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How Fine should Grain be Ground for Milk Cows?

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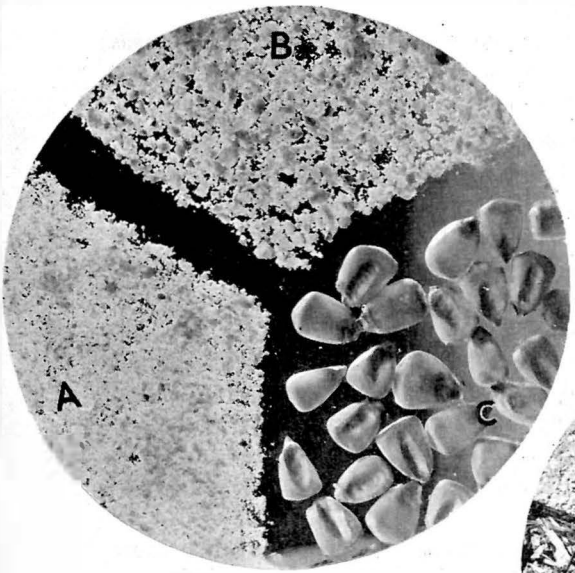

Jones believed it should be finely ground. Was he wrong? Would medium grinding have been better . . . or should he have ground it at all? Read the answers as supplied by these South Dakota Experiment Station workers.

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THE GROUND FEED BIN on the Jones farm was empty. Mr. Jones pulled the switch and soon the little mill was humming a song, that scarcely changed a note as the first few shovels of grain disappeared down its mouth.

Mr. Jones noted that the grain was scarcely more than cracked. He readjusted the mill to grind it finer, and soon it was spewing out an entirely different appearing product. Did Mr. Jones make a mistake when he readjusted his mill to grind the feed finer for his dairy cows?

Results of an experiment conducted at the South Dakota Agricultural Experiment Station would in-

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dicate that Jones did make a mistake by grinding the grain fine---one that is common in the dairy industry. These are a few results of the experiment:

1. It made little difference in the case of milk cows whether grain was ground coarse or fine in relation to the food value obtained by the cow from the entire ration. Feeds need only to be cracked sufficiently to expose the kernel interiors to digestive juices.

2. More benefit was derived from grinding corn than from grinding oats. A total of 110 pounds of alfalfa hay and whole corn ration was required to equal 100 pounds of an alfalfa hay and medium-ground corn ration in food value. For whole oats the comparison was 102 pounds to 100 pounds.

3. After subtracting the food value of the alfalfa hay, it was found 119 pounds of whole corn were required to equal 100 pounds of medium-ground corn in food value, and 105 pounds of whole oats were required to equal 100 pounds of medium ground oats. These figures may be used when combining these grains with other roughages in a ration. Little difference was noted in the food value of either grain when ground medium or fine.

4. Greater benefits were derived from grinding corn largely because greater amounts pass through the animal undigested when whole corn is fed. Nearly one-fifth (19.9 percent) of the whole corn fed was recovered from the feces (solid manure). For whole oats, recoveries in the feces ranged from 10.8 to 14.8 percent.

5. Ground grain rations were much more palatable than whole grain, and were more convenient for mixing with other ingredients in the ration.

Futhermore, it is generally understood that it costs more in time and money for fine grinding than for medium coarse grinding. The power cost is greater chiefly because of the greater length of time that the power must be used in grinding fine as compared with coarse. Calculations made from figures obtained from the South Dakota, Indiana and Ohio Stations indicate that it would take about 2 or 2½ times as much power to grind the finely ground grain as for the medium coarse as used in this experiment. For instance, Indiana reported that it took 0.21 kilowatt hours (K.W.H. electrical power) for coarse grinding of 100 pounds of corn and oats and 0.57 kilowatt hours for fine grinding. If one were paying for electrical power from a highline the cost would be directly proportional to the kilowatt hours used. Essentially the same relationships would exist if tractors or gas engines were used as a source of power.

It is impossible to make an exact statement as to the increase in time required but on the average about twice as much time is needed for fine grinding as for coarse grinding of grain.

The primary purpose for grinding grain is to increase digestibility. That is, make a larger percent of its food value available to the cow. If grinding grain doesn't increase its food value or palatability over whole grain there is no need to grind it.

Before the food value of grain can be made available to the cow for milk production or any physiological processes of the body, the digestive juices must break up and make usable the various nutrients in the grain and put them in a form available to the cow. If the grain has a hard covering like corn, the digestive juices cannot penetrate the kernel and therefore no digestion takes place.

It is not necessary that the corn be ground fine to effect this result. When the kernel of corn is broken into two or three portions the digestive juices come in contact with the interior of the kernel and dissolve out the inclosed food.

How The Food Value Was Measured

One way of finding out the actual food value which an animal gets from a given ration is to weigh accurately and analyze the amount fed and the amount voided in the solid excreta (feces) for a period of ten days or two weeks. The difference between the intake and the outgo of food nutrients represents the actual food value retained by the animal. Such an experiment is called a digestion trial. The hay and grain being fed to each cow are accurately weighed and sampled. After these samples are analyzed the difference between the outgo and intake can be figured. This, of course, represents the amount digested and available for use of the animal.

