigs eating complete pelleted rations gained faster than those fed complete meal rations. The average daily gains per pig were 1.97, 2.12, 2.01 pounds for pelleted form and 1.97, 1.87, 1.81 pounds for meal form. The feed required per pound of gain was 3.26, 3.02, 3.03 pounds for pelleted ration; 3.62, 3.41, 3.51 pounds for meal form ration. Pigs eating pelleted ration wasted less feed than those eating meal form rations. The feed efficiency also favored the complete pelleted ration.

This a continuation of feeding trials comparing the feeding value of sorghum grain in pellet and meal ration. Koch (1963) concluded that pigs eating the pelleted rations produced gain more efficiently than meal rations (3.46 vs. 3.72 lb. of feed per pound gain), in both comparisons even though the cost per ton of the pelleted rations was higher. Carcasses from the various lots did not differ significantly in U.S.D.A. grade. This was also true in previous study.

Koch et al. (1963) studied the preference and performance of pigs eating sorghum grain prepared by different processing methods during growing-finishing period. Days available and total consumption of each grain preparation were: whole, 86 days, 1752 lb.; rolled and pelleted, 56 days, 1111 lb.; dry rolled, 98 days, 328 lb.; steam conditioned rolled, 98 days, 310 lb.; steam

rolled, 98 days, 914 lb.; fine ground, 98 days, 22 lb. Six groups of eight pigs each were fed on sorghum grain from the same source and processed as above. A 40% protein supplement was fed free-choice or mixed with grain, (75-25). Processing method, average daily gain and feed efficiency (grain plus supplement per cwt. gain) were as follows: whole, 1.48 lb. (393 + 48 lb.); rolled and pelleted, 1.43 lb. (293 + 56 lb.); steam rolled, 1.45 lb. (347 + 63 lb.); steam conditioned rolled, 1.53 lb. (371 + 55 lb.); dry rolled, 1.46 lb. (339 + 55 lb.); complete ration, 1.59 lb. (405 lb.). Average daily gain differences were non-significant.

Nam (1963) studied the value of Griswold grain as affected by the different methods of preparations. Six treatments were used as follows: whole, dry rolled, rolled and pelleted, steam rolled, steam conditioned rolled and ground. In the dry rolled, a 0.02 inch roll spacing on a fine corrugated roll mill was used. In the rolled and pelleted, the grain was rolled as above, then pelleted using a 3/16 inch pellet die. The steam rolled grain was steamed to a temperature of 205° F and rolled with a roll spacing of 0.005 inch and cooled. The steam conditioned rolled grain was conditioned and binned for six hours before the rolling took place. The temperature immediately before rolling had fallen to 44° C. In the ground, the grain was ground through a 1/4 inch hammer mill screen.

The results indicated that the whole sorghum grain was the best liked by the pigs, following was: rolled and pelleted, steam rolled, steam conditioned rolled, dry rolled and the fine ground sorghum grain was the least liked. The descending order in feed required was: rolled and pelleted, 3.49 lb.; dry rolled, 3.94 lb.; complete ration, 4.05 lb.; steam rolled, 4.10 lb.; steam conditioned rolled, 4.26 lb.; whole, 4.41 lb. No significant difference

was obtained in gains as affected by the six rations. From this experiment, he concluded, pigs did prefer certain preparations more than others. With respect to preparations of sorghum grain, pigs showed they liked the unprocessed grain the best in this study.

Sorghum grain can be processed several ways for growing-finishing pigs. Trial conducted by Koch et al. (1964) were designed to determine the preparation pigs preferred and how the pigs performed when limited to one preparation.

The six preparations were: whole grain, dry rolled grain, dry rolled and pelleted grain, steam rolled grain, steam conditioned rolled grain and fine ground grain. The results indicated pigs definitely preferred whole grain or dry rolled pelleted grain over all other preparations, with no definite preference between the two preparations. They consumed very little of any of the other preparations. Average daily gains of pigs eating various preparations did not differ significantly.

Previous reports from Kansas Agricultural Experiment Station have shown that method of processing sorghum grains and rations may affect acceptance by the animal and efficiency of utilization. Jensen et al. (1965) reported the effects fineness of grinding of sorghum grain on feeding value for growing-finishing swine.

Either 1/8 inch or 1/16 inch screens were used in the hammer mill grinder to grind the sorghum grain. The respective ground products were pelleted (3/16 inch pellet). Fineness of grind had no significant effect on rate of gain (1.34 vs. 1.37 lb.), daily feed intake (3.54 vs. 3.65 lb.), or feed per pound of gain (2.63 vs. 2.66 lb.) from the sorghum grain ground through 1/8 and 1/16 inch screens, respectively. The results suggest no advantage of

one-sixteenth inch grind over 1/8 inch grind of sorghum grain used in diet for growing pigs.

