THE CREAMING OF RAW MILK

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ABSTRACT

The creaming of raw milk is of considerable significance not only for the raw milk trade, but also to secure a proper understanding of the whole creaming problem.

It was necessary to follow a standard procedure for measuring the creaming ability of milk to secure uniform results. Milk of individual cows was set for creaming a few minutes after milking. The creaming took place in graduated cylinders held in ice water at 35° to 40°F. Readings were taken after 2, 4, and 24 hours.

On milk with good creaming properties the cream layer was evident in 2 or 4 hours and the volume of cream decreased with age up to 24 hours. The cream layer tested about 25 per cent after 24 hours and the skimmilk about 0.5 per cent.

The volume of the cream layer on herd milk, expressed as percentage of the total volume of milk, was about 4.1 times the percentage of milk fat. Thus, Holstein milk testing 3.5 per cent gave a cream layer of 14.3 per cent, while Jersey milk testing 5.5 per cent gave 22.5 per cent of cream. The milk of the two breeds gave similar cream layer volumes for 1 per cent of fat, but milk from Holstein cows gave more uniform results. The creaming ability of milk of individual cows may vary markedly from milking to milking.

When milk had been quickly cooled to and held at 40°, the deepest cream layer was secured, but if stirred several hours later, the second cream layer was very shallow. The test of the cream was lowered and the richness of the skimmilk was increased. Milk cooled to and held at 60° gave short cream layers, but upon resetting at 40° the cream layer volume was

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1This bulletin is a popular presentation of a portion of Technical Bulletin No. 157 of this Station to which the reader is referred for a review of the literature on the subject and for the experimental data substantiating this publication. Also, in Bulletin No. 591 of this Station is a popular account of how the cream layer forms on milk.
increased. This increase in the volume of cream was caused by a decreased percentage of fat in the cream.

The agitation received by cold milk in partially filled cans en route to the milk plant did not affect creaming.

INTRODUCTION

The creaming of milk as it is produced on the dairy farm is of considerable commercial importance. There is need for information to show whether the volume of the cream layer is influenced by the individuality of the cow or the breed of cattle after due consideration has been given to variations in the fat content of the milk. An appreciable amount of milk is still consumed in the raw condition and the volume of the cream layer is of value. Variations in the creaming of raw milk have also materially influenced the results secured by pasteurization and have often so confused the investigator that the true effect of pasteurization on the creaming of milk was obscured.

METHOD OF DETERMINING CREAM LAYER VOLUMES

A very definite procedure must be followed to obtain accurate measurements of the creaming ability of milk. The most convenient container for the milk is a 100-cc cylinder. These cylinders are approximately the same height as 1-quart milk bottles, and since they are calibrated on the basis of 100, the percentage which the volume of cream is of the total volume of milk can be read directly from them. Milk bottles are generally very unsatisfactory for measuring cream layer volumes because the slant of the neck makes it impossible to measure the volume with accuracy. A special scale has been devised by other investigators for this purpose and it is of value in making rough comparisons. The samples of milk which are being tested must be poured into cylinders and placed at once in an ice water bath at a temperature ranging from 35° to 40°F. If large test tubes are used in place of cylinders, they should be spaced apart to allow circulation of the water so as to insure uniform and rapid cooling. Graduated cylinders cannot be packed closely together. The volume of the cream layers should be read after a few hours, such as 2- and 4-hour periods, and again after 24 hours. The reasons for definitely specifying these conditions have been made very evident by this study.

The creaming of milk was affected by the temperature at which it
was stored and the length of time which it was held before being set for cream layer determinations. The volume of the cream layer increased with decreased temperature of setting and reached a maximum between 32° and 40°. When the temperature of creaming rose above 45° or 50°, there was an appreciable shrinkage of the cream layer volume so that it became essential to maintain uniform conditions for accurate comparisons.

It was explained in a previous publication (Bulletin No. 591 of this Station) that the fat globules in milk rise as clusters, that a large proportion of the fat enters these clusters, and that these clusters attain their largest size when milk is quickly chilled below 40°. In milk of good creaming properties the cream layer has completely formed in 2 hours so that a reading made at the end of 2 hours should show a definite cream line. The tendency for fat to rise is always present and this continual upward pressure of the fat within the cream layer gradually produced shrinkage in the volume of cream on milk of good creaming properties. This shrinkage had taken place to a maximum within 24 hours so that a reading of the cream layer volume made after 24 hours gave a minimum value.

An average of over 400 individual tests of milk of good creaming properties, calculated on the basis of 4 per cent milk, showed the cream layer volume to be 22 per cent after 2 hours, 17 per cent after 4 hours, and 16.4 per cent after 24 hours. These results emphasized the importance of time of creaming even after the cream layer had formed.

