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Factors Affecting The Butterfat Composition Of Milk

JAMES H. KOSHI
AREA SPECIALIST
IN DAIRY SCIENCE

UNIVERSITY OF HAWAII
COOPERATIVE EXTENSION SERVICE

Cooperative Extension Work in Agriculture and Home Economics
College of Tropical Agriculture, University of Hawaii, Honolulu 14, Hawaii
United States Department of Agriculture Cooperating
Morton M. Rosenberg, Dean of the College of Tropical Agriculture and
Director of the Hawaii Cooperative Extension Service
Dale N. Goodell, Associate Director, Hawaii Cooperative Extension Service
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James H. Koshi
Area Specialist in Dairy Science

The sporadic variation in the butterfat composition of milk at the plant has often puzzled dairymen. Since the fat content has a direct bearing on the paycheck, dairymen want to be sure that there is good reason for a test that goes down.

The fat content of an individual cow's milk is affected by many different factors. Failure to recognize these factors often lead to confusion and frustration of all the parties concerned. But many of the factors influencing the composition of an individual cow's milk are not too important when dealing with the composition of the herd milk, because factors may cancel each other out. The fat test of a large herd tends to be more stable than that of a small herd. However, sometimes many of the factors may come together in such a way that a considerable change in the herd test occurs. Some of these factors are beyond the control of the dairymen so there is very little to be done about them. Other factors can be controlled to produce the highest possible test.

The more important factors known to influence the fat content of milk are the breed of the dairy cow, individual inheritance, feeding, management, and milking practices.

SAMPLING

Before a fat test can have meaning, the milk must be properly sampled first. To get a proper sample, the milk must be well mixed before sampling. Studies have shown that milk in a bulk tank must be agitated for at least 5 minutes in order to get a good representative sample. A good representative sample is very difficult to obtain if the milk has been frozen or if some churning has occurred in milk due to over-agitation while still warm.

Composite Samples

The preserved composite samples have been used by milk plants for many years as a common basis for obtaining an average test of the milk delivered by producers. Studies by different investigators have shown that average tests of the composite samples are lower than the average test of daily fresh samples, ranging from a minimum of 0.0125 percent to a maximum of 0.167 percent lower. The error, however, is considered to be within the error of the Babcock testing procedure. Therefore, testing of composite samples may be considered a way to get accurate results if the test is properly handled. Improperly collected or improperly handled samples cannot be used to accurately determine butterfat content.

INHERITANCE FACTORS

Inheritance determines an animal's ability to produce a certain amount of butterfat in relation to the amount of milk produced. Thus, a dairyman should select his cows and bulls for their genetic ability to produce the amount and quality of milk desired. The potential average butterfat test of a herd is set by the inheritance of the cows but the day-to-day fluctuation is influenced by environmental factors which will be considered later.

Breeds of Cattle

There is a distinct difference in the fat content of milk from cows of different breeds. The average butterfat test of various breeds are as follows: Holstein, 3.4 percent; Ayrshire, 3.9 percent; Brown Swiss, 4.0 percent; Guernsey, 5.0 percent; and Jersey, 5.3

percent. It is obvious that milk from herds composed largely of Jerseys and Guernseys will test higher than those from herds composed largely of Holsteins.

Individuals within Breeds

The butterfat tests within breeds vary greatly also. The minimum and maximum found in the low- and high-testing breeds are as follows: Holsteins, 2.6 to 6.0 percent; Jerseys, 3.3 to 8.4 percent. Thus, considerable variations within breeds are to be expected.

OTHER FACTORS

Individuals from Day to Day

Daily fat tests from individual cows, irrespective of breed, vary from day to day. One study of 2,000 cows tested during a 7-day period showed that a little over half of the cows varied from 1.1 to 2.0 percentage points in butterfat content of milk from one day to the next. About 17 percent of the cows produced milk varying more than 2.0 percentage points. Only about 28 percent of the cows showed a variation of less than 1.0 percentage point from one day to the next.

Individuals from Hour to Hour

In a study conducted at Minnesota, cows were milked hourly with the use of oxytocin for as long as 156 consecutive hours. Even though the milk secretion was relatively constant from one hour to the next, the fat test varied as much as 3.0 percentage points—that is, the butterfat test was 5 percent at one hour and 8 percent the next. During the study the fat test of one cow ranged from a low of 1.8 percent to a high of 12.1 percent.

Time Between Milking

When cows are milked at irregular intervals, more milk is produced during the longer intervals but the butterfat test will be lower than for the shorter intervals.

Night and Morning Milk

When milking periods are even, there is little variation in the test. Some studies have shown that the tendency is for night milk

to test slightly higher than morning milk. This is generally attributed to the greater exercise that cows get during the day.

Stage of Lactation

There is a definite change in the butterfat test during the lactation period. A cow in good condition when freshening will give milk with quite a high test for 1 to 2 weeks. The test will then decline gradually for 10 to 12 weeks, after which it will rise gradually to the end of the lactation. The test may be a whole percentage point higher near the end of a lactation period than at the beginning. If calving dates are not evenly spaced throughout the year, the herd test would probably be influenced by the stages of lactation. However, such influence would be very gradual and would not be sudden.