EXPERIMENTAL PROCEDURE

Phase One and Phase Two

Pigs from the Kansas State University experimental herd were used and the Poland China and Duroc breeds and Crosses of these breeds were used. Sixty feeder pigs averaging 49.5 pounds in weight and 12 weeks of age were randomly divided as uniformly as possible on the basis of litter, sex, and weight into 12 lots of 5 pigs each. Three barrows and two gilts were placed in each lot. The pigs had been weaned at 3 to 4 weeks of age and kept in confinement until 8 to 9 weeks of age. They had been on pasture prior to the start of the test. They had been vaccinated for Hog Cholera, Erysipelas, and wormed with Piperazine before being put on test.

The pigs were housed in concrete-floored pens which were approximately 6 feet wide by 18 feet long with 9 feet of the pen under roof. A fine mist was sprayed over the outside section of the pen during the daylight hours when temperature was 80° F and higher in the summer. Water was available at all times from an automatic waterer. Pigs were self-fed from two-hole wooden self-feeders.

Each of the six treatments was replicated to give a total of 10 pigs per treatment. A factorial design was used in order to study method of preparation and physical form of the ration. The design of the experiment was as follows:

Method of Preparation

	Ground sorghum grain	Steam rolled sorghum grain
Physical Form:	Meal	Meal
	Pellets	Pellets
	Crumbles	Crumbles

The ground sorghum grain was prepared by grinding in a hammer mill with a 1/4 inch screen. The steam rolled sorghum grain was prepared by exposure to steam at a temperature of 96° C (205° F) and then rolling through a fine corrugated roller mill with a roll spacing of 0.005 inch and cooled.

The processed grain was mixed with the other ingredients of the ration to form the meal ration. The complete mixed ration was pelleted through a 3/16 inch pellet die and some of the pellets were crumbled to make the crumble ration.

The composition of the rations used are shown in Table 1. The rations were changed from the growing to finishing phase when the pigs weighed approximately 100 pounds.

The chemical analysis of the rations fed is presented in Table 2 on an as received moisture bases. The same lot of grain was used to make all preparations.

The pigs were weighed and feed consumption data were obtained at two week intervals during the experiment. The experiment was divided into two phases and the data are analyzed by phase for the complete experiment. The first phase was from the beginning of the experiment when the pigs weighed about 49.5 pounds until they weighed approximately 100 pounds while the second phase was from 100 pounds to 200 pounds.

A sample of pigs was probed for backfat thickness at 200 pounds.

Table 1. Composition of the rations.

Rations	Growing phase	Finishing phase
Milo %	80.72	90.05
Soybean oil meal %	16.00	7.00
Di. Ca. Po_4 %	1.00	0.70
Limestone %	0.70	0.70
Salt %	0.50	0.50
Vitamin-Antibiotic[a] %	1.00	1.00
Trace mineral[b] %	0.08	0.05
Total	100.00	100.00
	Calculated composition	
Nutrients		
Protein %	15.21	13.11
Fat %	2.40	2.58
Fiber %	2.51	2.22
Ca. %	0.59	0.49
P. %	0.54	0.44
Lysine %	0.70	0.47
Tryptophan %	0.17	0.13
Methionine & Cystine %	0.48	0.40

Note:

a/ Contained per pound: 15,000 I.U. of vitamin D, 150,000 I.U. of vitamin A, 264 mg. Riboflavin, 528 mg. Ca. Pantothenate, 722 mg. Niacin, 264 gms. Choline, 440 mcg. B_{12} and 1 gm. Chlortetracyline antibiotic.

b/ Contained in %: Mn 10, Fe 10, Zn 5, Cu 1, Co 0.1, I 0.3, and Ca 12-14.

Table 2. Chemical analysis of the rations used in both growing-finishing phase.

Preparation	Physical	Moisture %	Protein %	Ash %	Fat %	Fiber %
Growing phase						
Ground	Meal	-	-	-	-	-
	Pellets	12.2	15.6	3.7	2.5	2.3
	Crumbles	12.1	17.4	3.8	2.6	2.6
Steam rolled	Meal	13.1	15.8	3.7	2.7	2.2
	Pellets	12.2	15.3	3.8	3.1	2.4
	Crumbles	12.4	16.3	3.7	2.9	4.2
Finishing phase						
Ground	Meal	11.2	12.9	3.5	2.6	2.4
	Pellets	11.6	12.8	3.5	2.7	1.9
	Crumbles	12.2	13.0	3.2	2.5	2.0
Steam rolled	Meal	14.0	12.6	2.9	3.0	2.0
	Pellets	13.1	13.2	3.4	3.5	2.0
	Crumbles	12.5	12.9	3.3	4.2	2.0

Data were analyzed by analysis of variance according to the method of Snedecor (1964).

