

THE FAT CONTENT OF MILK

Why It Varies

By T. R. FREEMAN

SUMMARY ● *The Breed* is the most important factor influencing the fat test of milk. Ranking from highest to lowest in the richness of their milk are the Jerseys, Guernseys, Brown Swiss, Ayrshires, and Holsteins. Even within a given breed there is much *individual variation* among animals in the fat content of their milk. This variation is probably the next most important factor in explaining differences in fat tests of milk. Although it is recognized that the *health of the cow* may influence the fat test of her milk, it is not possible to predict just what that influence may be. A diseased cow may be producing milk which is high, low, or normal in fat content. Generally speaking, as the *age of the animal* increases the fat test of her milk decreases slightly. This drop in fat test amounts to only about 0.5 percent, on the average, during the productive life of a dairy cow. A *seasonal trend* in the richness of herd milk has been observed: usually the fat test is highest in winter and lowest in summer. As the *stage of lactation* of a cow advances the fat content changes. For about the first 2 months the fat drops slightly, remains fairly constant for 2 or 3 months, and then increases gradually to the end of the lactation period. Conditions related to the *milking operation* may affect the fat test of the milk. The first portion of milk drawn is much lower in fat than the stripplings. If the intervals between milkings are not the same, the milk drawn after the shorter interval will test higher in fat. There is also some variation in the fat content of milk from the different quarters of the same udder. The kind of *feed* which the cow receives will normally have little or no effect on the fat test of her milk. Seemingly, however, feeding a ration deficient in roughage may reduce the fat test of the milk.

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By T. R. Freeman

Probably no other single topic of discussion in the entire dairy industry is characterized by so much misunderstanding, mutual suspicion, accusation, counter-accusation, bickering and other enervating forms of verbal activity as that dealing with the fat content of normal cow's milk. Some adjustment in the degree to which butterfat dominates our dairy economy appears to be taking place. The outcome of this apparent shift is, of course, problematical. Come what will, butterfat no doubt always will be considered an important constituent of milk. It is not the purpose of this publication to pursue a discussion of the relative importance of fat among the several constituents of milk, but rather to point out the many conditions which are known or believed to have an effect on the amount of fat present in normal milk.

The following factors will be considered: the breed, the individual cow, health of the cow, age of the animal, season of the year, stage of lactation, the milking operation, feeding conditions, and other management factors. Some of these factors will be of interest only when comparing one herd with another, or one locality with another. Many of the conditions to be considered, however, will help the dairyman understand why his herd varies from one time to another, and why there may be considerable variation among the individual animals in his herd.

THE BREED

It is almost universally recognized that the breed of dairy cow involved is the most important single factor determining the fat content of normal milk. Investigators interested in this problem have made hundreds of thousands of fat tests on milk produced by the various dairy breeds all over the world. The average values which they report do not always agree precisely, because each investigator has obtained samples of milk produced under slightly different circumstances. However, the results of these studies can be used as valuable, practical guides in setting up "norms" or standards for comparative purposes.

In the United States are five recognized breeds of dairy cattle. The following values can be considered reliable for purposes of comparison, as they are what would ordinarily be referred to as the "average fat test" for each breed:

PERCENT FAT IN MILK	
Jersey	5.30
Guernsey	5.03
Brown Swiss	4.00
Ayrshire	3.95
Holstein	3.48

The least amount of information is available on the composition of Brown Swiss milk. Consequently the value given for the fat content of milk of this breed may need slight revision in the future as more data are made available.

INDIVIDUAL VARIATIONS

It has just been noted that each breed produces milk which, on the average, contains an amount of fat characteristic of that particular breed. For instance, Jersey milk is said to have an average fat content of about 5.3 percent. This "average" was determined after the testing of many thousands of samples of milk obtained from hundreds and hundreds of individual animals of that breed.

If one were to examine all the individual fat tests used in calculating the average value for Jersey milk, he would find that they vary from considerably less than 5.3 percent to considerably more. A similar observation could be made concerning each of the other breeds. These individual variations are the result of each animal having a slightly different inheritance than that of every other animal. These small differences in inherited ability to produce milk of a certain fat content are sometimes difficult to demonstrate because so many other things may also cause individual samples of milk to deviate considerably from the "average" or "standard" fat content.

