RELATION BETWEEN THE BACTERIAL COUNT OF WHOLE MILK AND THAT OF THE CREAM AND SKIM MILK SEPARATED FROM IT [1]

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INTRODUCTION

In studying the milk ordinances of many municipalities it is found that when a maximum bacterial count for milk is designated, a much higher maximum bacterial count for cream of the same grade is allowed. This increase covers a wide range, varying usually from 300 to 500 per cent. A review of the literature upon this subject shows that but little work has been done, or at least few results have been published, dealing with the effect of separation upon the bacterial count of cream and skim milk. It would seem that the maximum bacterial standards for cream appearing in many milk ordinances are not based on scientific facts.

The Bureau of Dairying of the United States Department of Agriculture has been carrying on work with centrifugal and gravity separators in order to determine what effect separation has upon the bacterial count of the cream and skim milk.

CENTRIFUGAL SEPARATION

A steam-turbine separator with a capacity of 1,350 pounds per hour was used. It was run at its rated capacity. After use, the separator parts were cleaned with hot water containing a strong washing powder, then thoroughly rinsed with hot water, and steamed for three minutes over an open steam jet. After cooling, the parts were assembled, again steamed, and then placed in a clean inclosed cabinet until the next run.

After the separator had attained its proper speed, mixed-herd milk at a temperature between 80° and 85° F. was separated. Samples of the whole milk, cream, and skim milk were taken after separation had been in progress about three minutes. The milk sample was taken at the outlet of the supply bowl, and the cream and skim milk samples from their respective spouts. The samples for bacteriological analysis were immediately plated. Standard methods for bacteriological analysis of milk, as recommended by the American Public Health Association,[2] were followed. Plates were incubated for 48 hours at 37.5° C. Fat determinations were made with the Babcock fat test. Samples were taken from 100 separate runs of

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[2] AMERICAN PUBLIC HEALTH ASSOCIATION AND ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. STANDARD METHODS OF MILK ANALYSIS. BACTERIOLOGICAL AND CHEMICAL. Ed. 4, 40 p., illus. New York City. 1923.

the separator. The average bacterial count of 100 samples of whole milk was 435,240 per cubic centimeter. The cream and skim milk resulting from the separation of the milk gave average bacterial counts of 500,830 and 312,740 per cubic centimeter, respectively. The average per cent butterfat of the whole milk was 3.905, and that of the cream 34.64. The per cent fat in the skim milk was 0.02. The average increase of the bacterial count of all the cream samples over the milk from which it was obtained was 14.84 per cent. Twenty-three of the 100 samples of cream showed a lower count than the whole milk. The per cent decrease for these samples was 14.06. Seven samples gave the same count for the cream as for the whole milk. The increase in 70 samples of cream showing an increase over whole milk was 23.87 per cent. (See Table I.)

TABLE I.—*Increase and decrease of bacteria per cubic centimeter in cream as compared with whole milk*

	Per cent
Increase in bacteria per cubic centimeter of 100 samples of cream over the whole milk from which the cream was separated	14. 84
Increase in bacteria per cubic centimeter of the 70 samples of cream showing increase	23. 87
Decrease in bacteria per cubic centimeter of the 23 samples of cream showing decrease	14. 06

Seven samples gave same count as whole milk.

Both high and low count milk was used. The percentage of fat varied from 3.4 per cent to 5.0 per cent. The bulk of the samples gave a bacterial count between 25,000 and 100,000 bacteria per cubic centimeter. (See Tables II and III.)

TABLE II.—*Range and average of bacterial counts and butterfat determinations in 100 samples of whole milk and in the cream and skim milk separated from it by centrifuge*

	Bacteria per cubic centimeter		Percentage of butterfat	
	Range	Average	Range	Average
Whole milk	9,000–14,410,000	435,240	3.4– 5	3.905
Cream	7,000–18,600,000	500,830	17.5–54	36.64
Skim milk	9,000– 7,500,000	312,740	----------	----------

TABLE III.—*Samples grouped according to bacterial counts*

	Bacteria per cubic centimeter						
	10,000 and lower	10,001 to 25,000	25,001 to 50,000	50,001 to 100,000	100,001 to 500,000	500,001 to 1,000,000	1,000,001 and higher
Number of samples:							
Whole milk	4	13	38	20	8	7	9
Cream	2	16	33	22	11	7	9
Skim milk	4	29	27	13	8	4	9

When the same samples are grouped according to their bacterial count, it appears that the greatest per cent of increase in the cream

over the whole milk occurs with milk of low bacterial count. The greatest per cent of decrease also occurs with low-count milk. Part of this variation is possibly due to limits of laboratory error, which would be more pronounced in a low-count than in a high-count milk when figuring percentage increases and decreases.

Table IV gives the grouping of the samples according to bacterial count, together with the percentage relationship of the counts of the cream and whole milk by bacterial groups.