RESULTS

Phase One

The results of the experiment will be divided into three parts as follows: phase 1 start to 100 pounds, phase 2, 100 to 200 pounds and the combined phase 1 and phase 2 or from start to 200 pounds.

Data on the feed consumed by pigs during phase 1 are shown in Table 3.

During the first 14 day period, the pigs showed a definite preference for ground sorghum grain in crumble form. An average of 231 pounds of feed per lot processed by that method was consumed by the pigs during the first period. Next in preference by the pigs as indicated by the amount eaten was steam rolled sorghum grain in crumble form, with an average of 222 pounds of feed consumed. The average amount of feed consumed per lot by the pigs for the other treatments follow: steam rolled sorghum grain in meal form, 216 pounds; steam rolled sorghum grain in pellet form, 213.5 pounds; ground sorghum grain in pellet form, 201.5 pounds, and ground sorghum grain in meal form, 191.5 pounds.

The preference for ground sorghum grain in the crumble form continued during second 14 day period. An average of 261.5 pounds of feed in this form was consumed by pigs during the second period. This was 27 pounds more than was consumed by pigs on the steam rolled sorghum grain in crumble form which ranked second. The average feed consumption of pig per lot for the other treatments follow: steam rolled in crumble form, 234.5 lb.; ground in pellet form, 225 lb.; ground in meal form, 221.5 lb.; steam rolled in pellet form,

Table 3. Feed consumed during the three 14 day periods of phase 1. (July 22, 1965 to September 1, 1965)

Preparations and Physical form	Treatment no.	Ave. amount of feed consumed per pen by periods			Ave. daily feed consumed/pig	Ave. total feed consumed per lot
		1st	2nd	3rd		
Ground		lb.	lb.	lb.	lb.	lb.
Meal	1	194	221	255	3.27	670
Pellets	2	201	225	218	3.14	644
Crumbles	3	235	262	308	3.93	805
Steam rolled						
Meal	4	216	196	263	3.05	675
Pellets	5	213	204	234	3.40	651
Crumbles	6	222	239	273	3.58	735

two hundred three pounds; and steam rolled in meal form, 196 lb. During this period, one pig died due to a malignant lymphoma.

In the third period, the data still showed definite preference for ground grain in crumble form by the pigs. The amount of feed eaten by pigs on the other treatments was similar to the data obtained during the first two 14 day periods. Based on the amount of feed consumed, there appeared to be a definite preference by the pigs for the crumble form of the feed regardless of the method of preparation.

Data on the performance of the pigs during phase 1 are given in Table 4.

The pigs fed ground sorghum grain in crumble form, ate more feed and gained more rapidly, 1.48 pounds per day, then the pigs in any of the other lots. Pigs fed steam rolled grain in crumble form and those fed ground grain in meal form gained 1.34 and 1.29 pounds per head per day, respectively. However, the pigs fed steam rolled sorghum grain in crumble form wasted an estimated 203 pounds of feeds per lot which was deducted from the feed for this group. Pigs which were fed ground sorghum grain in pellet form also wasted about 83 pounds of feeds in lot 8. This is an enormous waste in a short period. The wasting of feed is a possible indication of an unpalatable feed. In processing the feeds for these lots the grain was steamed and put under heat of 205^{o} F. and it is possible that this destroyed or changed the food nutrients of these feeds, or made the feed unpalatable. Pigs fed the steam rolled sorghum grain in pellet form, made the lowest daily gains, 1.12 pounds per head per day in this experiment. Those receiving the steam rolled sorghum grain in meal form made the next lowest daily gains, 1.14 pounds per head per day. Daily feed figures indicate that pigs fed steam rolled sorghum grain in meal form consumed less feed than pigs on the other

Table 4. The comparative value of sorghum grain prepared by different milling processing for growing pigs in dry-lot. (Ave. of duplicated lots.)

Treatment	Ration fed					
	Fine ground			Steam rolled		
	Meal	Pellets	Crumbles	Meal	Pellets	Crumbles
Treatment no.	1	2	3	4	5*	6
No. of pig/treatment	10	10	10	10	9	10
Av. initial wt. lb./pig	49.4	49.6	49.9	49.7	49.6	49.7
Av. final wt. lb./pig	100.3	99.4	110.2	96.6	104.2	104.5
Av. total gain lb./pig	50.9	49.8	60.3	46.9	54.6	54.8
Av. daily gain lb./pig	1.29	1.21	1.48	1.14	1.12	1.34
Av. daily feed lb./pig	3.27	3.14	3.93	3.05	3.40	3.58
Av. feed/lb. gain	2.54	2.59	2.65	2.67	2.92	2.68

*In lot 11, one pig died and not used in calculating from the results.

treatments.

The analysis of variance was calculated to measure the significance of the differences in average daily gain and average feed efficiency. Data tabulated in Table 5 and Table 6 show the results of the analysis of variance for average daily gain and feed required per pound of gain for phase 1.