In trying to find out the effects of grinding grain to different degrees of fineness, 12 different cows were used and 68 separate digestion trials were run. Both corn and oats were studied. The ration was made up of half by weight of alfalfa hay and half of the grain being studied. In some of the trials the grain was ground medium to coarse, in some it was finely ground, and in others the grain was fed whole, as shown on the cover page. The screens used are shown in Fig. 1. In some of the trials alfalfa hay had to be fed alone in order to find out how much of the nutrients digested from the mixed ration should be credited to the hay so that the amount digested from the grain part could be calculated separately.

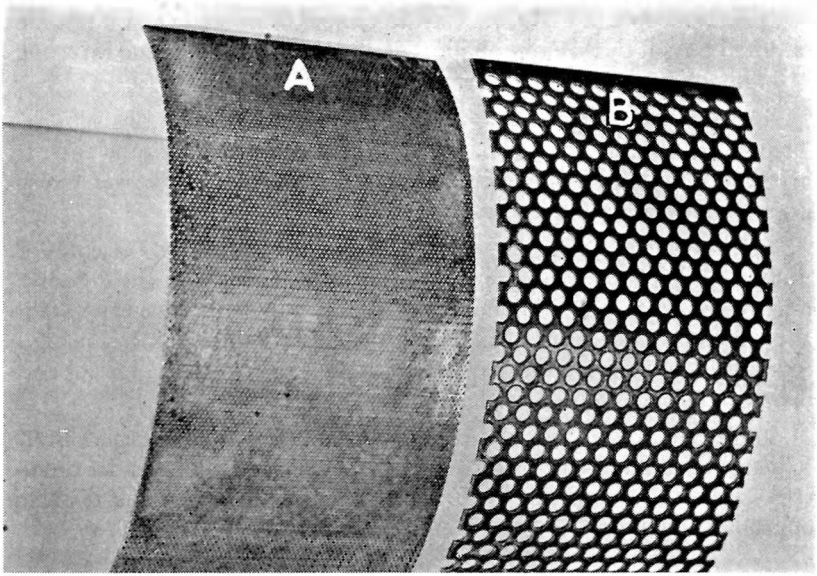

Fig. 1. The screens used in the hammer mill for grinding the grain in this experiment. A is the 1/16 inch screen for fine grinding and B the 7/16 inch screen used for medium to coarse grinding.

Effects of Fineness of Grinding Grain on Food Value of the Whole Ration

The results shown in Table 1 were calculated from the information thus obtained. This table shows the number of pounds of the ration (half alfalfa hay and half corn) required to furnish the same food value when the corn is fed finely ground or whole as is supplied by 100 pounds when the corn is ground medium coarse.

Table 1. Comparative food value of medium ground, fine ground and whole corn.

Ration	Amounts to Furnish Equivalent Food Value
	Pounds
1. Alfalfa hay and medium ground corn	100.0
2. Alfalfa hay and finely ground corn	100.5
3. Alfalfa hay and whole corn	110.5

Thus, with corn as the grain part of the ration, it made practically no difference in the food value (total digestible nutrients) of the whole ration whether it was ground medium coarse or very fine. Actually, 100.5 pounds of the alfalfa hay and finely ground corn ration equaled 100.0

pounds of the ration of alfalfa hay and medium ground corn. When whole corn was fed, however, it took 110.5 pounds of the ration to supply the same food value.

When oats were used with alfalfa hay to make up the ration, the results showed that medium grinding was just a little better on the average than fine grinding. The poorest results were obtained when whole oats were fed but there was only a small difference between the whole oats and the finely ground oats. The effect on the food value of the whole ration when the oats portion is fed whole or ground, either medium or fine, is shown in Table 2 in a manner similar to the method just explained for corn.

Benefits from grinding oats were not as great as for grinding corn. For instance, it took only 102.1 pounds of the alfalfa and whole oats ration to supply the same food value as 100 pounds of alfalfa hay and medium ground oats, whereas, it took 110.5 pounds of the alfalfa hay and whole corn to equal the food value obtained from 100 pounds of alfalfa hay and medium ground corn.

Table 2. Comparative food value of medium ground, fine ground and whole oats.

Ration	Amounts to Furnish Equivalent Food Value
	Pounds
1. Alfalfa hay and medium ground oats	100.0
2. Alfalfa hay and finely ground oats	101.3
3. Alfalfa hay and whole oats	102.1

Effect on Cost of the Ration

A little figuring will readily illustrate the cost to be expected from grinding as far as the effect on the food value is concerned.

