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***Variations in the Test of Separator Cream.***

One of the greatest problems that has presented itself to the creamery patrons and managers of the West-Central states for the past few years is that of the cause of variation in the test of cream. The latter have been bothered by their patrons with innumerable inquiries as to why their cream tested 3 or 4 per cent different at one time than at another, although the cream screw of their separators remained unchanged. The Dairy Department of this institution has not infrequently noticed a difference of 5 per cent in the cream delivered by many of its patrons under such circumstances. Patrons naturally thought they were being cheated, and creamerymen imagined they were being abused by the seemingly unjust suspicions. More or less difficulty has also been experienced in producing a heavy cream, which is desirable for shipping, and for the standard of first grade. Various attempts have been made by dairy authorities to give plausible answers to the questions, but no definite conclusions as to the amount of variation from suggested causes, and little practical advice as to the production of a heavy cream has been published. The following are quotations from two such authorities:

To the Managers of Missouri Creameries.—Since suggesting a test of 30 per cent fat for all first-grade cream, I have received letters calling attention to the injustice of requiring so rich a cream when there are many good separators in use that will not deliver cream of that grade.

If any of your patrons have separators that ordinarily deliver only a 20 to 22 per cent cream, advise those patrons to proceed thus :

Separate about one-half of the run of milk, then mix cream gotten with the remaining half of the whole milk and continue separating as usual. The cream obtained will test 30 or over and no more fat will be lost in the skim-milk than under ordinary method. I have in this way increased the test of cream from 16 to 27, from 20 to 33, from 17 to 28 and from 22 to 34, with no extra loss in the skim-milk. This done and the farmer has more milk, better cream, and less express to pay.—*N. Y. Produce Review, May 2, '06.*

Cream of nearly any thickness may be obtained from a hand separator, but under the ordinary farm conditions of running these machines, variations in the richness of the cream are caused by:

1. Changes in the temperature of the milk.
2. Changes in speed of the separator bowl.
3. A variation in the amount of milk run through the separator in a given time.
4. The amount of skim-milk or water used to flush the bowl when through separating.
5. Changes in the richness of the milk, either from morning and night's milk or from changes in the lactation period of the cows.

These five conditions will influence the test of the cream, even though the cream screw is not changed. But, on the other hand, cream of uniform richness may be obtained from a separator by avoiding, as far as possible, variations in the conditions just mentioned.

A thin cream is obtained by running the separator below speed, by skimming hot milk, or by crowding the separator, i. e., trying to force milk through the separator too fast; also by using too much skim-milk or water to flush out the bowl when through skimming. A thick or rich cream will be obtained when the opposite course is adopted in running the separator.—*Chicago Dairy Produce, April 24, 1906.*

In the first instance the patrons would have to separate half of their milk and pour the quantity of cream that is obtained into the other half and separate again, thus making more work and a chance of losing a small per cent of fat in the skim-milk both times. The saving of time is a great item on the farm as well as in the creamery or any other branch of business. The results of experiments conducted at this station show that a 35 per cent or heavier cream may be obtained from all of the standard machines by proper adjustment of the cream screw and by heating the milk to about the normal animal temperature (100° to 105° F.). The use of cheap machines and a low separating temperature are conducive to the production of a thin cream.

In the second answer we notice that "a thin cream may be obtained by skimming hot milk." We have found the opposite to be the case in all our tests carried on along this line. Whole milk was separated by the same power machine at temperatures varying from 50° to 180° F., the cream screw and speed remaining un-

changed. The same experiments were carried on with various hand separators, the following being an average of the results obtained:

Table showing effect of temperature on percentage of fat in cream and in skim-milk. Averages of ten trials with each separator.

SEPARATOR NO.	Temp. of whole milk, °F.	Percentage of fat.				
		Whole milk.	Cream.	Skim-milk.	Including flush water.	
					Cream.	Skim-milk.
1.....	82	4.0	32.0	.020	30.0	.019
	65	4.0	30.0	.300	29.0	.025
2.....	115	4.0	32.0	.010	30.0	.010
	100	4.0	30.0	.010	29.5	.010
	90	4.0	29.5	.012	28.7	.010
	80	4.0	29.0	.080	28.4	.018
	70	4.0	27.0	.089	25.6	.020
3.....	165	3.8	27.4	.020	26.0	.018
	100	3.8	27.0	.020	25.0	.019
	80	3.8	25.0	.023	24.5	.020
	50	3.8	30.0	.250	25.0	.280
4.....	160	4.0	25.0	.010	24.6	.010
	82	4.0	23.2	.025	23.0	.020
	72	4.0	16.3	.090	14.0	.070
	52	4.0	30.0	.500	20.0	.480
5.....	120	3.9	34.0	.075	32.0	.075
	85	3.9	30.0	.085	29.0	.079
	60	3.9	15.0	.275	15.0	.200
6.....	100	3.7	41.5	.010	40.0	.010
	70	3.7	30.0	.030	29.0	.020
7.....	180	4.0	53.0	.010	50.0	.010
	110	4.0	50.0	.010	49.4	.010
	80	4.0	49.0	.015	48.0	.010
	70	4.0	47.0	.029	45.8	.020