TABLE IV.—*Per cent increase and decrease of bacterial counts of cream and whole milk, classified by grouping of whole milk bacterial count*

Bacteria per cubic centimeter	Increase in cream over whole milk		Decrease in cream under whole milk		Number of samples showing no change
	Number of samples	Average per cent	Number of samples	Average per cent	
0 to 50,000	37	28.07	12	15.907	6
50,001 to 100,000	17	25.2	3	13.13	1
100,001 to 500,000	4	14.82	4	14.722	
500,001 to 1,000,000	4	10.245	3	9.396	
1,000,001 and over	8	10.936	1	6.06	
Total	70		23		7

Out of a total of 70 samples showing an increase in the bacterial count of the cream over the whole milk, 64 samples (or 91.4 per cent) gave an increase of 50 per cent or less. In no instance was there a greater increase than 90 per cent. All of the 23 cream samples which showed a decrease in the count under that of the original whole milk gave a decreased count of 50 per cent or less.

From the work which has been presented, it would seem that there is no basis of fact for the assumption that the bacterial count of centrifugally separated cream should be several hundred per cent higher than the whole milk from which it is derived, provided the separator is clean.

GRAVITY SEPARATION

For this work a gravity separation can 18 inches high and 8½ inches in diameter was used. At the bottom was placed a pet cock to draw off the skim milk. A small strip of glass was inserted in the side, extending upward from the bottom of the can sufficiently so that the dividing line between the cream and skim milk could be observed. As a means for holding the milk in the separator at a low temparature, the can was placed in a large tank with sufficient ice and water around it to extend above the depth of the milk in the can.

Before the separator can was used it was thoroughly washed with hot water containing a strong solution of washing powder, then thoroughly rinsed, and finally inverted over a steam jet and allowed to steam for five minutes. The cover was cleaned and steamed in the same manner. After steaming, the cover was placed on the can and the separator was allowed to cool. Fresh mixed-herd milk was then placed in the separator. Samples for bacterial count and fat content were taken. The can was then set into the cooling and

storage tank. The samples for bacterial count were suspended in the ice water, thus assuring that storage conditions would be the same for both the whole-milk sample and the separator can. At the end of 24 hours the separator can was taken out and the skim milk drawn off through the pet cock. Samples for bacterial count and fat test were taken. The cream was then drawn off and samples taken, all being 24 hours old. The average temperature at the beginning of the holding time was 38.44° F. At the end of 24 hours, when the skim milk and cream were drawn off, the average temperature was 45.88° F. The highest individual temperature was 52° F.

Bacterial counts and fat determinations were made the same as with the centrifugal separation samples. Twenty-five lots of milk were separated by this method.

In no case was it found that the cream had a lower count than the whole milk. Two out of twenty-five samples of skim milk showed an increase in the bacterial count over that of the whole milk, while 23 samples gave a lower count, The average counts per cubic centimeter of the 25 samples were: Whole milk, 135,880; cream, 283,680; skim milk, 33,556.

The average per cent increase in bacterial count of the cream over the whole milk was 160.86 per cent. The average fat percentages were: Whole milk, 4.208; cream, 20.52; skim milk, 1.22.

The bacterial counts in the milk varied from 2,000 to 850,000 per cubic centimeter. The majority of the samples gave a bacterial count of 100,000 or lower. The average percentage of butterfat was 4.208, but two samples were 5.0 per cent or higher. (See Tables V and VI.)

TABLE V.—*Range and average of bacterial counts and butterfat determinations in 25 samples of whole milk and in the cream and skim milk separated from it by gravity*

	Bacteria per cubic centimeter		Percentage of butterfat	
	Range	Average	Range	Average
25 samples whole milk	2,000- 850,000	135,880	3.0- 5.8	4.208
25 samples cream	5,000-1,700,000	283,680	14.0-24.0	20.52
25 samples skim milk	900- 180,000	33,556	0.5- 2.0	1.22

TABLE VI.—*Samples grouped according to bacterial count*

	Bacteria per cubic centimeter						
	10,000 and under	10,001 to 25,000	25,001 to 50,000	50,001 to 100,000	100,001 to 500,000	500,001 to 1,000,000	1,000,001 and over
Number of samples:							
Whole milk	4	7	4	3	4	3	0
Cream	1	1	7	4	7	2	3
Skim milk	14	4	1	4	2	0	0

In contrast with centrifugally separated cream, gravity separated cream shows a much higher percentage increase in bacterial count over whole milk. The low-count milk gives the greatest increase in bacterial count in the cream. Table 7 shows the groupings of the milk according to bacterial counts, together with percentage increase of cream over whole milk of each group.

TABLE VII.—*Per cent of increase in bacterial count of gravity cream over that of whole milk, classified by groupings of whole-milk bacterial count*

Bacterial count of whole milk	Number of samples	Average per cent of increase	Number of samples showing no change
0 to 50,000	15	198.96	0
50,001 to 100,000	3	156.34	0
100,001 to 500,000	4	89.88	0
500,001 to 1,000,000	3	95.53	0
1,000,001 and over			
Total	25		0

CONCLUSIONS

Centrifugal separation with a clean separator will not result in cream having a greatly higher bacterial count than the whole milk from which the cream is obtained.

Gravity separated cream will give a much higher bacterial count than the whole milk from which it comes.

In view of the fact that gravity cream plays a very minor part in the market-cream trade, it would seem that those milk ordinances allowing cream of a certain grade with a bacterial count hundreds per cent greater than milk of the same grade are based upon custom rather than scientific investigations. High counts in market cream may very probably be due to a poor quality of milk used for separation and to lack of care in sterilizing equipment rather than to any normal causes involved in the process of separation.

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