With alfalfa hay at $10.00 per ton each pound would cost one-half cent. With corn at 56 cents per bushel each pound of whole corn would cost one cent. Figuring the cost of grinding at seven cents per 100 pounds (price commonly charged for grinding) each pound of medium ground corn would cost 1.07 cents. On this basis the cost of 100 pounds of the alfalfa and medium ground corn ration would be as follows:

50 pounds alfalfa	@ ½ cent per pound	25.0	cents
50 pounds medium ground corn	@ 1.07 cents per pound	53.5	cents
	Total	78.5	cents

It takes 110 pounds of the alfalfa and whole corn ration to supply an equivalent food value and this would cost as follows:

55 pounds alfalfa	@ ½ cent per pound	27.5	cents
55 pounds whole corn	@ 1.0 cent per pound	55.0	cents
	Total	82.5	cents

Thus even after paying seven cents per 100 pounds for grinding the corn it still makes a cheaper ration because 78.5 cents worth of this ra-

tion will furnish as much food value as 82.5 cents worth of the alfalfa hay and whole corn ration. On this basis, if one were to feed a 1200 pound cow giving 30 pounds of four percent milk for a month, it would cost $6.68 for the alfalfa hay and medium ground corn ration and $7.02 for the alfalfa hay and whole corn ration or a difference of $0.34 in favor of grinding. By substituting different figures for the cost of hay, corn, and grinding the price which one can afford to pay for grinding may be arrived at for varying grain and hay prices.

In a similar way the cost could be figured out for the oats and alfalfa hay rations from the standpoint of the influence of fineness of grinding on the nutrients obtained from a given amount of feed. Of course, the results would be less pronounced in favor of grinding oats as it only took 102 pounds of the whole oats and alfalfa ration in the first place, to equal 100 pounds of the medium ground oats and alfalfa hay ration.

Effect of Grinding Grain on Digestibility of Protein in the Ration

The preceding results have been figured on the basis of the total digestible nutrients in the ration. The effect of the fineness of grinding the grain on the digestibility of the protein part of the ration was quite similar to that already reported for the total nutrients. For instance, when whole grains were fed, it took more of the ration to furnish the same amount of digestible crude protein than it did when ground grains were used. Again the difference was greatest in the case of corn where it took about 110 pounds of the whole corn and alfalfa hay ration to supply digestible protein equivalent to that in 100 pounds of the ground corn and alfalfa hay ration. Similarly the difference in results on the protein was also small as between medium and fine grinding of the grain.

How Grinding Affects the Food Value of the Grains Alone

By subtracting the nutrients obtained from the alfalfa hay part of the ration it is possible to estimate the nutrients received from the grain part of the ration alone. By making such calculations for each of the rations in this trial it is possible to get some idea of the effect of different degrees of fineness of grinding on the nutritive value of the grains alone. Such figures may be used to indicate the relative food value of the grains as affected by grinding where they are to be combined with other kinds of roughages in a ration. Table 3 below shows the effect of grinding on the food value of the grain alone for both corn and oats. In each case the pounds of finely-ground grain and of whole grain required to equal the food value provided by 100 pounds of medium ground grain is shown.

Table 3. Comparative food value of medium ground, fine ground and whole corn and oats.

Type of Preparation	Amount to Furnish Equivalent Food Value	
	Corn	Oats
Medium Ground	100.0 lbs.	100.0 lbs.
Finely Ground	96.2 lbs.	103.3 lbs.
Whole Grain	119.3 lbs.	105.1 lbs.

This table shows that there is not much difference in the food value between medium and fine grinding of the grain. It took slightly less finely ground corn (96.2 pounds) to equal 100 pounds of medium ground corn, but for oats it took slightly more (103.3 pounds). This averages out to practically a 100 pounds of the finely ground grains to equal 100 pounds of the medium ground grains. For the whole grain, however, it took 119.3 pounds of corn and 105.1 pounds of oats to equal 100 pounds of the medium ground grains, respectively.

General Considerations and Conclusions

From the work of this experiment, the results reported by other stations and the observations of practical dairymen, it can be stated that the food value of the harder grains with smooth, glossy, seed coats, such as corn, is increased more by grinding than is the case with softer grains having rougher hulls such as oats. Smoothness and hardness seem to be more important than mere thickness of the hull. More of the hard smooth grains pass through the digestive proccesses without being broken open or penetrated by the digestive juices; hence, much of the food value escapes into the feces. Chemical analyses of whole kernels appearing in the feces shows that practically none of the food value has been removed.

Dairy calves and heifers under one year seem to prefer whole to ground grain. They chew it until it is well broken up which makes complete digestion possible. Older cows, however, prefer ground grain, especially corn and other grains with hard seed coats. To insure complete digestion it seems to be necessary to merely break up the kernel into several portions so that the interior parts are exposed to the digestive juices. Nothing further is gained by the increased cost in time and money required for fine grinding. Furthermore, the finely ground grain is less palatable for dairy cows, and there is likely to be more loss in feeding especially if it is handled outdoors where it is exposed to the wind.

From the standpoint of the food value obtained, palatability, cost, and ease of mixing and handling, the medium grinding of grain which is just sufficient to break up the kernels into several portions is the best practice in preparing grain for dairy cows.