The analysis shows that pigs fed the ground sorghum grain gained significantly faster and required significantly less feed per pound of gain ($P < .05$) than pigs fed the steam rolled grain. The average daily gains of the pigs on the different physical forms of feed also differed significantly ($P < .05$). Pigs fed rations in the crumble form gained significantly faster than pigs fed either meal or pelleted rations. There was no significant difference between the gains of the pigs on the meal and pelleted rations.

Phase Two

Pigs were removed from the experiment as they exceeded 195 pounds on weigh day, and the experiment was terminated after all treatment except one averaged above 190 pounds. A sample of the first pigs from test were probed for backfat thickness.

A summary of the results of the finishing phase from 100 to 200 pounds is shown in Table 7. The results of the analysis of variance for average daily gain and feed required per pound of gain are found in Tables 8 and 9, respectively. There were no significant differences in either rate or efficiency of gains of the pigs during phase two.

Pigs fed the ground grain gained faster and more efficiently than those fed the steam rolled grain. Pigs fed the ground grain in the crumble form made the fastest gains during this phase. However, pigs fed the steam

Table 5. Analysis of variance for average daily gain.

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.0457	0.0457	13.74	5.99	6.260
Feed form	2	0.1245	0.0623	10.92	5.14	8.534
P x F	2	0.0016	0.0008	10.92	5.14	0.110
Remainder	6	0.0439	0.0073			
Total	11	0.2157				

Table 6. Analysis of variance for average feed efficiency.

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.2269	0.2269	13.74	5.99	8.281
Feed form	2	0.0409	0.0205	10.92	5.14	0.746
P x F	2	0.0978	0.0488	10.92	5.14	1.781
Remainder	6	0.1641	0.0274			
Total	11	0.5297				

Table 7. Summary results of phase 2.
(September 16 to November 11, 1965)

Treatment*	Ground			Steam rolled		
	M	P	C	M	P	C
Treatment no.	1	2	3	4	5	6
No. of pigs/treatment	10	10	10	10	9	10
Av. on test wt. lb./pig	102.1	99.4	110.2	96.6	104.1	104.5
Av. off test wt. lb./pig	195.5	191.0	203.4	186.1	195.6	194.6
Av. total gain, lb./pig	93.4	91.6	93.2	89.5	91.5	90.1
Av. daily gain, lb./pig	1.52	1.46	1.58	1.39	1.50	1.47
Av. daily feed, lb./pig	5.29	5.15	5.60	5.33	5.40	5.44
Av. feed/lb. gain	3.49	3.51	3.56	3.82	3.66	3.68

*Meal, Pellets, Crumbles (M P C).

Table 8. Analysis of variance for average daily gains (Phase 2).

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.0121	0.0121	13.74	5.99	0.683
Feed form	2	0.0103	0.0051	10.92	5.14	0.288
P x F	2	0.0161	0.0080	10.92	5.14	0.451
Remainder	6	0.1064	0.0177			
Total	11	0.0385				

Table 9. Analysis of variance for average feed efficiency (Phase 2).

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.1282	0.1282	13.74	5.99	5.00
Feed form	2	0.0107	0.0053	10.92	5.14	0.207
P x F	2	0.0247	0.0123	10.92	5.14	0.480
Remainder	6	0.1541	0.0256			
Total	11	0.3177				

rolled grain in the crumble form gained slower than those fed steam rolled grain in the pellet form or ground grain in the meal form. The slowest gaining group of pigs was those fed steam rolled grain in the meal form.

Feed wastage continued to be a problem with the pigs in the steam rolled grain in crumble form. Feed was cleaned up around the feeders in these two pens almost daily and a total of approximately 500 pounds of feed was weighed back as feed wastage. This was not charged to the pigs but probably should be considered in evaluating this method of preparation and form of the ration. Wastage was not serious for pigs on the other treatments and although some wastage did occur, the amount was never large enough at one time to make a significant weigh back.

Combined Phase

The data for the two phases were combined to evaluate the overall results of the feeding trial from 49.5 to 200 pounds. The data for the complete trial are given in Table 10. The results of the analysis of variance are given in Tables 11, 12 and 13 for average daily gains, feed per pound of gain and average daily feed, respectively.

There were no statistically significant differences in rate or efficiency of gain or average daily feed of the pigs for the complete feeding period.