A very different result was usually secured with milk of poor creaming properties. The poor creaming quality was caused by the failure of the fat globules to form quickly into large irregular clusters. In such milk the cream line was often absent in 2 hours and was indistinct after 4 hours of creaming. Furthermore, since the clusters were very small and were rising slowly, a large portion of them had not reached the cream layer at the end of 4 hours so that the volume of the cream layer tended to increase with time rather than decrease, as was the case with milk of good creaming properties. For this reason it was generally possible to predict the creaming properties of milk by the 2- and 4-hour readings and to determine whether the cream layer volume would shrink or would be built up by standing. It should be stated that the number of instances in which the cream layer volume was built up with time were rather limited.
CREAMING OF MILK OF INDIVIDUAL COWS

During the course of this study more than 900 samples of Jersey milk and more than 600 samples of milk from Holstein cows were set for cream layer determinations within 2 or 3 minutes after milking. The immediate setting of the samples for creaming eliminated variations which may have been caused by aging the milk. The milk from more than 60 cows was used in these comparisons. Obviously, the age of individual cows and the stage of the lactation period varied enormously.

The results of these determinations clearly emphasized that the creaming of milk of individual cows varies markedly from one cow to another within a breed and that in most instances the creaming of milk from the same cow varies from milking to milking when due allowance has been made for variations in the percentage of fat. If the percentage of the cream layer after 24 hours of creaming is calculated on the basis of 5.5 per cent fat for Jersey milk, then the lowest average cream layer volume secured in these experiments for all individual Jersey cows was approximately 19 per cent, while the highest average cream layer volume secured on an individual milking of more than 20 cows was approximately 27 per cent. It is interesting to observe in this connection that the lowest cream layer volume secured on an individual sample of Jersey milk was 17 per cent, while the highest individual sample was 44 per cent, both results being expressed on the basis of a 5.5 per cent fat content. In view of the fact that these cream layer volumes have all been corrected by calculations to a fat content of 5.5 per cent, it is evident that the cream layer volume which will form on the milk of an individual cow cannot be predicted with a fair degree of accuracy from any past information concerning her milk. The only exception which should be made to this statement is that certain cows tended to give either low or high average cream layer volumes even tho there was rather marked variations from milking to milking. Cows which were sick or which had been milked incompletely often gave milk of very erratic creaming properties.

There was a tendency for the milk of Holstein cows to be considerably more uniform in its creaming ability than was the milk from Jersey cows. Assuming that the Holstein milk contained 3.5 per cent of fat, the shortest individual cream layer secured from the milk of any Holstein cow was 11 per cent and the deepest cream layer 17 per cent.
It is also very interesting to note that a far greater number of samples of Jersey milk were secured which gave no evident cream layer than was the case with Holstein milk. The reason for this unexpected result is not apparent, but the accuracy of the observation was evidenced by the fact that fat clusters generally formed more rapidly in Holstein than in Jersey milk.

Variations in the creaming of milk from individual Holstein and Jersey cows is clearly illustrated by Fig. 1 where the percentage of the cream layer to the total volume of milk is plotted to take care of variations in the fat content of the milk by dividing the percentage of cream layer by the percentage of fat. This method of expression eliminates differences caused by the fat content of the milk. The illustration clearly shows the greater uniformity in the creaming of Holstein milk.

**AVERAGE CREAM LAYER VOLUME FOR HERD MILK**

Fig. 1 shows that the average cream layer volume which forms on Holstein or Jersey milk is approximately 4.1 times the percentage of

![Diagram showing creaming ability of Holstein and Jersey milk.](image-url)

**Fig. 1.—The Creaming Ability of Holstein and Jersey Milk Shown as the Frequency, Expressed in Percentages, with Which These Milks Gave Cream Layers of Varying Volumes.**

The cream layer volumes are expressed as percentages of the total volume of milk and are divided by the fat content to secure uniformity in the comparisons. The figure shows that Jersey and Holstein milk gave the same average cream layer volumes per 1 per cent of fat, but that more uniform results were secured with Holstein milk.
fat. In other words, the volume of the cream layer which will form on herd milk can be quite accurately predicted by the percentage of fat in the milk, and if marked variations are secured from the anticipated cream layer volume it will be evident that the milk is of abnormal creaming properties or that faulty technic has been employed in making the determinations.

An illustration of this statement will make its significance very clear. Holstein milk containing 3.5 per cent of fat should give a cream layer of approximately 14.3 per cent; milk testing 4 per cent, a cream layer of 16.4 per cent; while milk testing 5 per cent should give a cream layer of 20.5 per cent. Milks with varying percentages of fat and the cream layers to be expected on them are illustrated in Fig. 2. These results will generally be secured for herd milk because the figures are based on the creaming ability of more than 1,000 individual samples of milk and because the creaming of the milk from a considerable number of cows will always approach this average. Observations reported in the literature on the creaming of milk at milk plants in
which due allowance has been made for various factors which influence the cream layer volume clearly substantiate the fact that the cream layer volume is approximately 4 times the fat content of the milk.

