

1419

THESIS.

THE PROCESS OF MAKING BUTTER FROM SWEET CREAM.

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1906.

Among all of the branches of the dairy business there is none so important as that of butter making. The demand for good butter is far greater than the supply and the regular customer and the fancy trade make money for the creamery man.

Now we must consider some of the different factors in the making of butter, they are numerous but I merely cite a few.

First the churn; there are limitless varieties of churns from the goat skin bag swinging in the air to the rotary churn run by power. Between these two extremes are found the dasher churn, the hand power barrel churn and many others. They will all make butter and they are all good, but some are better than others.

Much depends on the sanitary conditions of the churn. No one can make good butter in an unclean or unsanitary churn. There is much room for improvement in this line.

Another important factor is the butter maker. Any one can pour cream into a churn and start to going but not every one can make good butter. Just as in every line of work much depends on the "man behind the churn."

To be successful the butter maker must be a man of tact and perseverance and believe in the maxium that if at first you dont succeed, try, try again.

If the cream is too sweet or too sour, to warm or too cold, too old or with bad odor, etc., there will be trouble and the butter maker has more control over these influences than any one else.

The most important factor is the cream. The indiscriminate dumping together of all kinds of cream in a single churning

is a careless act and can only result in a poor grade of butter.

No. 1 sweet cream which has been pasteurized and then ripened to the proper degree of acidity, is a hard one to beat. But conditions are not always the best for making good butter and so the butter maker must make the best of what he has to work with. Cream arrives at the creamery in all degrees of acidity and condition. But the present grading of cream places a premium on sweet cream and so we come to the subject before us.

Sweet cream received at a creamery in good condition will make the very best butter. Where milk is received in good condition and the cream pasteurized after separating the butter maker can then have a great influence over the butter.

One important factor is the starter used in bringing the cream to the proper degree of acidity. Much time is used in ripening the cream and can be reduced to 30 minutes or an hour and this can be done by churning sweet cream.

Pasteurized cream with an acidity as low as .1 % can be churned in short time after being taken from the pasteurizer. To find the percentage of lactic acid in cream add a little phenothalein, to 17.6 C. C. of the cream, and then add decinormal Na O H until a permanent pink color appears, read the amount of Na O H used and multiply by .051 and this will give the per cent of lactic acid. For instance if it requires 6.5 C.C. of Na O H then $6.5 \times .051 = .33$ % acidity.

Now find the acidity of the starter to be used by the same method. Suppose the acidity of the starter is .72 %.

Now if we wish to churn the cream at .5 % acidity we subtract the per cent of acidity of the cream from the acidity

at which we wish to churn and subtract the desired acidity from the acidity of the starter. Divide the first result by the last and multiply the number of pounds of cream by this number and this will give the number of pounds starter required. For example; $.5 - .33 = .17$; $.72 - .5 = .22$; if we have 100 pounds of cream then $.17$ divided by $.22 = .77 \times 100 = 77$ pounds of starter required.

Now this is a pretty good method but if the cream is very sweet this amount of starter may not be sufficient to bring the cream to the desired acidity, which can be determined by taking a test from the churn after mixing. After the starter has been added mix well with the cream and allow to stand for 30 minutes to one hour at the end of this time take an acidity test and one can tell immediately if the required acidity has been attained. If not, more starter is added and the churning commenced as soon as the cream attains the desired acidity.

The following will show some of the variations which the cream shows when starter has been added, and the amounts of starter used, this will show some of the uncertainties of this method, but this can be over come by adding about 1/3 more starter than is denoted by trial test.

No.	lbs start- er used.	acidity of starter.	temp. ripened.	lbs cream.	acidity of cream.	time held ripening.
1.	100	.96	56°	273	.23	30 min.
2.	75	.94	50°	98	.16	60 "
3.	150	.71	54°	252	.14	30 "
4.	20	.8	48°	40	.15	10 "
5.	15	.63	46°	29	.1	30 "
6.	12	.1	50°	20	.18	30 "
7.	72	1.13	50°	160	.21	30 "
8.	82	.06	52°	211	.26	25 "
9.	100	.76	52°	123	.15	25°

Note,

The above formula did not always comply with practical conditions, but this may have been due to errors in testing.