Pigs fed ground grain in the crumble form gained 0.13 pound per head per day faster than those fed either ground grain in the meal form or steam rolled grain in crumble form. The slowest rate of gain, 1.30 pounds per head per day was made by pigs fed steam rolled grain in the meal form. The data for efficiency of gain was similar to that for rate of gain except that

Table 10. Summary results of the complete test.
(July 22, 1965 to November 11, 1965)

Lot no.	1	2	3	4	5*	6
No. of pigs	10	10	10	10	9	10
Preparation		Ground			Steam rolled	
Physical form**	M	P	C	M	P	C
Initial wt. lb./pig	49.3	49.6	49.9	49.7	49.6	49.7
Final wt. lb./pig	195.5	191	203.4	186.1	195.6	194.6
Av. daily gain, lb./pig	1.42	1.37	1.54	1.30	1.35	1.42
Av. daily feed, lb./pig	4.52	4.35	4.91	4.54	4.21	4.73
Av. feed efficiency, lb./pig	3.39	3.19	3.27	3.50	3.44	3.31

*One pig died and not used in calculating from the results.

**Meal, pellets, crumbles.

Table 11. Analysis of variance for daily gains (Complete Phase). (July 22 to November 11, 1965)

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.0234	0.0234	13.74	5.99	1.21
Feed form	2	0.0408	0.0204	10.92	5.14	1.82
P x F	2	0.0071	0.0035	10.92	5.14	0.31
Remainder	6	0.0669	0.0112			
Total	11	0.1382				

Table 12. Analysis of variance for average feed efficiency (Complete Phase). (July 22 to November 11, 1965)

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.0574	0.0574	13.74	5.99	0.95
Feed form	2	0.0535	0.0247	10.92	5.14	0.41
P x F	2	0.0209	0.0104	10.92	5.14	0.17
Remainder	6	0.1229	0.0604			
Total	11	0.2547				

Table 13. Analysis of variance for average daily feed.
(July 22 to November 11, 1965)

Source of variations	Degree of freedom	Sum of squares	Mean squares	F value		
				0.01	0.05	observed
Preparation	1	0.0075	0.0075	13.74	5.99	0.04
Feed form	2	0.2422	0.1211	10.92	5.14	0.69
P x F	2	0.1300	0.0650	10.92	5.14	0.34
Remainder	6	1.0550	0.1758			
Total	11	1.4347				

pigs on the pelleted rations were more efficient than would be expected from their rate of gain. Less feed wastage might explain the apparently more efficient gains of the pigs on the pelleted rations but the reason for gains slower than was obtained from crumbles is not apparent.

When only method of preparation is considered pigs fed the ground grain gained faster and more efficiently than those fed the steam rolled grain. In comparing the performance of the pigs on the various form of feed, those fed the crumble form gained faster and more efficiently than pigs on the other forms of feed. Gains were similar for pigs on the meal and pellets, but those fed the pellets gained more efficiently.

The data for the backfat thickness probes of the sample of pigs from each treatment are given in Table 14. The probes were corrected to a 200 pound basis using correction factors which are used for the Kansas Swine Evaluation Station. Probes were made at three places on the back of the pig as follows, just behind the shoulder, at the last rib and on the rump. The

Table 14. Summary results of live probe backfat thickness.

Lot no.	1	2	3	4	5	6
Preparation and treatments		Ground			Steam rolled	
	Meal	Pellets	Crumbles	Meal	Pellets	Crumbles
No. of pigs probe	5	4	5	3	3	5
Av. wt. lb./pig	208.2	203.7	216.2	205.7	230.0	211.0
Av. probe, inch./pig	1.11	1.19	1.23	1.02	1.27	1.27
Corrected 200 lb. probe	1.10	1.17	1.12	1.00	1.12	1.20

probes were made one and one-half inches off the midline of the back. Although the sample measured was very small, there was no indication of any difference in the fatness of the pigs. A difference would not be expected since there were no significant differences in rate of gain.

DISCUSSION

There was no statistically significant differences in average daily feed intake of the pigs fed the preparations. Pigs fed ground sorghum grain in crumble form ate the most feed per head per day. Next the pigs ate steam rolled grain in crumble form and ground grain in meal form in that order. Throughout the tests ground and steam rolled sorghum grain in pellet form were the least liked. This was also true in a previous study by Aubel (1961) who fed grain that was ground and pelleted instead of rolled and pelleted. The ground pelleted sorghum grain was the least palatable as compared to whole, ground, dry rolled, steam rolled and steam conditioned rolled sorghum grain. Jensen et al. (1959) reported that the pigs sometimes ate more meal form and sometimes more pellet form.

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) and Aubel (1961) 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 as was done in this test. 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 lungs of the pigs.

Few studies have been reported in which the palatability of sorghum grain in crumble form has been compared to the other physical forms of grain. If one considered feed consumption as an index of palatability as is usually done, ground sorghum grain in crumble form was more palatable since it was consumed more readily (Table 3) in this experiment than other preparations. Compared with the previous reports by Texas Agricultural Experiment Station (1930, 1931), Baker (1936, 1937, 1939), Loeffel (1957), Aubel (1961) and Nam (1963) for their conclusion that whole grain is the best liked by pigs than any other physical form of grain. Therefore, from this standpoint, one could consider the crumble form has almost the same physical form as the whole grain. However, if feed wastage is an indication of an unpalatable feed, the wastage of feed by the pigs fed the steam rolled grain in crumbles is an indication that it is the least palatable of the physical forms of the steam rolled grain. The feed wastage of the pigs in this group makes it difficult to make definite conclusions relative to palatability or efficiency of grains.