Several years ago workers at the Illinois Agricultural Experiment Station published figures to illustrate this matter of individual variations. They found, for example, that samples of milk from individual Jersey cows varied from a low of 3.28 percent to a high of 9.37 percent. The values which they published for other breeds showed variations of similar magnitude. So if one were to determine the average fat test for each animal in a Jersey herd (or other breed), based on an entire lactation period, a considerable spread among the averages would be observed.

HEALTH OF THE COW

Obviously, health is ordinarily significant only when dealing with individual animals. It is not likely that more than one or two cows in a herd would be producing abnormal milk because of sickness. Except in a very small herd such a condition would have little effect on the composite test from the mixed herd milk.

After searching the scientific literature for information on this point, one is disappointed to learn that a relatively small amount of work has been done. Some of the earliest experiments were not well controlled, and the early methods of testing for fat were perhaps not so reliable as those now used. In brief, there is only a very limited amount of dependable information available to help us understand the relationship between the state of health of the cow and the fat test of the milk she produces. Further beclouding the issue, this information does not show a consistent, clear-cut cause-and-effect rela-

tionship. This is true whether one considers sickness in general or some specific malady. Sickness usually causes a decrease in milk flow, but may or may not affect the fat test. It has been said that the milk produced by inflamed udders tends to approach the composition of blood. However, the effect on the fat content of the milk is not consistent. In some cases the fat test may be greatly reduced, while in others there may be no material change. One investigator reported that the fat content is, generally speaking, more likely to be increased than decreased as a result of the effect of disease. From a practical viewpoint this inconsistency means that one cannot predict any definite relationship between disease in the cow and the fat content of her milk—the latter may be high, low, or normal.

AGE OF THE ANIMAL

Most investigators who have studied this factor have observed a general tendency for the milk to decrease in fat content with successive lactations. The drop in fat test is not very great, however, being of the magnitude of only about 0.3 to 0.7 percent during the productive life of the animal. This observation is based upon results published by American and European workers. However, the effect of age of the animal is ordinarily of no significance in explaining variations in the fat test of herd milk or of individual cow samples over short periods of time.

SEASON OF THE YEAR

A great volume of material has been published by many workers interested in the relationship between season and the fat content of the milk. Most of the information indicates a definite seasonal trend in the average fat test of cow's milk. The investigators disagree as to the exact time of year when the fat test is highest or when it drops to its minimum. All agree, however, that the test is highest in the winter and lowest in the summer.

At least three different explanations have been suggested to account for this seasonal variation, including (1) changes in feeding conditions, (2) changes in average period of lactation of the herds, and (3) the seasonal changes in atmospheric temperature. Those who propose the first explanation believe that putting cows on lush spring pasture stimulates an upsurge in milk flow—the spring "flush"—which is accompanied by a lowered fat test in the milk. Others maintain the second explanation is more logical and believe that the changes in the milk are the result of a gradual change in the average stage of lactation. Most dairymen, they say, breed their cows to freshen in the spring. This makes the peak volume of production (and corresponding low-fat test) come during the summer months. By winter the cows have reached the latter part of their lactation period, and the fat test is increasing.

The third group believes that the cow responds physiologically to changes in atmospheric temperature, secreting more fat in cold weather and less in warm weather. As a matter of fact, experiments have been performed with cows maintained in temperature-controlled stalls, with results that seem to support this theory.

Of course it doesn't mean that, just because there are three theories, only one of them is entirely correct. In fact, it seems reasonable to believe that all three theories may be partly right—that each of the conditions discussed above may be involved in a true explanation of seasonal changes in the fat content of milk. From a practical viewpoint two things must be recognized: (1) there usually *is* a gradual change in the fat content of milk as the seasons progress; and (2) this seasonal change is probably less than most persons might suppose. It is doubtful if the highest average fat test of a commercial herd in winter is more than about 0.5 percent above the lowest test in the summer.

STAGE OF LACTATION

The effect of stage of lactation on the fat content of the milk probably would seem to most persons to be one of the simplest of the factors to determine experimentally. One would need only to make a fat test on milk samples taken at regular intervals from the time the cow freshens until she is dried off. However, it is not quite so simple as it seems at first glance. The average normal lactation period is 9 to 12 months in length, traversing in many cases an entire cycle of seasons.