Age of the Cow

The percentage of fat tends to decline slightly with age, but the total decline is very slight. The change is of very little importance in a herd where the average age of the animals remain relatively constant.

Climatic Condition

Generally, hot weather will cause the cows to produce lower testing milk than cool weather. It is felt that some of the seasonal changes may be due to the change in feeding practice which goes with the season.

Milk Yield

Generally, as milk production goes up, the butterfat test comes down. This is not always true.

First- and Last-drawn Milk

The butterfat test for the first few streams of milk drawn at any milking may be as low as 1.0 percent and gradually increase throughout the milking to as high as 12.0 percent or more for the last-drawn milk. It would not take too much milk left in the udders to change the butterfat test of the milk. This does not mean that one should prolong the milking to get the last drop of milk.

MILKING PRACTICE

To get the most butterfat and milk, and to best maintain the health of an udder, one should practice "managed milking" or the "rapid milking" technique. This procedure attempts to bring about the complete letdown of milk. Milk, even though already secreted and present in the udder, is not available to the milker unless the cow lets it down to the udder and teat cistern where the milker can remove it. The letdown of milk is controlled by the nerves located in the udders and involves the general attitude of the cow. If the cow is in a cooperative mood and the nerves are stimulated by massaging, washing, etc., a message goes to the posterior pituitary gland located at the base of the brain. The gland then releases oxytocin into the blood system which carries the hormone to the udder in about 40 seconds. The milk is then squeezed from the secretory portion to the cisterns below. In some animals, one can tell when a cow has let down her milk because the milk starts to leak out of the teats. In others the only sign is a tightening of the udder. For best results, milk should be removed within 5 minutes after stimulation. It is therefore poor practice to stimulate more animals than one can milk within a few minutes. This is not much of a problem in a parlor barn. However, in a stanchion barn, many cows are stimulated when first washed down but all are not milked immediately after. It is possible to get a second letdown but this is not as complete as the first in many cows. It has been shown that milking 20 minutes after stimulation could result in reducing the butterfat test by as much as 1.0 percentage point.

Careless handling or rough treatment of a cow just before or during milking may cause a decrease in milk quantity and a lower test. A change in milkers may lower or raise the test, depending on the individuals and the cows concerned.

FEEDING

For a long time it was generally accepted as fact that the fat test of a cow's milk could not be increased or decreased for any

length of time through feeding practices. Recent studies show a definite relationship between feeding and butterfat test but no one has yet found a ration that would materially increase the butterfat content of milk for any duration. Feeding certain oils has temporarily increased the fat test of milk and feeding other oils has decreased the test. High or low protein intake seems to have very little or no effect on butterfat test. It seems that genetic makeup controls the potential upper limits of fat test.

The necessity of roughage in the diet to maintain a good butterfat test was observed as early as 1938. Since that time, much work has been done to substantiate this early observation.

In Hawaii the low butterfat test of milk involves complicated problems. The problem is especially acute since roughage supply is very limited. However, in many cases the problem does not seem to be easily solved just by adding more roughage.

Several recent studies have shown fairly well that low roughage alone is not the problem. A study conducted in England showed that flaked corn decreases the fat test more than crushed oats or barley.

A University of Maryland study showed that the fat content of milk taken during mid-lactation is not easily decreased even with hay level as low as 3 pounds per day when the usual concentrate mixtures are fed. In studies started in 1950, it was further found that no marked reduction in milk fat content is achieved when cows in mid-lactation are maintained on 4 pounds or less of hay (long, chopped, or pelleted) when a commercial concentrate or a simple mixture of commonly used grains is fed.

Further studies have shown that when feeds with heated starch is substituted for the energy source, it is possible in some cases to depress the fat content. Cows receiving the more commonly fed concentrates, even with lower than normal levels of roughage, produced milk with only slight decreases in the fat content. It seems, then, that cows receiving rations consisting of low roughage combined with heated starch will produce milk with a low fat content.

The problem of reducing fat content by feeding is not simple. It seems that the amount of roughage and concentrate fed, the kinds of roughage and concentrates fed, and the amount of heating to which the concentrates were subjected, all have some effect on the butterfat test. The fat content of milk from cows fed at a high plane of nutrition tend to be decreased more than milk from cows fed at a low plane.

Research results indicate that long fibers in the roughage are better to maintain a high butterfat test than short fibers. For example, the coarse chopped alfalfa hay is better than ground alfalfa and long hay is better than chopped hay.

To avoid a low butterfat test, it is necessary to feed as much coarse roughage as is economically possible and avoid the use of heated starch when practical. Starch in concentrates could be heated by steam rolling and pelleting under high pressure. Therefore, under certain conditions, steam rolled barley or pelleted feed may depress the butterfat test in milk.