Whether palatability would be an advantage or not depends on the feed conversion and the average daily gains of pigs fed that type of preparation. In any case, whenever increased gains of an animal are reported, one is fairly safe to assume that one of these factors was operative--either increased feed intake or better feed conversion. Also, where animals consumed the same amount of a feed, it is the feed conversion ability that should determine the differences in rates of gain. In short, any factor that affects the

normal function of the digestive tract in general, is likely to affect the rates of gain in response to a given nutrient.

The analysis of variance indicated there were no statistically significant differences in rate of gain from the processing of the sorghum grain except during phase one. During phase one pigs gained significantly faster when fed ground grain than steam rolled grain. Pigs fed crumbles also gained significantly faster than pigs fed other forms of feed. These differences disappeared during the second phase and for the entire experiment. Such results would be expected in view of results previously reported by other researchers.

In comparing whole, steam rolled, and steam rolled conditioned rolled sorghum grain fed free-choice with a supplement Aubel (1959) reported only 0.04 pound difference between pigs fed whole and steam conditioned rolled grain. A difference of 0.13 pound per day was found between pigs fed whole grain and those fed steam rolled grain. Pigs fed steam rolled and dry rolled sorghum grain had a difference of 0.02 pound in average daily gain with the advantage favoring steam rolled grain. Aubel (1960), there was also only slight differences in average daily gains between pigs fed whole grain, steam conditioned rolled, steam rolled and dry rolled sorghum grain. In Aubel's 1961 report the range of variation was 0.24 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.

Nam (1963) reported pigs fed whole, dry rolled, rolled and pelleted, steam rolled, steam conditioned rolled and ground sorghum grain had a range of variation of 0.16 pound per day in average daily gain. The lowest average daily gain was 1.43 and the highest, 1.59.

The present experiment showed a difference of 0.25 pound per day in average daily gain for the complete experiment. The lowest average daily gain was 1.29 and the highest, 1.54. Yet the analysis indicated no statistically significant effect of treatment on the average daily gain. Although statistical analysis does not prove a point, it does help to conclude whether the differences are real or whether they are due to chance.

Feed conversion per pound gain and cost are the decisive points in the choice of a physical preparation of sorghum grain in swine feeding.

Data presented in Table 10 indicated the best feed conversion for the complete test was for the ground sorghum grain in pellet form. The next best was for the ground grain in crumble form. The descending order of feed conversion of other processed sorghum grain was steam rolled crumbles, fine ground meal, steam rolled pellets, and finally the steam rolled sorghum grain in meal form.

Pelleting a ration has been shown to be a good means of increasing feed efficiency. Jensen (1959) and 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 a pelleted complete ration. Pigs eating pellets were more efficient. Aubel (1961) 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. He reported that pigs fed fine ground sorghum grain gave the best feed conversion than other treatments. Nam (1963) fed sorghum grain in whole, rolled pelleted, dry rolled, steam rolled, steam conditioned rolled

and complete ration. He reported that pigs required less feed per pound of gain for the rolled pelleted form than any other physical form. 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 extreme amount of steam rolled sorghum grain in crumble form. 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 grain. Which finding is correct? It is impossible to say as the results reported may have been influenced by environment, variation in feed ingredients and feed preparation techniques.

The second fact one must consider from the results of this experiment is the poor feed conversion of pigs fed steam rolled sorghum grain in meal form. Koch (1962), and Jensen (1965) conclude that pigs fed sorghum grain in meal form were somewhat inferior in feed conversion to those fed sorghum grain in pellet form. The same observation was made in this experiment especially for the pigs fed steam rolled grain. In processing the feed in these lots the grain was steamed and put under heat of 205° F. It is possible this destroyed or changed the food nutrients of these feeds, or made the feed unpalatable. However, 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. The softened grain was not broken during the rolling process but was flattened.

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. In this experiment, the cost of the ration per hundred pounds feed

was furnished by the Department of Flour and Feed Milling Industry of Kansas State University and these costs are shown in Table 15.

In Table 15 is presented the cost of rations used in swine feeding trial.

Table 15. Cost of rations.

Rations	Feed Costs	
	Growing	Finishing
	cwt.	cwt.
Ground		
Meal	3.39	3.06
Pellets	3.54	3.21
Crumbles	3.54	3.21
Steam rolled		
Meal	3.39	3.06
Pellets	3.54	3.21
Crumbles	3.54	3.21

Cost of ingredients in July, 1965 basis:

Sorghum grain	$2.55/100 lb.
Soybean oil meal	$4.85/100 lb.
Di Ca Po_4	$5.75/100 lb.
Limestone	1 cent/lb.
Salt	2 cent/lb.
Vitamin D	28 cent/lb.
Vitamin A	27 cent/lb.
B Vit. mix.	64 cent/lb.
Aurofac-10	87 cent/lb.
B12 supplement	20 cent/lb.