INFLUENCE OF PRE-COOLING MILK ON CREAMING

In ordinary dairy practice it seldom happens that milk is set for creaming within a few minutes after it is produced. The question immediately arose concerning the influence of previous cooling upon the volume of the cream layer which formed when the milk was finally set for creaming.

When milk was quickly cooled to 40° or below immediately after milking, the deepest cream layer was secured in the shortest period of time and the test of the skimmilk layer was lowest. Creaming was usually completed in 2 hours, except for the continued packing of the cream layer into a smaller space. Milk forms this cream layer in the cans in which it is stored, but it is generally not delivered to the milk plant for 12 to 15 hours. If it is bottled at the dairy farm, this process is usually accomplished in the morning after the night’s milk has been stored over-night. The milk is thoroly stirred in the morning and placed in bottles for creaming, usually after mixing with morning’s milk.

Under these conditions, the milk might form an average cream layer volume, but generally this was not the case. The milk re-creamed slowly, the cream layer volume was decreased, and the percentage of fat in the cream layer was decreased while the fat content of the skimmilk was greatly increased. The reason that the cream layer volume was sometimes normal in volume was due to the great decrease in richness. It is interesting to note that the pre-cooling of milk to 40° for several hours before setting for creaming generally destroys a larger portion of the creaming ability of Holstein milk than is the case with Jersey milk.

Milk is generally cooled on the farm to temperatures in the vicinity of 50°, and at this temperature of storage there is often little effect upon the cream layer volume when milk is re-creamed. The fat rises poorly into the cream layer, but the decrease in the amount of fat in the cream is made up by the lower percentage of fat, thereby giving the same approximate total volume. It is interesting to note that for milk stored over-night at 60° the depth of the cream layer is usually increased upon subsequent creaming, even tho the cream rises slowly
and incompletely. When milk is not cooled for a few hours immediately following milking, the volume of the cream layer which forms upon setting at 40° is not materially affected. Consequently, the uncooled morning's milk as delivered to a milk plant or as bottled at the dairy has its creaming ability altered but slightly or not at all.

Fresh herd milk set immediately at 40° for creaming for 24 hours usually gave a cream testing about 25 per cent and skimmilk testing slightly less than 0.75 per cent. After an over-night aging at 40° followed by mixing and resetting for a 24-hour creaming period, the test of the cream was decreased to 15 per cent and the richness of the skimmilk was increased to 2 per cent. At warmer aging temperatures the skimmilk tested between 1 and 2 per cent.

INFLUENCE OF AGITATION OF MILK ON CREAMING

There is a prevalent belief among milk plant operators that the agitation of cold milk in partially filled cans or tanks en route to the plant often seriously impairs the creaming powers of the milk. That such milk may have poor creaming powers due to storage at cold temperatures has just been emphasized. A special study was made of the effect of agitating this milk.

The experiments showed conclusively that hauling partially filled cans of milk in a truck over gravel roads did not noticeably affect its creaming powers, and that the effects of agitating the milk and of storing milk without agitation have been confused. Cold milk withstood rather severe and prolonged agitation with but slight decreases in the cream layer volume when the milk was at 40° and with slight increases when the milk was at 60°.

DISCUSSION

The problem of securing the maximum cream layer volume on milk sold raw by the producer and which is not subsequently pasteurized is a difficult one. For best sanitary qualities, lowest bacterial count, and the most thorough rising of the fat into the deepest cream layer, the milk should be quickly cooled to 40° or below and bottled at once. Delivery to the consumer about 4 hours after bottling will insure the greatest volume of cream at the time of delivery as the layer shrinks on standing.

This procedure can be practiced for morning's milk which is generally
quickly cooled, mixed with the cold night's milk, and bottled. The full cream layer volume of the night's milk may not be secured, especially if it has been quickly cooled to 40°.

There are two possible procedures which will give better cream layer volumes, but both are subject to criticism from other viewpoints and cannot be generally recommended. The night's milk held at 40° may have its creaming properties restored by warming in the morning to 105° to 110° with 5 to 10 minutes holding. This milk should then be quickly cooled to 40° or less, and if the cold morning's milk is then added, the entire batch will have good creaming properties. This procedure may be illegal because Grade A raw milk must be cooled to 50° or below within 1 hour and held at or below that temperature. The other procedure is to cool the night's milk to 45° to 50° and hold at this temperature until morning. The cooled morning's milk can then be added. This procedure is subject to the criticism that should the temperature rise much above 50° the regulations for Grade A raw milk are violated and there is danger of bacterial multiplication.

The dairy farmer who sells milk to a pasteurizing plant need not be concerned over the impaired creaming ability of milk held at 40° before delivery because milk is generally not held at this temperature for delivery to pasteurizing plants and because the creaming properties of the milk are restored in part or in full by proper pasteurization.