Some recent work at Michigan has shown that finely ground roughage results in a definite decrease in saliva secretion. Since the bicarbonate composition of saliva is high in the ruminants, the conjecture was made that the addition of sodium bicarbonate (plain baking soda) may have some effect on the fat test of milk. It was found that adding sodium bicarbonate to a low roughage ration maintained the fat test.

Thus we know now that feeding can have a great deal of influence on the butterfat test of milk, but all the answers are not in yet. In the meantime, each individual dairyman must study his own situation carefully and feed accordingly. The feed that works well under one condition may not work under another.

SUMMARY

The major factors shown to influence the butterfat content of milk have been briefly discussed.

To summarize:

Samples must be properly taken and properly handled.

Dairymen must consider a combination of factors in trying to increase the butterfat content of milk, the major ones being the breeds of dairy cows, individual inheritance, feeding, management, and milking practices.

Small fluctuations in the butterfat test from one sample to the next is probably due to any one or a combination of factors. But any drastic and persistent reduction in test is probably due to feeding practice.

Finally, dairymen should recognize that some day a high butterfat test may be de-emphasized or even be considered undesirable. Therefore, in working out a breeding and selection program, the matter of solids-not-fat in milk must be considered.

BIBLIOGRAPHY

Allen, N. N. "The Fat Percentage of Milk as Affected by Feeding Fats to Dairy Cows," *J. Dairy Sci.*, 1934, 17: 379.

Balch, C. C., *et al.* "Studies of the Secretion of Milk of Low Fat Content by Cows on Diets Low in Hay and High in Concentrates. I. The Effect of Variations in the Amount of Hay," *J. Dairy Res.*, 1952, 19: 39.

Balch, C. C., *et al.* "Studies of the Secretion of Milk of Low Fat Content by Cows on Diets Low in Hay and High in Concentrates. V. The Importance of the Type of Starch in the Concentrate," *J. Dairy Res.*, 1955, 23: 10.

Cobble, J. W. and H. A. Herman. *The Influence of Environmental Temperatures on the Composition of Milk of the Dairy Cow*. University of Missouri Agr. Expt. Sta. Res. Bul. 485, 1951.

Contributions to Ruminology. University of Maryland Agr. Expt. Sta. Misc. Pub. 291, 1957.

Ensor, W. L., J. C. Shaw and H. F. Tellechea. "Special Diets for the Production of Low Fat Milk and More Efficient Gains in Body Weight," *J. Dairy Sci.*, 1959, 42: 189.

Erb, R. E., *et al. Lactation Studies. V. Causes in Variations in Fat Percentage.* Washington State University Agr. Expt. Sta. Cir. 229, 1953.

Freeman, T. R. *Effect of Breed, Season, and Stage of Lactation on Certain Constituents and Properties of Milk.* University of Kentucky Agr. Expt. Sta. Bul. 667, 1959.

Gould, I. A. and R. E. Stout. *Fat Variations in Milk.* University of Maryland Agr. Expt. Sta. Misc. Pub. 80: 1, 1949.

Jacobsen, D. H. and G. C. Wallis. *Factors Affecting the Composition of Milk.* University of South Dak. Agr. Expt. Sta. Bul. 331, 1939.

Jenness, Robert, *et al.* "The Density of Milk Fat: Its Relation to the Accuracy of the Babcock Test," *J. Dairy Sci.*, 1942, 25: 949.

Koshi, J. H., J. D. Donker and W. E. Petersen. "The Effect of Hourly Milking with the Use of Oxytocin on the Butterfat Percentage and Saponification Number." Paper presented at A.D.S.A. meeting, 1953.

McClymont, G. L. "The Relation of the Type and Quantity of Roughage and Grazing to Fat Content of Milk." *Australian Vet. J.*, 1950, 26: 111.

Newlander, H. A. and W. S. Arbuckle. *Variations in the Fat Content of Milk.* University of Maryland Agr. Expt. Sta. Bul. 459, 1956.

Nielsen, V. H. "Sampling and Testing Bulk Tank Milk," *Amer. Milk Review and Milk Plant Monthly,* June 1958: 84.

Overman, O. R., F. P. Sanmann and K. E. Wright. *Studies of the Composition of Milk.* University of Illinois Agr. Expt. Sta. Bul. 325, 1929.

Shaw, J. C., *et al.* "Production of Low-fat Milk. I. Effect of Quality and Quantity of Concentrate on the Volatile Fatty Acids of the Rumen and on the Composition of the Milk," *J. Nutr.*, 1959, 69: 235.

Trout, G. M. and Earl Weaver. *Why Milk Tests Vary.* Michigan State University Agr. Ext. Ser. Bul. 96, 1950.

Turner, C. W. *Factors Affecting the Composition of Milk.* University of Missouri Agr. Expt. Sta. Bul. 365, 1936.

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COLLEGE OF TROPICAL AGRICULTURE
COOPERATIVE EXTENSION SERVICE

Thomas H. Hamilton
President of the University

Morton M. Rosenberg
Dean of the College of Tropical Agriculture
and
Director of the Cooperative Extension Service

Dale N. Goodell
Associate Director, Cooperative Extension Service