A summary of the feed costs per 100 pounds gain of the pigs is given in Table 16.

Table 16. Summary results of feed costs* for the complete trial, 49.5 to 200 pounds.

Lot no.	1	2	3	4	5	6
Preparation		Ground			Steam rolled	
Physical form	Meal	Pellets	Crumbles	Meal	Pellets	Crumbles
Total days on test	105.4	100.8	99.8	105.0	102.2	102.2
Final weight, lb./pig	195.5	191.0	203.4	186.1	195.6	194.6
Feed per cwt. gains, lb.	338	314	326	350	344	331
Feed cost per cwt. lb.	$9.91	$10.47	$10.56	$11.02	$10.93	$10.97
Ranking in cost[a]	1	2	3	6	4	5

*Does not include cost of feed wastage which was weighed back.

[a]1 is the lowest feed cost.

There were no statistically significant differences for average daily gains and average feed efficiency between pigs fed the different preparations and physical forms. Therefore, from an economical standpoint, the results from Table 16 indicates that one should choose ground sorghum grain in meal or pellet form for swine feeding during the growing-finishing period.

Steam rolled grain should be avoided since the feed cost was not only more expensive than ground grain but also was less favorable for feed conversion and average daily gains of the pigs.

However, this experiment indicated that although ground grain in crumble form did not produce the best feed conversion or have the lowest cost, it did produce the greatest average daily gains by the pigs. Pigs fed ground grain

in crumble form required the fewest days to get to market weight. Therefore, one trying to take advantage of the market price could possibly profit by using this method of processing.

SUMMARY

A total of 60 weanling pigs were used in a study of the effects of method of preparation of sorghum grains and physical form of the ration on the performance of growing-finishing swine. The experiment was conducted in confinement on concrete floored pens and each treatment was replicated. Sorghum grain was steam rolled or ground through a hammer mill and the ration was fed in a meal, pellets, or crumble form. The analysis of the data was divided into three phases as follows: (1) growing 49.5 to 100 pounds, (2) finishing 100 to 200 pounds and (3) complete 49.5 to 200 pounds.

During the growing phase pigs fed ground sorghum grain gained significantly faster and more efficiently than pigs fed steam rolled grain. Pigs also gained significantly faster when fed feed in crumble form than when fed either meal or pellet form. The best gains were made by pigs fed ground grain in crumble form. The amount of feed consumed indicated a preference by the pigs for the crumble form of the ration. However, feed wastage was a serious problem for pigs fed steam rolled grain in crumble form.

During the finishing phase, no statistically significant differences were obtained between pigs on any of the treatments. However, pigs fed the ground grain in the crumble form continued to gain faster than those on other treatments. Pigs fed the steam rolled grain in crumble form continued to waste feed.

When the two phases were combined, there were no significant differences

in rate and efficiency of gains between pigs on any of the treatments. Pigs fed ground grain in the crumble form made the most rapid gains while those fed steam rolled grain in meal form made the slowest gains. Pigs fed ground grain in the pellet form made the most efficient gains. When feed costs were considered pigs fed the ground grain produced cheaper gain than those fed the steam rolled grain. Pigs with the least feed cost per pound of gain were those fed the ground grain in a meal form.

A sample of pigs were probed for backfat thickness when they were weighed off the test at 200 pounds. In the small sample measured no apparent differences between pigs on the various rations were observed.

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APPENDIX

Table 17. Summary results by lot of phase 1.
(July 22 to September 1, 1965)

Lot no.	1	2	3	4	5	6	7	8	9	10	11*	12
No. of pigs	5	5	5	5	5	5	5	5	5	5	4	5
Preparation	Ground			Steam rolled			Ground			Steam rolled		
Physical form	M	P	C	M	P	C	M	P	C	M	P	C
Av. crude protein	15.21%						15.21%					
Initial wt. lb./pig	49.2	49.6	50.2	50.0	49.6	49.4	49.4	49.6	49.6	49.4	49.6	50.0
Final wt. lb./pig	102.2	98.4	110.6	93.3	90.8	104.4	102.0	100.4	109.8	99.4	117.5	104.6
Av. day on test	41	41	41	41	41	41	41	41	41	41	41	41
Av. daily gain, lb./pig	1.29	1.19	1.47	1.07	1.00	1.34	1.28	1.24	1.48	1.22	1.25	1.33
Av. feed/lb. gain	2.49	2.71	2.71	3.09	2.88	2.66	2.59	2.47	2.61	2.70	3.19	2.71

*One pig died due to a malignant lymphoma and not used in calculating the results.

