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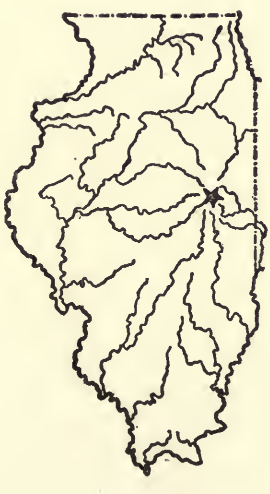
EFFECT OF TEMPERATURE OF PASTEURIZATION ON THE CREAMING ABILITY OF MILK

By H. A. HARDING



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EFFECT OF TEMPERATURE OF PASTEURIZATION ON THE CREAMING ABILITY OF MILK

By H. A. HARDING, Chief in Dairy Bacteriology

INTRODUCTION

Until 1900 commercial pasteurization was a compromise between the heating which the scientist considered necessary in order to free milk from the danger of carrying disease germs, and the heating which would leave the milk in a condition acceptable to the consumer. Under these circumstances, milk was pasteurized in but limited quantities by a few dealers, and the use of the pasteurized product was practically restricted to infant feeding.

Since the recommendation by Russell and Hastings in 1900[1] that pasteurization at 140° F. for thirty minutes be accepted as satisfactory from the sanitary standpoint, commercial pasteurization has spread over the country with ever increasing rapidity. In about 1913 pasteurization began to be generally recognized as the most important safeguard of the healthfulness of the milk supplies of the country.

The principle of pasteurization has been considered settled for more than two decades. However, during this period the practice of pasteurization has undergone many changes. There has been little question but that the bulk of pasteurized milk has been properly treated in the various pasteurizing machines. On the other hand, criticism regarding minor points has been rather constantly raised. The three points in connection with which pasteurizing machines are most open to criticism are: (1) the lack of exactness in heating the first and last milk during the act of pasteurizing; (2) the occasional escape of milk thru leaky valves; and (3) the results from foam. This feeling of uncertainty regarding the practical details of commercial pasteurization has finally led to a definite demand for pasteurization at 145° F. for thirty minutes as a minimum temperature and time.[2]

This movement for a higher temperature in pasteurization has arisen in a perfectly natural way as a method of increasing the margin of safety surrounding a process which is extremely important from the standpoint of public health. In view of the fact that the earlier attempts to pasteurize milk at high temperatures produced a commercially unacceptable product, and thereby sharply curtailed the use of pasteurized milk, it is desirable that careful study be given the effect upon the milk of the suggested change in pasteurizing temperature to a minimum of 145° F. The recent development of a method by which the creaming ability of milk can be easily and accurately measured opens the way for a study of this problem.[3]

Many of the typical pasteurizing machines have a capacity of 10,000 to 20,000 pounds of milk per hour. The high cost of such machines and the necessity of a force of experienced attendants to operate and care for the machinery, together with the need of a large supply of milk in testing the machines under working conditions, made it practically imperative that such a study be conducted in commercial milk plants. Owing to the generous cooperation of the Gridley Dairy Company of Milwaukee, the Sheffield Farms Company, Inc., of New York City, the Detroit Creamery Company of Detroit, the Pevely Dairy Company of St. Louis, and the Bowman Dairy Company of Chicago, it was possible in this study to cover practically all the prominent types of pasteurizing machinery. The author desires to express appreciation of the generous assistance of these firms.

ESTABLISHMENT OF PASTEURIZING TEMPERATURES

In 1895 when Russell proposed pasteurization of milk for twenty minutes at 155° F.,[4] there was some uncertainty regarding the time and temperature necessary to destroy the germs of tuberculosis. The explanation for these variations in scientific results was found by Theobald Smith in 1899.[5]

The problem of the destruction of disease germs in milk by pasteurization was again studied by Russell and Hastings in 1900,[6] and by Rosenau in 1908.[7] In each of these three separate investigations the results were practically identical.

