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The Effect of Fineness of Grinding Grain on Milk Production

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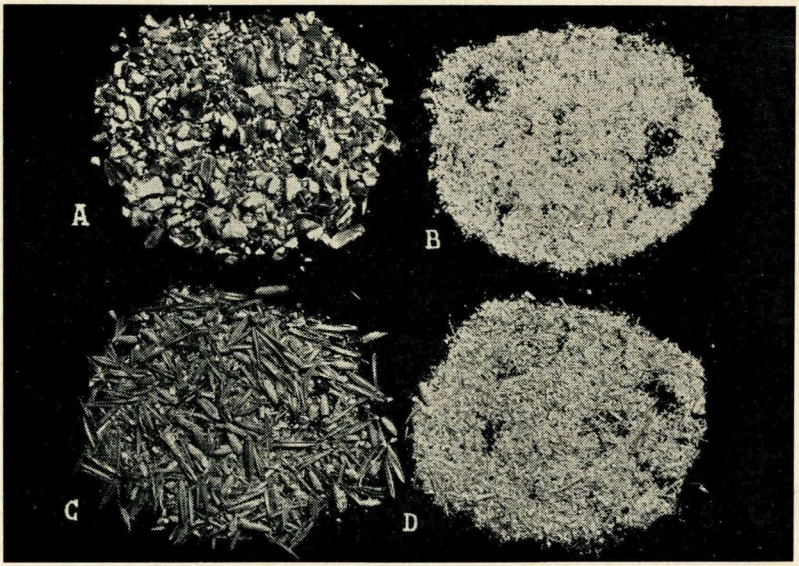

Fig. 1. Shown below are A and B, the coarsely and finely ground corn, and C and D, the coarsely and finely ground oats. The grains were ground to these finenesses according to the screen sizes pictured in Fig. 2.

The Effect of Fineness of Grinding Grain on Milk Production

By T. M. Olson

Will grinding grain increase milk production? If so, how fine should the grain be ground? Also, what is the actual cost of grinding?

These are some of the questions that a dairy farmer is concerned with when he considers the advisability of grinding grain for his cows.

The fineness of grinding has been investigated by the South Dakota Station and after two year's trials it was concluded that:

1. Milk cows prefer ground grain to whole grain. They prefer coarsely ground grain to finely ground grain. That is, grain kernels that are merely broken in two or three parts are preferred to grain ground flour fine. They prefer whole oats to whole corn.
2. The hardness and size of the kernels of grain affects the digestibility more than the thickness of the grain covering. For instance, more of the whole corn passes through the cow undigested than whole oats when these grains are fed to milk cows.

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3. When whole grains are fed to milk cows approximately 20 percent pass through the cows undigested. (Some experiment stations have reported as high as 35 percent of undigested whole grain.) The grain which passes through the cow has not been decreased in its nutritive value.
4. The cost of grinding grain increases with increased fineness. Obviously it takes longer to grind grain fine, and therefore the labor as well as the power costs increase.

These conclusions indicate that it pays to grind grain for milk cows, unless the grain is very cheap. Even when grain is low in price it probably is not advisable to require heavy producing cows to consume approximately 20 percent or more grain in order to receive a given number of pounds of nutrients, or an equivalent in nutrients to the ground grain.

Review of Literature

Previous work reported by Darnell and Copeland (1) shows that cows consumed more grain when it was ground, and that greater milk production resulted. These results were obtained in comparing the whole with the ground grain. It is not stated what degree of fineness of grinding grain was used in these trials. Wilbur (2) found that feeding medium finely ground corn and oats resulted in greater milk production than either coarsely ground or pulverized ground grain. He concluded, however, that "medium finely ground corn and oats and cracked corn and oats gave satisfactory results in production, maintenance of body weight and economy of production." The trials showed that it did not pay to feed whole grain to dairy cows. Silver (3) concludes that "fine grinding of grain is conducive to high power requirements, especially for those feeds which are high in fibre content." He says "Coarse grinding will lessen the wear and tear on the grinding unit, increase its capacity, and decrease the horse power required."

Bohstedt (4) found that it required 29.5 pounds of medium ground and 29.8 pounds of fine ground barley to produce 100 pounds of milk. The power and machinery costs for grinding barley ranged from $0.45 per ton for medium fine grinding to $1.62 per ton for fine grinding. The corresponding costs for corn were $0.28 per ton for medium to $1.06 per ton for fine grinding. Power costs were computed at the rate of 5 cents per horsepower hour. The coarse grinding of grain was equal or superior to fine grinding of grain in every particular.