S. 80 lbs starter testing .67 and 70 lbs butter milk at .76: B. Butter milk fresh from sour cream churning used as starter. When the cream did not come up to .5 % acidity the time required to churn was longer and the quality, aroma, and grain were not as good as in those in which the desired percent of acidity was attained. I also tried to churn as cold as possible so that there might be better body to the butter and also that more water should be incorporated in the butter. These are two very essential points; first, because the selling qualities of butter depend much on its body, and as first grade and fancy butter brings much better prices than second grade, then the object must be to get as good a grade of butter as is possible. Second, as it is quite profitable to sell water at the price of butter, it is quite important that water up to the legal limit should be incorporated in the butter. The over run in churning is the profit for the creamery company.

In churning sweet cream the question has often been raised, what is sweet cream? When we wanted to know how much sweet cream there was on hand we would go into the refrigerator and taste of the cream in each can. This is one test, but a more certain way is to take a sample from each can and test with the alkali for the % of acidity. But yet the question is not decided, how much lactic acid may cream contain before it can be called sour. When it tastes sweet, can it be called sweet? No, for the taste is some times defective and not always to be relied on. But cream which does not show over .3 % lactic

acid may be called sweet.

It will be seen from the above figures that cream tested all the way from .1 % to .26 %. The cream that tested the lowest was taken directly from the pasteurizer and was probably as sweet as it could be obtained anywhere. 29 lbs of this very sweet cream was mixed with 15 lbs of fresh butter milk taken directly from the churn and testing .63 % lactic acid and then allowed to stand for 30 minutes before churning.

In the cream testing .26 % there were three cans partly full. One of these cans was past the sweet cream limit a little, testing .325 % but the three lots being mixed together brought the whole amount to the sweet taste, also sweet by test.

To this 211 lbs of sweet cream, was added 82 lbs of starter which tested .96 % acidity. This starter was pretty sour and quite thick and was only allowed to stand together 25 minutes before churning.

It will be noticed that the two times when the starter was the sourest, that it tested over 1 %. This is pretty sour starter and was only used because there was no other at hand.

In No. 6 for instance 12 lbs starter testing 1 % lactic acid was added to 20 lbs. cream testing .18 % at a temperature of 50° F. and allowed to stand 30 minutes before churning. In No. 7, 72 lbs. of starter testing 1.13 % lactic acid was added to 160 lbs. cream testing .21 % acidity and held for 30 minutes at a temperature of 50 % F. Here is an instance of very sour thick starter well advanced toward acidity.

The variation between the temperature at which the cream was held while ripening. The variation in temperature was from 46° to 56°. In all cases ice was added to reduce the tem-

perature, when a large amount of ice was required it was noticed that it took longer to churn and that the over run was low, of this however I will say more later.

In these churning amounts of cream varying from 20 to 273 lbs. were used so that the results would be applicable either in a large creamery or on the farm. There were three varieties of churns used. The large cylinder churn, a small hand power barrel churn and a swing churn. The results in the two small churns were practically the same as one did not seem to require any longer time than the other on an average.

In experiment No. 3 the mixing of two kinds of starter was tried, so that butter milk kept on hand since the last churning might be used as a starter.

The question as to whether or not Butter milk was a good starter has often been agitated and the general opinion is that it is not as good as skim milk starter but I did not find it so, as under the same conditions, butter milk as a starter gave as good results as skim milk starter.

No.	Time between Paste. & churning	Oz. color.	churn.	Time required to churn.	salt.
1.	26 Hours	33 C.C.	1/4 full	45 min.	10 lb.
2.	4 "	13 C.C.	1/4 "	30 "	3, 1/2 lb.
3.	30 "	27 C.C.	1/4 "	1, 3/4 hrs.	7, 1/2 "
4.	24 "	5 C.C.	3/4 "	2 "	18 oz.
5.	30 min.	2.75 C.C.	1/2 "	50 min	12 "
6.	10 hours.	3.2 C.C.	1/2 "	2 hrs.	12 oz.
7.	24 "	none.	1/4 "	1, 1/2 "	5 lb.
8.	24 "	33 C.C.	1/4 "	45 min.	6, 3/4 lb.
9.	4 "	12, 1/2 C.C.	1/5 "	15 "	5 "

It will be seen from the above that the cream had been kept for from 30 minutes to 36 hours after pasteurizing. It will also be noticed that the cream which had been kept the longest was not so sour as some which had been kept a shorter time.