The studies of Rosenau showed that the germ of tuberculosis is much more resistant to heat than any of the other disease germs which occasionally find their way into milk. In all the above mentioned studies, the number of germs of tuberculosis added to the tested samples of milk was vastly greater than would be present as the result of natural infection. Even under these circumstances there were times when living germs of tuberculosis could not be found after the milk had been heated to 140° F. for one minute. Only in a few cases were any of the germs alive at the end of ten minutes of heating, and in no case were any found after heating for fifteen minutes at this temperature.

While the conclusions from these three investigations were identical, there are interesting differences in the suggestions of the investigators regarding commercial pasteurization. Smith made no recommendations on this subject. Russell and Hastings suggested a minimum of 140° F. for twenty minutes. Rosenau, with identical scientific results before him, recommended 145° F. for thirty minutes.

The feeling is common among those who have carefully considered commercial pasteurization, that in view of the importance of the pasteurizing process from the standpoint of public health and the imperfections of the operation and supervision of pasteurizing machinery, the margin of safety in pasteurizing time and temperature should be as wide as the production of a satisfactory commercial article will permit.

DISTINCTION BETWEEN CREAM LAYER AND CREAM LINE

At present the phrase "cream line" is used by milkmen in referring to two distinctly different things, one of which is properly called the cream line, and the other is more accurately referred to as the cream layer.

The fat globules are quite evenly distributed in freshly drawn milk, but they tend to rise because of their specific gravity. On standing there is soon formed an upper layer commonly called cream. The relative volume of the cream and the fat-poor milk below depends largely upon the fat content of the milk. However, there are a number of factors which at times markedly change the normal relations. Important among these factors is the temperature at which milk is pasteurized.

The facility with which milk develops this cream layer is referred to as creaming ability. In bottled milk this creaming ability is commonly expressed in terms of the depth of the layer of cream in the bottle or in the percentage of the volume of the bottle occupied by the cream.

As the cream layer forms there is developed a more or less distinct line of demarkation between the layer of cream and the fat-poor milk below. This line of demarkation is quite properly called the cream line. Unless a cream line is present it is impossible to measure the depth of the cream layer. Because the cream line and the depth of the cream layer are so closely associated, they are often confused. It is important that they be considered as two clearly distinct phenomena, because the influence of temperature upon the two is quite different. The present study concerns itself with the effect of the temperature of pasteurization upon the cream layer.

THE PRACTICAL IMPORTANCE OF THE CREAM LAYER

The cream layer is important for two reasons; first, the housewife uses the volume of cream in the bottle as an index of the richness of the milk; and second, she has need of cream in her culinary operation and she is accustomed to obtain this cream from the top of the bottle.

Until the studies of Theobald Smith in 1899 and of Russell and Hastings in 1900 made it evident that milk would be safe when pasteurized at 140° F., commercial pasteurization made practically no progress because the temperatures previously recommended were such as to practically destroy the cream layer.

In New York City in 1914 the health authorities required pasteurization at 145° F. for thirty minutes, but the difficulties encountered by the milkmen because of the destructive action of this treatment upon the cream layer were such that the requirement was soon modified to that of 142° to 145° F. for thirty minutes. At present there are only a few cities which require the pasteurization of their ordinary milk supplies. In the remaining cities pasteurized milk is sold in competition with raw milk. Because of the importance ascribed by the consumer to the cream layer, the pasteurized milk which fails to carry essentially as much cream as the raw milk does not meet with popular favor.

It is agreed by practically all students of the question that proper pasteurization is the most important step in the production of a safe milk supply. An efficient pasteurization is exceedingly important, but it is also important that the relation of pasteurization to the cream layer be understood, so that in the zeal to provide as wide a margin of safety as possible the increase in pasteurization temperature will not be carried so far beyond the actual requirements of the case as to reduce the use of safe, pasteurized milk.

MEASUREMENTS OF CREAMING ABILITY

The various methods of measuring the creaming ability of milk are discussed at length in Circular 249 of this Station.

Three of these methods are adapted to the measurement of cream which has risen in the milk bottle. The simplest of these is to stand bottles beside each other and compare the depth of the cream layers. Another method is to measure the distance from the top of the bottle to the line dividing the cream from the milk. More accurate comparisons may be made by determining the volume occupied by the layer of cream. Where the total volume of the bottle is known, the content of cream may be expressed in percentage by volume. The first two methods are quite inaccurate and the third is rather laborious.