Obviously then the experimenter has a difficult problem to resolve if he is to arrive at the truth. The problem is of this type: if a cow calves in March, the decreases and increases in the fat test of her milk will parallel both the seasonal progression and the advancing stage of lactation. How much, if any, of the change in fat content of the milk should be attributed to physiological changes in the cow as she advances in lactation? To arrive at an answer to this question many research workers have obtained milk samples from individual cows throughout hundreds of lactation periods. These studies represent all dairy breeds and include a fairly uniform distribution of lactations beginning in each month of the year. A careful survey shows a rather consistent trend. The fat content of the milk decreases during the first 2 to 3 months, remains fairly constant for a month or so, and then slowly increases to the end of the lactation period.

On the average, the maximum variation in the fat test of the milk during a single lactation (excluding the colostrum) is probably 0.5 percent or less. This applies, of course, to individual cows. The variation in the fat test of herd milk resulting from this factor will be even less, the range depending upon the number of animals in the herd and the extent to which the breeding schedule is spread over the entire year.

THE MILKING OPERATION

The first portion of the milk drawn from the udder will contain a smaller percentage of butterfat than will the strippings. In a study of this phenomenon in four breeds of dairy cows, one experiment station found that if the initial 8 or 9 percent of the milking were withheld the remainder of the milk would test about 0.2 percent higher in fat. Many years previously workers at another station had studied this same problem. They divided the milking into nine successive portions and tested each portion to find the fat content. In a single milking the fat test varied from as low as 1.4 percent in the first portion to as high as 11.0 percent in the last portion. This shows why it is so essential to mix thoroughly a complete milking from a cow if one wishes to determine the true fat test of her milk.

In respect to the milking operation it should be mentioned that the interval between milkings may have some influence on the fat test. If the milkings come at approximately equal (12-hour) intervals there will probably be little variation in fat test from one milking to the next. However, if the two intervals are not uniform the fat test usually is higher from the milking following the short interval. If in the summer the dairyman milks early in the morning and late in the evening, one would expect the morning milk to be the richest in fat. Because of those conditions it is very important to mix thoroughly the samples obtained from two successive milkings in order to determine the true average fat test of the milk.

There will also be some variation in the fat test of milk from the different quarters of the same udder. This behavior follows no uniform pattern, even in the same udder. While the greatest difference between quarters of the same udder is not large, probably averaging about 0.2 percent fat, it nevertheless lends emphasis to the importance of obtaining a complete milking from a cow that is being tested for ability to produce fat.

FEEDING CONDITIONS

The possible effect of feed on the composition of milk, particularly its fat content, has long been a subject of great interest to dairyman, teacher, and scientist. To say that it has been a controversial subject is certainly an understatement. In the early history of scientific agriculture an attempt was made to associate high-fat dairy rations with the production of milk rich in fat. Experiments have repeatedly proven, however, that the fat test of the milk cannot be increased significantly by adding fat-rich feeds to the ration. If the cow is receiving a reasonably well-balanced ration, a low fat test in the milk cannot be ascribed to the feed she is receiving.

It does appear, however, that an adequate amount of good quality roughage in the ration of the dairy cow is necessary if she is to produce milk of normal composition. One of the earliest observations of this

relationship was made at the New York Agricultural Experiment Station over 50 years ago, in connection with cheese making experiments. This phase of their studies received very little recognition, and it has only been during recent years that dairy investigators have "discovered" this relationship. It now appears to be a fairly well established fact, however, that cows inadequately supplied with roughage are likely to produce milk containing an abnormally low concentration of both fat and solids-not-fat. This observation is substantiated by reports from at least three experiment stations in the United States, as well as from investigations in England and Australia.

If silage or good quality hay is not available during periods when pastures are nonproductive, the quality of the milk may suffer until roughage is again provided. This situation could conceivably occur at any season of the year, depending upon geographical location and weather conditions. In some instances the effect has been so pronounced as to cast suspicion on the honesty of the dairyman producing such milk.

All factors which may affect this phenomenon have not yet been exhaustively studied. Nevertheless, when a milk sample is observed to be low in fat, and the usual explanations do not seem to suffice, an inquiry into the roughage feeding program might provide the answer to the problem.

OTHER MANAGEMENT FACTORS

Some writers have stated that management is one of the most important of all factors affecting the fat content of milk. The dairy cow is a creature of habit. If her habitual daily routine is suddenly changed she may respond with a change in the amount and composition of the milk she produces.

For instance, changing a herd from hand milking to machine milking (or vice versa) may cause at least a temporary change in the fat test of the milk. A change in milkers, sudden fright, mistreatment, etc. are all likely to affect the milk to a greater or lesser degree. In general, any change in management practices which brings about less desirable conditions usually results in the production of milk with lower fat content.

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