From these figures it will be seen that the higher the temperature (other conditions being equal, up to a certain point, about 150° F.) the richer the cream, and the lower the temperature the less the per cent of fat until the cream separator begins to clog up. The variation ranges from 1 to 19 per cent, as in the case of separator 5. A separator **clogs** at different temperatures, depending upon the kind of machine used and whether or not the bowl is previously flushed with hot water. In the latter case the water tends to warm the bowl and the milk and cream follow the outlet with the water, and after getting well started it is easier to continue separation than to start the cream and milk without water at the beginning.

When the milk is cooled to a temperature where the separator clogs, the cream hole naturally begins to clog also. The size of the hole is reduced, and this acts on the same principle as turning the cream screw in and causes separation of a thicker cream. It will also be seen that the amount of flush water used

will affect the per cent of fat in the cream from 1 to 3 per cent, with exceptional cases where it reaches 10 per cent. In all cases we used just enough flush water to properly flush the machine, the quantity depending on the temperature, acidity and quantity of milk used. Where the milk was separated at a low temperature and the separator partially clogged, more flush water was required than in the case of the warm milk. It will be noticed from the table that there is a greater variation in the cream test between the tests with and without flush water when separating at a low temperature, and the above is the explanation.

In the second series of experiments we first separated 4 per cent milk at 85° F. when the cream separators, five in number, were in perfect working condition. After taking samples of the cream and skim-milk in each case we adjusted the machine so as to cause a vibration of the bowl in running. This was done in some instances by unleveling the machine, and in some instances by raising or lowering the bowl too much, or by placing the machines on an unsteady foundation. The following is a result of the average of the tests of the cream and skim-milk:

Table showing effect of unsteadiness of bowl on percentage of fat in cream and skim-milk. Average of eight trials with each separator.

SEPARATOR NO.	Temp. of whole milk, °F.	Acidity of whole milk.	Per cent of fat in whole milk.	Percentage of fat.			
				Cream.		Skim-milk.	
				Steady.	Unsteady.	Steady.	Unsteady.
1.....	85	.20	3.9	38.8	24.0	.010	.030
2.....	85	.20	3.9	29.0	27.0	.015	.025
3.....	85	.20	3.9	32.0	18.0	.020	.040
4.....	78	.20	3.9	25.0	21.2	.025	.050
5.....	78	.20	3.9	25.0	9.0	.020	.300

It will be noticed that the variation due to the vibration of the bowl is from 2 to 16 per cent fat in the cream, and from .01 to .3 per cent fat in the skim-milk. A greater vibration than was produced in the latter case would soon ruin a machine. We consider this the extreme limit at which a separator could be run without danger to the operator, and if continued over thirty minutes would heat the bearings. Many machines are run with a slight vibration due to unsolid foundation, unleveling, improper oiling, irregularity of speed, etc. Such variations changed the per cent of fat in the cream from one to ten per cent.

In the third series of experiments milk was run through six different cream separators at a low speed. For instance, where the listed speed was 5000 revolutions of the bowl per minute it was reduced to 4000, and where it was 6000 the speed was reduced to 4800, etc. The same separators and the same kind of milk

were again used, the separators being run the last time at normal speed, but at one half capacity only. The following is the result of the tests of skim-milk and cream from the separators in this experiment:

Table showing effect of difference in speed of separators, and of rate of flow, on percentage of fat in cream and skim-milk produced.

SEPARATOR NO.	Temp. of whole milk °F.	Per cent of fat in whole milk.	Acidity of whole milk.	Percentage of fat.							
				Cream.				Skim-milk.			
				Full capacity..	One-half capacity..	Low speed.	Normal speed.....	Full capacity..	One-half capacity..	Low speed.	Normal speed.....
1.....	85	3.9	.01	28.0	36.8	25.6	28.0	.02	.010	.035	.02
2.....	85	3.9	.01	35.0	43.0	30.0	35.0	.02	.010	.045	.02
3.....	85	3.9	.01	28.0	35.0	23.8	28.0	.01	.015	.025	.01
4.....	85	3.9	.01	27.6	33.0	24.0	27.6	.02	.010	.040	.02
5.....	85	3.9	.01	30.0	40.0	25.0	30.0	.02	.010	.050	.02
6.....	85	3.9	.01	35.0	41.0	28.0	35.0	.03	.020	.055	.03

The reduction of speed caused a lowering of the per cent of fat in the cream and a corresponding rise in the per cent of fat in the skim-milk. Running the separator at one-half capacity increased the efficiency of the machine and consequently raised the per cent of fat in the cream and lowered it in the skim-milk.