In the present study the measurements of creaming ability were made by filling round-bottomed test tubes, one-inch in diameter, to a depth of 216 millimeters (8½ inches), with the milk to be tested. These tubes of milk were immediately cooled in ice water, and when cool were held at 40° F. for approximately twenty-four hours. The depth of the resulting cream layer was measured in millimeters, and each millimeter of cream represented 0.47 percent by volume.

The volume of cream as determined in this way agrees closely with the volume of cream developed in bottles under similar temperature conditions.

CORRECTIVE EFFECT OF MOMENTARY HEATING UPON THE CREAMING ABILITY OF COLD MILK

The temperature of milk when drawn from the cow is about 100° F. The best dairy practice aims to bring the milk promptly to a temperature of 50° F. or below. During the colder months, the temperature of the milk often falls nearly or quite to the freezing point before it reaches the milk plant.

TABLE 1.—EFFECT OF MOMENTARY HEATING UPON THE CREAMING ABILITY OF MILK

Date	Raw milk		Heated milk		
	Temperature	Cream	Temperature heated	Cream	Change
	° F.	%	° F.	%	%
Apr. 12	39	11.32	85	13.21	+1.89
May 11	40	9.43	141	12.26	+2.83
Apr. 21	41	8.07	132	12.26	+4.19
Apr. 4	42	9.90	140	11.79	+1.89
June 16	45	11.32	142	13.21	+1.89
June 16	47	11.32	142	13.68	+2.36
June 17	48	11.87	142	13.21	+1.34
Oct. 25	48	11.79	143	13.21	+1.42
Feb. 19	49	7.55	90	10.85	+3.30
Oct. 26	49	13.68	143	14.62	+ .94
Feb. 4	50	11.79	96	14.15	+2.36
June 18	50	11.32	142	12.74	+1.42
Oct. 24	51	12.74	143	12.97	+ .23
Oct. 25	51	12.26	143	11.02	—1.24
Oct. 26	51	14.38	143	14.15	— .23
Oct. 26	51	14.62	143	14.15	— .47
Oct. 26	51	13.68	143	12.97	— .71
Oct. 26	51.5	14.15	143	14.15	.00
Oct. 25	52	12.97	143	13.21	+ .24
Oct. 26	52	12.97	143	13.91	+ .94
Oct. 26	53	13.91	143	13.21	— .70
Oct. 25	53.5	12.50	143	12.50	.00
Oct. 24	54	12.74	143	12.74	.00
Oct. 24	54	12.26	143	12.74	+ .48
Oct. 25	54	13.44	143	12.97	— .47
Oct. 26	54	12.74	143	13.91	+1.17
Oct. 26	54	13.91	143	13.91	.00
Oct. 26	54	14.62	143	14.15	— .47
Oct. 24	55	14.85	143	14.38	— .47
Oct. 25	55	12.50	143	11.02	—1.48
Apr. 2	56	14.62	85	14.15	— .47
Oct. 24	56	13.91	143	13.68	— .23
Oct. 25	56	12.97	143	13.21	+ .24
Oct. 26	56	14.15	143	12.74	—1.41
Apr. 22	57	14.15	129	14.15	.00
Oct. 24	57	15.09	143	14.85	— .24
Oct. 26	57	14.15	143	13.44	— .71
Apr. 23	58	11.79	131	11.79	.00
Oct. 24	58	14.62	143	13.68	— .94
Oct. 25	58	13.91	143	12.74	—1.17
Oct. 25	58	13.68	143	12.26	—1.42
Oct. 25	58.5	13.21	143	12.26	— .95
Apr. 21	59	12.26	133	12.26	.00
June 24	66	15.09	141	13.68	—1.41
June 25	68	15.57	143	13.68	—1.89
June 26	69	15.57	142	13.68	—1.89

Measurements of the creaming ability of cold milk as delivered at milk plants, together with measurements of the creaming ability of the same milk after momentary heating to various temperatures, are given in Table 1.