The color ~~used~~ used was W & R. butter color and was used in the proportion of 35 C.C. to 100 lbs of butter fat, until the cows began to get grass and then the proportion of 20 C.C. of color too one hundred pounds of butter fat was used. In experiment 7, I neglected to put any color in the cream and when the butter was taken out of the churn the color was good enough. When the cows have grass very little color is needed.

In churning it was found best to have the churn about 1/4 to 1/3 full of cream so as to secure the greatest agitation. It will be noticed that when the churn was ^{near} more full than this that it required longer to churn. I also found that when the churn would be about 1/2 full that there was a tendency ^{for the cream} to inflate with air and increase the size, some times nearly 1/4 of the original. This made considerable trouble in the small churns and two or three times I was compelled to take out part of the churning and put it into another churn.

The time required to churn was from 15 minutes to two hours. Just what all of the factors were which caused the variation in time required is not know. In the shortest time required the cream tested .15 % lactic acid and was allowed to stand twenty-five minutes with 100 lbs of starter testing .76 % this made the quickest churning we had. ^{cream was churned at} The churning was made at 52° F.

The next quickest churning was thirty minutes and 98 lbs.

of cream testing .16% was mixed with 75 lbs of starter testing .96% and held at 50° F. for one hour.

In the two churnings requiring the longest time Nos. 4 and 6, the conditions were slightly different. In no. 4, 40 pounds of cream testing .15% lactic acid was mixed with 20 lbs of starter testing .8% and held at 48° F. for ten minutes and was then churned in a barrel churn. In no. 6, 20 lbs of cream was mixed with 12 lbs. of starter. The cream tested .18% and starter 1.%. This was held at 50° F. for 30 minutes, then churned in a barrel churn.

In salting butter, salt is added in the proportion of 10 lbs of salt to 100 lbs. of butter fat. This is about the desired amount which the trade demands.

No.	Lbs. Butter fat.	Temp of butter.	Temp. of B. M.	Size of granules.	Shape of granules.	Temp. of wash water.	No of time washed.
1.	90	58°	58°	wheat	round	60°	1
2.	35	56°	56°	"	"	53°	1
3.	75	60°	60°	fine	"	60°&70°	2
4.	14.4	44°	44°	wheat	"	60°	1
5.	8.28	58°	58°	lumps	"	40°	1
6.	9.	50°	50°	wheat	"	50°& 60°	2
7.	56	55°	55°	peas	ragged	55°& 60°	2
8.	67.5	58°	58°	wheat	"	55°& 60°	2
9.	51.6	62°	62°	peas	round	55°& 60°	2

No.	Working time.	% fat in B. M.	Lbs fat lost.	Lbs butter made.	% over run.	% under run.
1.	1 min.			107	18	
2.	45 sec.	.2		41		
3.	1 min.	.4		100	30	
4.	1 "		2.2	14		3.5
5.	1 "	.44	1.6	8		4.5
6.	1 "	.42	.27	9		
7.	1 "	.01		60	17	
8.	1 "	.013	1.7	78	17	
9.	1 "	.075	.9	59	13.5	

Nos. 4 and 5 were both over churned and over worked. The temperature of the butter varied with the temperature at which it was churned and with the temperature of the wash water. The temperature of the butter milk in all we noted was the same as that of the butter.

The size of the granules of butter varied from that of very fine to large lumps. The lumps we caused by over working the butter. The shape of the granules was often both round and ragged in the same churning but only in two churnings Nos. 7 and 8 did the ragged granules predominate.

The wash water was at different temperatures varying from 40° in No. 5 to 60° in some of the others. in Nos. 3, 6, 7, 8, 9, and 10 I used two wash waters at different temperatures. The average working times was about one minute, or 8 or 10 revolutions of the big cylinder churn.

In some of the experiments I neglected to test the butter milk for fat contents but in those which were tested it varied from .017 to .44% Nos. 5 and 4 were decidedly overchurned thus causing some of the butter fat to be driven back into the butter

milk and thereby decreasing the amount of butter.

The pounds of fat lost in manufacturing depended much on the length of churning time, and care must be used in stopping when the butter comes.

The actual number of pounds of butter made differed somewhat from the theoretical calculations. As the over run did not always result as estimated and in two cases Nos. 5 and 4 there was actually an under run. The theoretical over run is about all the way from 13.5% to 30%. If the results of Nos. 3 and 4 could be combined and churn 30% over run in 5 minutes we would have a money making creamery.