Table 18. Summary results by lot of phase 2.
(September 16 to November 11, 1965)

Lot no.	1	2	3	4	5	6	7	8	9	10	11	12
No. of pigs	5	5	5	5	5	5	5	5	5	5	4*	5
Preparation	Ground			Steam rolled			Ground			Steam rolled		
Physical form	M	P	C	M	P	C	M	P	C	M	P	C
Av. crude protein	13.11%						13.11%					
Initial wt. lb./pig	102.2	98.4	110.6	93.3	90.8	104.4	102.0	104.4	109.8	99.4	117.5	104.6
Final wt. lb./pig	197.0	181.2	196	172.8	181.8	198.6	194	200.8	210.8	199.4	209.5	190.6
Av. days on test	63.4	59.8	57	62.6	65.4	59.8	59.8	65.4	59.8	65.4	57	62.6
Av. daily gain, lb./pig	1.50	1.38	1.50	1.26	1.39	1.58	1.54	1.54	1.66	1.53	1.61	1.37
Av. feed/lb. gain	3.39	3.44	3.71	3.88	3.48	3.76	3.59	3.58	3.41	3.77	3.84	3.63

*One pig died due to a malignant lymphoma and not used in calculating the results.

Table 19. Summary results by lot of the complete test.
(July 22 to November 11, 1965)

Lot no.	1	2	3	4	5	6	7	8	9	10	11	12
No. of pigs	5	5	5	5	5	5	5	5	5	5	4	5
Preparation	Ground			Steam rolled			Ground			Steam rolled		
Physical form	M	P	C	M	P	C	M	P	C	M	P	C
Initial wt. lb./pig	49.2	49.6	50.2	50.0	49.6	49.4	49.4	49.6	49.6	49.4	49.6	50.0
Final wt. lb./pig	197	181.2	196	172.8	181.8	198.6	194	200.8	210.8	199.4	209.5	190.6
Av. daily gain, lb./pig	1.41	1.31	1.49	1.18	1.24	1.48	1.43	1.42	1.59	1.41	1.45	1.36
Av. daily feed, lb./pig	4.35	4.14	4.90	4.26	4.09	4.97	4.62	4.56	4.92	4.81	5.22	4.44
Av. feed/lb. gain	3.55	3.17	3.30	3.59	3.29	3.36	3.22	3.21	3.23	3.41	3.59	3.27

EFFECTS OF METHOD OF PREPARATION AND PHYSICAL FORM ON FEEDING VALUE OF SORGHUM GRAIN FOR GROWING-FINISHING SWINE

by

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The experiment was conducted at Kansas State University to determine the effect of various sorghum grain processing methods on swine performance during the growing-finishing period.

Sixty feeder pigs averaging 49.5 pounds in weight and 12 weeks of age were randomly divided as uniformly as possible on the basis of litter, sex, and weight into 12 lots of 5 pigs each. They were put in concrete floor pens 6 feet wide by 18 feet long with 9 feet of the pen under roof. All pigs had been wormed and vaccinated before being assigned to the first phase experiment.

All pigs received the same ration. The feed was fed in two-hole wooden self-feeders. The sorghum grain in each feeder varied in method of preparation and physical form. The six treatments were: ground grain in meal, pellets and crumbles; steam rolled grain in meal, pellets and crumbles. Water was available at all times. For analysis the data were divided into phase 1, growing period of 49.5 to 100 pounds, phase 2, finishing period of 100 to 200 pounds and the complete period of 49.5 to 200 pounds.

During the growing phase, pigs fed ground sorghum grain gained significantly faster and more efficiently than pigs fed steam rolled grain. Pigs also gained significantly faster when fed feed in crumble form than when fed either meal or pellet form. The best gains were made by pigs fed ground grain in crumble form. The amount of feed consumed indicated a preference by the pigs for the crumble form of the ration. However, feed wastage was a serious problem for pigs fed steam rolled grain in crumble form.

During the finishing phase, no statistically significant differences were obtained between pigs on any of the treatments. However, pigs fed the ground grain in the crumble form continued to gain faster than those on other

treatments. Pigs fed the steam rolled grain in crumble form continued to waste feed.

When the two phases were combined, there were no significant differences in rate and efficiency of gains between pigs on any of the treatments. Pigs fed ground grain in the crumble form made the most rapid gains while those fed steam rolled grain in meal form made the slowest gains. Pigs fed ground grain in the pellet form made the most efficient gains. When feed costs are considered pigs fed the ground grain produced cheaper gain than those fed the steam rolled grain. Pigs with the least feed cost per pound of gain were those fed the ground grain in a meal form.

A sample of pigs were probed for backfat thickness when they were weighed off the test at 200 pounds. In the small sample measured no apparent differences between pigs on the various rations were observed.