These data were derived from observations at six widely separated milk plants. While the fat content of the milk received at these plants averaged between 3.4 and 3.6 percent, that of individual samples varied more widely. The treatment of the milk previous to sampling is not known in detail, but the conditions varied from that of milk which was being delivered from nearby farms to that of milk which had been delivered at country milk plants, cooled to about 40° F., and shipped by rail to the city plant. Accordingly, there was a wide variation in the temperatures to which the milk had been cooled and in the agitation to which it had been exposed while cold.

The results presented in Table 1 are arranged according to the temperature of the milk at the receiving vat. There is no evident relation between the creaming power of the cold milk and the temperature at which it was received, except that the three samples received above 65° F. all show a high creaming power. These samples represent milk coming directly from nearby farms. The four samples of raw milk which developed less than 10 percent of cream by volume came from four different plants. In each case they represent milk which had either been held cold for considerable time at the plant, with prolonged agitation, or had been subjected while cold to corresponding agitation during transportation.

After leaving the receiving vat the milk was heated, in some cases by a forewarmer and in other cases by a pasteurizer. Samples were collected and the creaming power determined after this momentary heating.

In the case of the milk received at or below 50° F., a momentary heating ranging from 85° to 142° F. resulted in a measurable increase in the creaming power. On the other hand, when the temperature of the milk on its receipt was between 50° and 60° F., a similar heating usually produced little change; and when the temperature on receipt was above 65° F., such heating resulted in a distinct decrease in the creaming ability.

In observing the effect of any given treatment upon the creaming power, such treatment is frequently judged by the relative amounts of cream obtained upon the raw and upon the treated milk. The above data suggest that the amount of cream which will develop upon raw milk depends quite largely upon the agitation to which it has been subjected while cold.

The results given in Table 1 show that milk with a comparable fat content, when moderately heated, is given a fairly comparable creaming power regardless of the agitation to which it has been exposed while cold. A more detailed study of this phase of the question is necessary before it will be certain that the creaming power thus attained is identical with the original creaming power of the fresh milk. In fact, the results from the last three samples suggest that the creaming power of fresh warm milk is slightly reduced by a momentary heating to 141°-143° F.

This corrective effect of momentary heating upon the creaming ability of milk is quite important in connection with the study of the effect of the pasteurizing process. Thru this corrective action, the effect of earlier agitation while the milk is cold is largely removed and the milk is given a fairly uniform creaming power. Under such circumstances the variations in the creaming power of pasteurized milk having the same fat content are practically all due to the temperatures used in pasteurization.

THE DESTRUCTIVE EFFECT OF HIGHER AND MORE PROLONGED HEATING

The measurements in this study were made in the plants earlier mentioned, partly because they were representative plants and partly because the observations could thus be made to include practically all the systems of pasteurization now in commercial use. There was also in mind the common belief that each different type of machine has its own peculiar effect upon the volume of cream which will develop.

In this study samples were collected, at convenient intervals, all the way from the receiving vat up to and including the bottles. Samples were taken in many instances after the milk had been held at the given temperature for periods ranging from five minutes to an hour, but the study was centered upon the effect after a holding period of thirty minutes.

The samples obtained in commercial plants were taken under regular working conditions, except that the temperature of pasteurization was deliberately varied from the lowest temperature consistent with safety and with the local ordinances, up to 145°-149° F. All temperatures shown on the charts are those at the close of the thirty-minute holding period. In some plants the lower limit was 140° F., while in others it was 142° F. In the plants of the Sheffield Farms Company Inc. no samples were obtained after pasteurizing at a temperature of less than 145° F.

Ideal conditions for testing the effect of the pasteurizing temperature upon the creaming power of milk would include a sufficient supply of raw milk of uniform composition so that it could be run thru a single pasteurizer with all conditions kept constant except the temperature of pasteurization. In commercial plants the most common difficulty is the variation in the fat content of the raw milk supply.