In the fourth series of experiments milk of different per cent of acidity was separated to ascertain whether or not the per cent of acidity in the milk influenced the degree of accuracy in separating. Samples were also taken after flush water had been added to determine the difference in amount of flush water required for milk of varying degrees of acidity. The results are given in the table below :

Table showing effect of difference in acidity of milk on percentage of fat in cream and in skim-milk produced. Temperature, 85° F.

SEPARATOR NO.	Whole milk.		Cream.		Cream, including flush water.		Skim-milk.	
	Acid.	Fat.	Acid.	Fat.	Acid.	Fat.	Acid.	Fat.
1.....	.25	3.8	.23	26.0	.23	25.0	.23	.015
	.29	3.8	.29	30.0	.29	28.4	.29	.010
	.41	3.8	.39	27.6	.39	23.6	.39	Trace.
	.42	3.8	.40	26.5	.39	24.5	.40	.030
2.....	.26	3.8	.23	31.2	.23	28.9	.23	.015
	.29	3.8	.29	28.0	.29	26.9	.29	.010
	.50	3.8	.49	36.0	.49	26.0	.49	.010
	.42	3.8	.40	32.0	.49	32.0	.49	.010
3.....	.29	3.8	.28	30.0	.27	29.0	.40	.050
	.24	3.8	.23	29.0	.23	28.0	.23	Trace.
	.29	3.8	.29	22.0	.29	20.0	.29	Trace.
	.43	3.8	.41	35.0	.41	30.0	.41	Trace.
4.....	.50	3.8	.49	34.2	.49	31.8	.49	.020
	.26	3.8	.23	28.7	.23	27.0	.23	.015
	.30	3.8	.29	22.0	.29	20.0	.29	Trace.
	.44	3.8	.42	22.6	.42	20.4	.42	Trace.
	.51	3.6	.49	32.0	.49	28.9	.49	.015

This table shows an irregular variation in the test of cream and skim-milk, due perhaps to small clots which form in partially soured milk and sometimes obstruct the milk and cream outlets enough to hinder normal work. It will also be noticed that the milk containing the highest per cent of acid produced the richest cream. This is due to the fact that the greater the per cent of acidity in milk the quicker a layer of casein and slime forms around the inner circumference of the bowl while separating. This reduces the size of the cream outlet, and consequently a thicker cream is skimmed.

CONCLUSION.

Any or all of the six chief causes for variation in the test of cream may occur on almost any farm and contribute to the differences which are seen on the creamery patron's statements from time to time. Improper reading of the test may explain additional variation. We have not dealt with that, because it can be controlled by creamery inspectors and the law.

In the summer a cream separator is naturally warmer than it is in the winter, and consequently during the winter months it cools several degrees, the first milk entering the bowl. Milk quickly cools off while standing in cold weather, and is usually separated at a lower temperature in winter than in summer. This is only a gradual variation, however, and is not very noticeable. There are several minor causes of variation, such as that of sudden starting, difference in quality of morning and evening milk, improper oiling, etc. The chief causes of variation, however, and the amount of variation in each case are as follows:

1. The temperature of milk makes a difference of from one to five percent in the test of cream at average skimming temperature, greater variation being caused in extreme cases.

2. The amount of flush water used with average skimming temperatures makes a difference of from one to three per cent, in extreme cases making a difference as great as ten per cent.

3. The variation in steadiness of the bowl makes a difference of from two to sixteen per cent, depending on the amount of vibration.

4. The variation of the speed of the bowl causes a difference of from one to thirteen per cent in the test of cream, depending on the variation in speed.

5. The amount of milk allowed to flow through the separator bowl from one-half to full capacity makes a difference of from one to six per cent, depending upon the divergence from full capacity of the machine.

6. The amount of acid in the milk causes an irregular variation in the test of cream, depending upon the amount of acid it contains. Where the acid reaches a high point, .3 to .4 per cent for instance, and the separator is used continuously for an hour or more, it will eventually clog the same as in the case of cold milk. The cream will then become thicker until the separator is entirely clogged. The extent of the clogging will depend on the amount of acid in the milk and the size of the machine. The higher the acidity and the smaller the machine the sooner the separator will clog.