Colby (5) found the power consumption for different degrees of fineness of grinding as follows:

	Hammer mill kilowatt hrs.	Burr mill kilowatt hrs.
Coarse grinding per cwt.	0.42	0.40
Medium grinding per cwt.	0.60	0.57
Fine grinding per cwt.	1.00	1.+

He considered one kilowatt hour equal to one horse power.

Brackett and Lewis (6) found that the cost of grinding grain varied widely depending on the degree of fineness. Medium to coarse ground grain was

preferred. He concluded that it pays to grind grain when the cost of grinding does not exceed 10 percent of its cost. This is in line with the findings of several other workers.

Fenton and Logan (7) concluded that it was profitable to grind grain for livestock. The cost of electric motor power is about the same as gasoline engine power, exclusive of interest and depreciation. Their work showed fine grinding of grain greatly increased the cost for power. The cost of grinding roughage including labor, power and equipment, ranged from $0.99 to $1.34 per ton.

Martin and Roberts (8) report the cost of grinding 100 pounds of grain varies widely depending on the fineness of grinding, the condition of the grain, cost of power, and amount of grinding done annually, etc. The range was 86.1 cents to as low as 2.7 cents per cwt.

The work at the South Dakota Station (9) indicated a range in cost for grinding a ton of roughage from $1.81 to $4.78. Trials at Iowa (10) found roughage grinding costs ranging from $3.50 for alfalfa hay, to $1.75 for alfalfa hay and stover. Maryland (11) workers reported costs for roughage grinding ranging from $2.72 for alfalfa hay to $6.35 per ton for soybean hay and the South Carolina Station (12) found an average cost of $2.21 per ton for oats and vetch hay.

Results of trials at six Stations (8, 12, 13, 14, 15, 16) indicate a slight increase in milk production when ground roughages are fed but not sufficient increase to pay the cost of grinding. Fine grinding of roughages and the grinding of good quality roughages are not profitable. The digestibility of roughages is not increased by grinding.

Experimental Procedure

The trials, the results of which are reported herein, were begun during the winter of 1939-40 and continued in 1940-1941. The double reversal plan was used. Four cows in the early stages of their lactations were chosen, so that a fairly heavy milk flow was realized. The cows were fed a good quality of alfalfa hay, corn and oats. The grains were ground in a hammer mill using a 1/16 inch screen for the finely ground, and a 3/4 inch screen for the coarsely ground. These screens are shown in Fig. 2.

Whole corn and oats were also fed but the cows failed to eat enough of the whole grains to maintain milk flow, and therefore these trials were discontinued. If the cows were forced to eat the whole grains it was felt that milk production would decrease to such an extent that the results would have little experimental significance.

These trials differ from those of workers in other stations, in that digestion trials were conducted at the conclusion of each experimental period. It is important to know whether the coarsely ground grain is as well digested as the finely ground or pulverized grain, and the only way to ascertain this fact is to conduct digestion trials. Three 14-day digestion trials were employed the first year, and three 10-day trials were conducted the second year.

The cows were weighed at 10-day intervals and at 3 successive days at the beginning and close of each period to note variations in the weight. The pal-

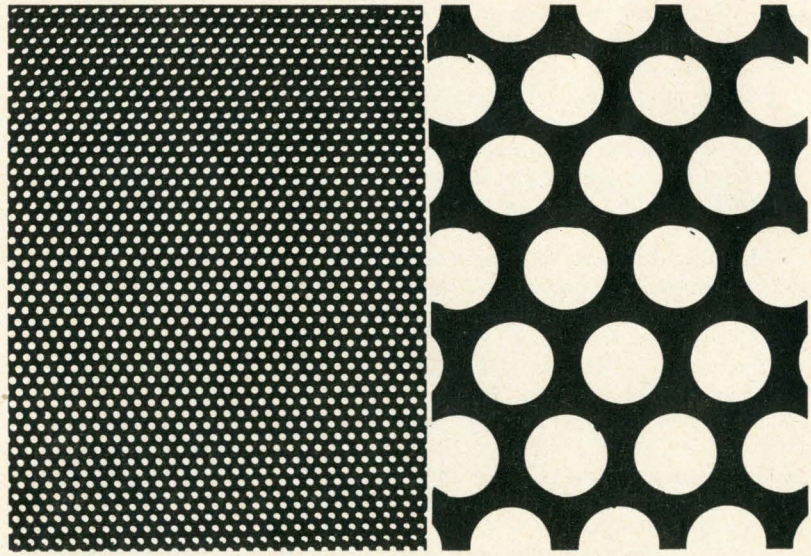

Fig. 2. The grains used in this experiment (see Fig. 1) were ground in a hammer mill using a 1/16 inch screen for the finely ground (left) and a ¾ inch screen for the coarsely ground.

atability was gauged by the eagerness with which the cows ate the grains. Inasmuch as no other concentrates were included in the ration the cows were fed rather liberal amounts of corn and oats with the alfalfa hay. In other words, more than the Haecker Feeding Standard requirements were fed.