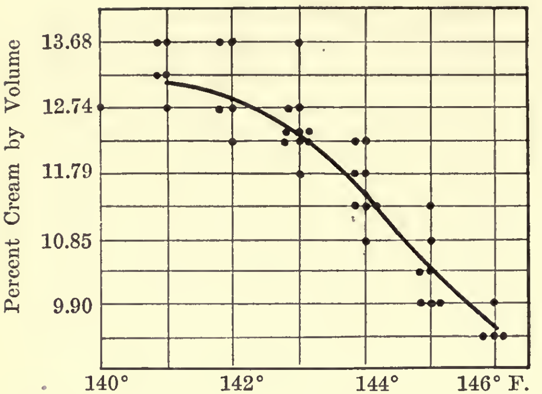

Fig. 1.—Forty Tests of the Effect of Pasteurizing Temperatures on the Cream Layer

However, very satisfactory conditions for the study were found in a plant in which the milk was received from two country stations, where it had been cooled to about 40° F. before being shipped to the city plant. In the city plant it was held cold in large tanks until needed. The results of forty tests of the result of pasteurization for thirty minutes at temperatures ranging from 140° F. to 146° F. are given in Fig. 1.

In Fig. 1 each dot shows the result from a single test, and by its position indicates the temperature of pasteurization and the percentage of cream by volume which developed. For example, the dot at the extreme left indicates that a sample of milk pasteurized for thirty minutes at 140° F. developed 12.74 percent of cream by volume.

The line running across the chart connects the averages of the results at each temperature and shows their relation. This line in Fig. 1 indicates that there is a distinct difference between the effect of pasteurization at 142° F. and at 144° F. upon the creaming ability of the milk. As the temperature of pasteurization rises above 144° F., the volume of cream decreases rapidly.

A similar group of results was obtained in a milk plant in another city, where the milk on receipt was held in large tanks before pasteurization. In this plant the observations extended over temperatures ranging from 140° to 151° F. The results from forty-five such measurements are shown in Fig. 2.

It will be seen from Fig 2 that between 142° and 144° F. there is a distinct change in the direction of the line connecting the averages at each temperature, and this sharp decrease in the volume of the cream continues rather uniformly up to a pasteurization for thirty minutes at 151° F. At this latter temperature, the resulting cream amounts to less than 4 percent.

It should be noted in this connection that altho pasteurization at 151° F. had reduced the volume of cream more than 80 percent, a distinct cream line was still formed. Such observations make it plain that the temperature of pasteurization exerts a powerful influence

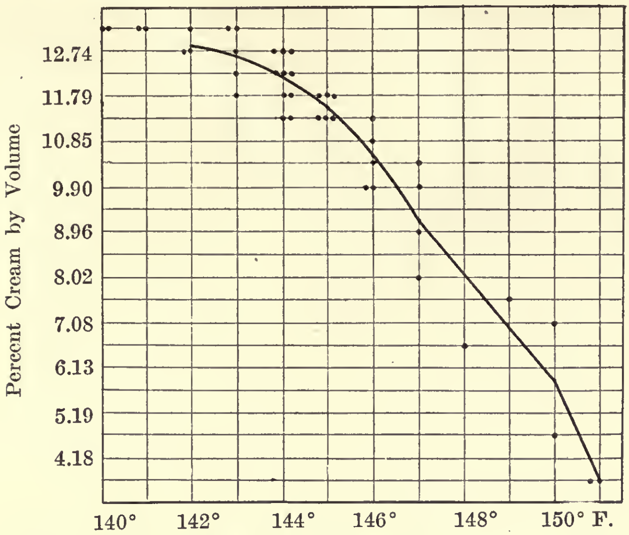

Fig. 2.—Forty-five Tests of the Effect of Pasteurizing Temperatures on the Cream Layer

upon the volume of cream even before it reaches the point where it destroys the cream line entirely.

In the two plants from which results have been presented the milk was of relatively uniform fat content before pasteurization. In a plant in a third city the conditions were equally satisfactory, except that owing to the nature of the supply there was more variation in the fat content during the day's run.

The results from fifty-five tests of pasteurization at temperatures ranging from 140° to 146° F., in the third plant, are shown in Fig. 3.

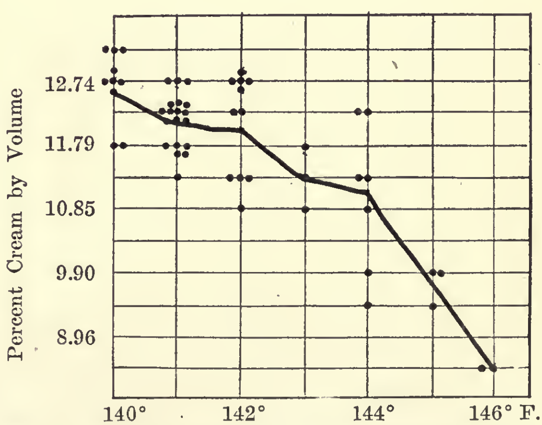

Fig. 3.—Fifty-five Tests of the Effect of Pasteurizing Temperatures on the Cream Layer

It will be seen from Fig. 3 that the results from this plant were very similar to those obtained from the two plants already mentioned. This fact is particularly striking because of the fact that each plant operated a distinctly different kind of pasteurizer. It will be noted that there is again a distinct decrease in the volume of the cream layer between pasteurization at 142° F. and at 144° F., and this decrease continues as the temperature of pasteurization is increased.

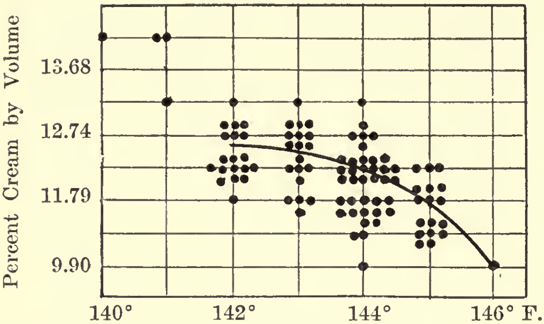

Fig. 4.—Ninety-eight Tests of the Effect of Pasteurizing Temperatures on the Cream Layer

All the foregoing results were obtained at city plants. At country plants, close to the point of production, the pasteurizing machinery is started as soon as a small supply of milk is at hand, and at times the milk in the receiving vat may be that of only one or two patrons. Under such conditions there is a maximum variation in the fat content and a corresponding variation in the results of the measurements.

The results of ninety-eight tests at such a country plant are shown in Fig. 4.

Owing to a number of disturbing factors, the results shown in Fig. 4 are somewhat less accordant than those previously shown. It chanced that about one-third of the patrons of this milk plant used milking machines, and about one-half of the tests were made at the time of the first hot wave of the season, when the milk was unduly acid. The remaining observations were made about one month later, when conditions were normal. The results of this second visit, taken by themselves, would show a normal temperature relation.

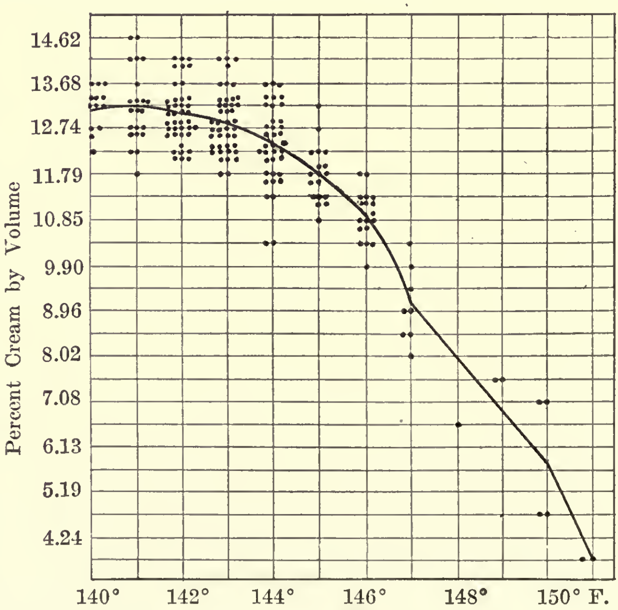

Fig. 5.—Two Hundred Eight Tests of the Effect of Pasteurizing Temperatures on the Cream Layer