Discussion of Results

These trials were concerned primarily with the differences in production of the cows when being fed coarsely ground versus finely ground grains. During the two trials four cows received the coarse grain for a total of 60 and 40 days respectively and an equal number of cows received finely ground grain for the same number of days.

Table 1. The Double Reversal Feeding Trials

Days	Cow Number 1939-1940				Days	Cow Number 1940-1941			
	403	423	160	258		150	263	438	439
30	Coarse	Fine	Coarse	Fine	20	Coarse	Fine	Coarse	Fine
30	Fine	Coarse	Fine	Coarse	20	Fine	Coarse	Fine	Coarse
30	Coarse	Fine	Coarse	Fine	20	Coarse	Fine	Coarse	Fine

The double reversal plan of the experiment compensated for the normal decline in milk production due to the advance in lactations.

Table 2 shows the average pounds of alfalfa hay and grain consumed during the coarse and fine grain grinding periods for the two trials, and the re-

sulting milk and fat production. (The data in the first and third periods are averaged.)

Table 2. Average Feed Consumption and Milk Production for the Two Trials

Type of grain	Alfalfa lbs.	Grain lbs.	Milk lbs.	Fat lbs.
Coarsely ground	4307.5	2500	5246.0	217.36
Finely ground	4481.5	2530	5231.4	217.24

These data indicate that during the coarsely-ground-grain feeding periods the cows produced 2.098 pounds of milk for each pound of grain received while during the finely-ground-grain feeding period they produced 2.069 pounds of milk for each pound of grain received.

Expressing the same data in terms of fat-corrected milk (.4M + 15F)* the data show that during the coarse grain feeding period it required 46.66 pounds of grain to produce 100 pounds of fat-corrected milk. During the fine-grain--grinding periods it required 47.23 pounds to produce 100 pounds of fat-corrected milk.

Effect of Coarse and Fine Grinding of Grain on Digestibility of Entire Ration

To determine the affect of fineness of grinding on milk production, digestion trials were conducted. Therefore the coefficients of digestion obtained during the trials add significance to the results. Inasmuch as the degree of fineness of grinding grain was the only difference in the ration, the average digestibility is expressed in Table 3 on coarse and fine grinding of grain.

Table 3. Digestibility for the Whole Ration*

Degree Grinding	Dry Matter Percent	Crude Protein Percent	Crude Fiber Percent	Nitrogen Free Extract Percent	Ether Extract Percent	Ash Percent
Coarse	69.08	72.26	41.45	81.91	60.91	37.23
Fine	68.05	74.04	40.08	81.80	60.62	34.94

*The coefficients of digestibility expressed represent the average of six digestion trials involving eight cows.

The data in Table 3 indicate no appreciable difference in the digestibility of coarsely and finely ground grains in the rations used in these trials.

Inasmuch as digestion trials were conducted during both feeding periods, it is possible to express the production on the basis of total digestible nutrients (T.D.N.) which after all is the true measure of the feed used by the cows.

Table 4. T.D.N. Required to Produce 100 lbs. Fat-Correct Milk*

Type of grain	F.C. Milk	Total T.D.N.	Maint. T.D.N.	Net T.D.N.	T.D.N. required to produce 100 lbs. F.C.M. Milk
Coarse grinding	5358.82	4298.95	1778	2520.95	47.05
Fine grinding	5351.16	4570.37	1796	2774.37	51.84

*Fat-corrected milk is merely a convenient term to express the milk and fat production with one figure. The production of milk and fat is expressed as a given pounds of 4 percent milk, by the formula (.4M + 15F). That is, the pounds of milk multiplied by 0.4 added to the pounds of fat multiplied by 15 gives one figure known as fat-corrected milk (F.C.M.).

Table 4 indicates the total digestible nutrients consumed to produce 100 pounds of fat-corrected milk after deducting the total digestible nutrients

needed to maintain the cows for the period in which the milk was produced.