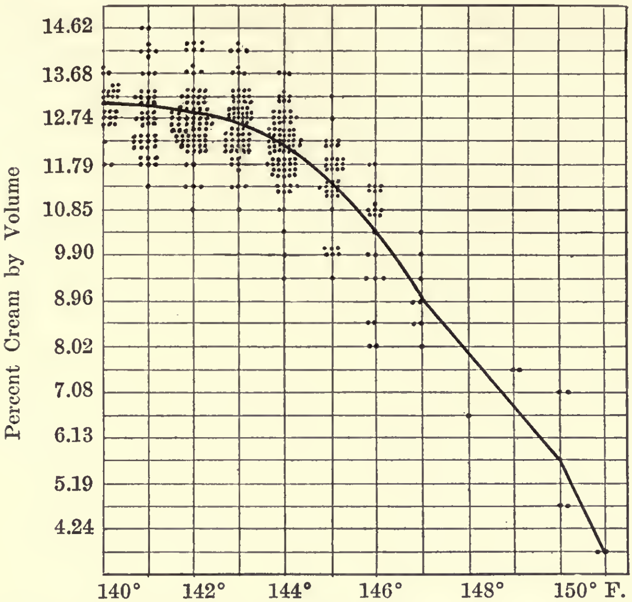

Fig. 6.—Summary of 401 Tests of the Effect of Pasteurizing Temperatures on the Cream Layer

These results emphasize the fact that while the temperature of pasteurization may be, and often is, the largest factor in determining the volume of cream in the milk bottle, this cream volume is also influenced by other factors which are still for the most part little understood.

All the results thus far presented were obtained by the use of a single pasteurizing machine in each plant. Many of the larger plants are equipped with two or more machines. In Fig. 5 are given the results from 208 measurements, which include samples from five different pasteurizers in two adjoining plants handling a common milk supply. Three of these machines were of the same make, but these three machines varied as widely in their effect upon the creaming power of the milk handled in them as did the three machines of different makes. The differences in the effects from the five machines were really very slight. The data from one of these machines have already been presented in Fig. 2. The results shown in this chart are more varied than those previously shown. This is due in part to the larger number of observations, in part to the effect of the different machines, and in part to the fact that these tests extended over a period of about four months.

However, the general effect of pasteurization upon the cream is practically identical with that found in the other plants already discussed. The volume of cream begins to decrease noticeably at temperatures between 142° and 144° F., and this decrease grows rapidly with the increase in the temperature of pasteurization.

The results presented in Figs. 1 to 5, showing the effect of the temperature of pasteurization upon the volume of cream later developed on the milk, were taken from five different plants. These plants were selected from a larger number in which tests have been made, because in each of these plants the tests were sufficient in number to provide a basis for a dependable estimate of the effect of the pasteurizing temperatures used, and because in each of them the average fat content of the milk handled ranged between 3.4 and 3.6 percent, altho the individual samples varied more widely. The data from other plants, so far as they go, were entirely in harmony with those here presented.

Since these data, while accumulated in widely scattered cities, are really quite comparable, the results of the 401 tests are grouped in Fig. 6.

While the results shown in Fig. 6 vary considerably, the fact stands out clearly that the cream rising on the milk pasteurized at 142° F. was distinctly more abundant than that rising on the milk pasteurized at 144° F. As the temperature of pasteurization rises above 144° F., the decrease in cream becomes rapidly more pronounced. Taking the volume of cream obtained at 142° F. as the basis of calculation, the loss in volume as the pasteurizing temperature is increased to 145° F. amounts to slightly more than 10 percent; at 146° F., it has increased to 16.6 percent; and at 148° F., it has increased to approximately 40 percent by volume.

LIMITATIONS OF TEMPERATURE CONTROL

Milk pasteurization is frequently spoken of as tho it were conducted at a fixed temperature. While this represents an ideal toward which the industry is striving, it is one which has not been realized.

The details of temperature control vary with the different types of pasteurizing machinery. The vat pasteurizers depend largely upon direct control by the operator, while the continuous machines are commonly provided with automatic devices. However, these automatic regulators require continuous oversight and adjustment, and at best the temperature fluctuations are merely kept within more narrow limits.