The data show that it required 4.79 pounds more T.D.N. to produce 100 pounds of F.C.M. milk or about 10.18 percent more T.D.N. with fine than with coarse ground grain to produce 100 pounds of fat-corrected milk.

The total consumption of grain and hay (averaging the first and third periods) varied only slightly between the coarsely ground and finely ground feeding periods. The grain consumption for the two trials was 2500 and 2530 pounds. The hay consumption was 4307.5 and 4481.5 pounds respectively for the coarsely and finely ground feeding periods. Thirty pounds more grain and 74.0 pounds more of alfalfa hay was consumed during the finely ground periods.

The plan of the experiment provided for the same cows on both the coarsely and finely ground grain periods but obviously at different stages of their lactation. If a cow should for some reason fall off materially in milk production for some reason other than the nutritive value of the ration she might easily change the balance of total milk yield in favor of one or the other periods. However no such rapid decline took place as is indicated in Table 5.

Table 5. Milk Production (in pounds) for the Three Periods

Cow No.	Coarse grain period	Fine grain period	Coarse grain period	Days
403	1208.8	1115.3	1136.1	90
160	722.2	695.5	645.0	90
150	462.2	473.4	471.3	60
438	518.4	551.8	504.1	60
	Fine grain	Coarse grain	Fine grain	
423	812.5	785.5	750.6	90
258	782.0	740.1	695.8	90
263	505.7	480.4	467.3	60
439	387.2	406.0	389.7	60
Total	**5399.0**	**5248.0**	**5059.9**	

The milk production recorded in Table 5 indicates a normal decline in milk yield due to advancing lactation. The decline from the first to second period was 2.79 percent. From the second to third period 3.58 percent. A total decrease in milk of 6.37 percent in 75 days. A decline in the milk yield of 5 percent per month is not at all unusual.

Palatibility of Grains

Although no data is offered to indicate the difference in palatibility of grains of different degrees of fineness of grinding it was apparent that the cows preferred the coarsely ground grain. They ate sparingly of the whole grain, particularly corn. The cows showed preference for the coarsely over the finely ground grains, although they ate all of both that was fed them.

Effect on Weight

Table 6 includes the weight of the cows during the three periods. The cows were weighed on three successive days at the beginning and end of the trials, and one weighing at the close of the ten day periods.

Table 6. Weights of Cows on Coarse and Fine Ground Grains

Cow No.	Coarse grain period	Fine grain period	Coarse grain period	Av. of 1 & 3 periods
403	1220	1099	1173	1197
160	805	838	922	864
150	1058	1072	1036	1047
438	1188	1195	1215	1202
	Fine grain	Coarse grain	Fine grain	
423	1305	1224	1346	1325
258	985	982	1011	998
263	1258	1223	1232	1245
439	1265	1233	1305	1285
Avg.	**1135**	**1108**	**1155**	**1145**

Before the cows were put on the trials they were receiving silage which may account for the slight decrease in weight in the second period in the case of four cows. It is noted that a decrease occurred when the cows were changed from coarse to fine as well as when they were changed from fine to coarse.

When the weight of the cows in both periods is arranged on the basis of coarse and fine grinding periods the average weights of the cows were 1122 pounds for the coarse grain periods and 1133 pounds for the the fine grain periods. These data would seem to indicate no significant effect of course and fine grains on the weight of cows.

Summary and Conclusions

1. A series of two trials was conducted in which eight milk cows in their early stages of lactation, were fed coarsely and finely ground corn and oats in equal parts by weight, and good quality alfalfa hay.
2. The cows were fed sufficient grain and hay to provide a ration adequate in amount to satisfy their milk production and maintenance.
3. The cows were weighed on 3 successive days at the beginning and end of each period.
4. Fourteen-day digestion trials were conducted at the close of each 30-day period the first year. Ten-day digestion trials were conducted at the close of each 20-day period for the second year.
5. The data indicate that the degree of fineness of grinding grain did not affect the weight of the cows, or the digestibility of the ration.
6. The coarsely ground grain was more palatable than the finely ground grain.
7. The cows produced 14.65 pounds more milk, and 0.12 pounds more fat during the coarse than during the fine grinding periods.
8. It required 47.05 pounds of T.D.N. to produce 100 pounds of fat-correct milk during the coarse grain periods and 51.84 pounds T.D.N. for the fine grain periods, after deducting the T.D.N. required for maintenance.
9. These trials indicate that coarsely ground grain is equal or superior to finely ground grain.
10. The cost of grinding increases with the increase in degree of fineness of grinding.

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