In extreme cases the limits of temperature fluctuation may be as wide as ten degrees; more commonly they do not amount to more than five degrees, and in well regulated plants the variation during the day's run may be held down to about three degrees. It is very rare indeed that fluctuations in the temperature of pasteurization for the entire day are consistently kept within any narrower limits.

The phrase "pasteurized at 142°-145° F., for thirty minutes" is accurately descriptive of the work in many of the best milk plants. In such plants the bulk of the milk is pasteurized at 144° F., with occasional brief deviations in either direction. In the plants having the most perfect temperature control of any known to the author, the temperature fluctuations amount to about two degrees. In addition to a constant and exacting personal supervision, this perfection of temperature control has been preceded by an initial cash outlay for plant and equipment of well above a half-million dollars.

Few milk companies have an amount of business and a financial backing which will permit such heavy investment. Altho it is to be hoped that the same accuracy of temperature control may be attained thru less expensive installation, the fact seems to be that so far it has not been thus attained.

SUMMARY

The layer of cream on the bottle of milk as delivered to the consumer is important because the consumer uses it as an index of the richness of the milk and as a source of cream.

Since 1900 a heating of the milk to 140°-145° F. for thirty minutes has been generally recognized as proper pasteurization. Recently there has been a growing demand that the temperature of pasteurization be increased to 145° F. for thirty minutes as a minimum time and temperature.

In the operation of practically all large commercial pasteurizers, a variation of at least three degrees Fahrenheit is practically unavoidable. Many machines vary even more widely. Accordingly, the requirement of 145° F. as the minimum temperature means pasteurization at 145° to 148° F.

The data here presented show that the volume of cream on milk begins measurably to decrease when the temperature of pasteurization rises from 142° F. to 144° F. As the temperature goes higher, the decrease in the volume of cream becomes rapidly more pronounced; at 145° F. it amounts to slightly more than 10 percent by volume; at 146° F. it amounts to 16.6 percent; and at 148° F. to approximately 40 percent.

RELATION OF THESE FINDINGS TO THE MILK PROBLEM

As has been pointed out, without the presence of a satisfactory layer of cream in the top of the milk bottle it is difficult to induce the public to purchase pasteurized milk.

The results here presented show that when the temperature of pasteurization is raised to 144° F., the volume of cream begins measurably to decrease. As the temperature of pasteurization is further increased, the damage to the cream layer increases rapidly.

It has been further pointed out that there is an unavoidable fluctuation in the temperature of pasteurization, and that this fluctuation rarely amounts to less than three degrees and often ranges more widely. Accordingly, if pasteurization is defined as heating to 145° F., as a minimum, for thirty minutes, such pasteurization involves heating the milk to 145°-148° F., and in many plants will involve even higher temperatures.

Taking these two sets of facts together it is evident that the requirement that milk be pasteurized at a minimum temperature of 145° F. for thirty minutes will result in a sharp reduction of the cream layer. This conclusion is not only to be drawn from the foregoing studies, but it is also in entire accord with practical experience.

The pasteurizing process is the most important protection which the public has against the spread of disease thru milk. It is therefore important that this process carry the broadest practicable margin of safety. At the same time it is equally important that the margin of safety should not be carried to such limits as to produce a milk unacceptable to the public, and thereby reduce the consumption of safe, pasteurized milk.

Repeated, careful studies by different scientists have uniformly shown that the most resistant disease germs which may enter milk are destroyed by a fifteen-minute heating at 140° F. Under such circumstances pasteurization at 142°-145° F. for thirty minutes provides a very considerable margin of safety, both in the matter of temperature and of time of exposure.

The proposition to require pasteurization at a minimum of 145° F. for thirty minutes involves so large a destruction of the cream layer, which is highly esteemed by the public, that such requirement would probably result in a decreasing consumption of pasteurized milk. Accordingly, this increase in the margin of safety would hardly seem justified in the absence of any evidence that 142°-145° F. is insufficient, and in the absence of any attempt to provide increased safety in other ways.

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