

T H E S I S .

"THE EFFECT OF PERCENTAGE OF WATER,
SALT AND ACIDITY OF BUTTER TO
ITS KEEPING QUALITIES."

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1907.

HISTORY.

With the advance of civilization there seems to be an increase in the demand for more fancy as well as more wholesome articles of food. This is not only in the line of delicacies but in staple articles as well. This increase in demand is very marked in the products of the dairy and creamery. Milk has been a very important article of food for ages back, but it was almost solely used as a beverage, and no attempt was made to find its composition or to learn what could be made of it.

Butter, as we all know is made from the fat in milk. It is one of the oldest of foods. Even as far back as 2000 years B. C. we learn that the Hindoos were interested in cattle raising and valued their cows according to their yeild of butter. We know nothing of the quality of the butter made at that time, however, expect that it must have contained about as much casein as fat, judging from the Greek derivation of the word "butter" which means, cow cheese. Butter was first used as an ointment for injuries to the skin, later it was used to enrich cooked foods, and only the rich could afford to use it. It was seldom eaten fresh, the common practice was to melt it and store it underground, leaving it there for years, sometimes as long as a half century.

Butter-making as we know it today has been in practice for a number of generations, but it has been only within the last twenty years that any attempt has been made to improve the product or make investigations concerning it.

Even with the advanced learning on the dairy line, that we have today, there are many points that we are not clear on or indeed know nothing about. We know that bacteria play a very important part in butter-making and while we may have positive control of these germs in the bacteriological laboratory, it would not be practical to apply same treatment in making butter. However, the butter-maker today is not altogether handicapped in that line, he has at least partial control of the germs in his cream. He can pasteurize his cream thereby killing nearly all the undesirable ones and supply desirable ones in the shape of starter.

The temperatures at which to churn and wash are also under his control. He knows how to regulate the temperature according to weather and conditions of his cream. But with all his knowledge he has not been able to produce an article of food which will keep unchanged for any length of time, and still possess the necessary flavor and aroma.

If butter could be sterilized as other articles of food without destroying its eating qualities, we would have no trouble in solving the problem, but since this cannot be done it remains to find the method by which we can secure butter of good keeping qualities, without destroying its essential properties.

With the equipment the butter-maker has today, it should not be a hard matter to control the acidity of cream, (though it is not so easy in a gathered cream factory) percent of salt, percent of water and temperatures. It is by the proper

adjustment of these conditions that it is possible to make the best butter. There would be a different combination for each lot of cream and to determine this can only be done by practice and experiments.

The object of the experiment which was conducted was to find the effect of acidity, salt and water of butter to its keeping qualities.

The acidity was determined by use of Mann's acid test, titrating cream against 1/10 N solution of Sodium Hydroxide using Phenolphthalein as indicator. The percent of water was obtained by the Gray method.

In the first experiment a can of good cream ^{was} selected and without pasteurizing it, divided it into three equal parts. The first was churned as it was acidity .28%. The second was ripened with starter to .45% and the third was ripened to .55%. Each churning was divided into two lots of four pounds each. In one was put 1 oz. salt per pound of butter and the other 1 1/2 oz. salt per pound of butter. The object was to have a different percent of water in the four pounds of each lot, and it was the intention to keep as much water as possible in the first pound, and gradually work it out taking samples at intervals. This operation was followed throughout the experiment. Of course the insufficient working that the first pound received has a tendency to produce mottled or streaky butter, and the last pound being over worked had a tendency to be greasy. But these points were over-looked in scoring, since the sole purpose was to determine the difference in flavor and the butter must be originally the same if reliable results are to be obtained.

As each sample was taken, it was labeled with the percent of water, acid and amount of salt, as well as date, temperature, churned and washed and put in refrigerator where average temperature was 52° F.

The cream was ripened for the second and third churnings at room temperature 63°-65° F. and then put in an ice chest to check further growth. It is possible that this low temperature induced the growing of some undesirable bacteria, but it was not noticeable in cream afterwards. The following table shows the results of the first sets of churning, using same cream.

	Date churned.	Percent acidity.	Oz. salt per lb. butter.	Percent water.	Temp. churned.	Date scored.	Score of flavor.
No.1.	April 4, 1907.	.28	1 oz.	15.0	56.	May 14.	38.
	"	"	"	12.5	"	"	38.5
	"	"	"	12.0	"	"	38.5
	"	"	"	10.0	"	"	37.5
	"	"	1 1/2	14.0	"	"	38.5
	"	"	1 1/2	12.5	"	"	37.5
	"	"	"	11.0	"	"	38.5
	"	"	"	10.0	"	"	38.0
No.2.	April 5.	.45	1 oz.	13.5	55	May 16.	36.5
	"	"	"	12.5	"	"	37.0
	"	"	"	12.0	"	"	37.0
	"	"	"	12.0	"	"	37.0
	"	"	1 1/2	13.5	"	"	35.0
	"	"	"	12.4	"	"	36.0
	"	"	"	11.6	"	"	36.0
	"	"	"	11.5	"	"	36.0
No.3.	April 6.	.55	1 oz.	13.5	53	May 18.	37.0
	"	"	"	13.0	"	"	38.0
	"	"	"	12.5	"	"	37.75
	"	"	"	12.0	"	"	38.5
	"	"	1 1/2	13.5	"	"	37.5
	"	"	"	12.5	"	"	38.0
	"	"	"	12.0	"	"	37.75
	"	"	"	12.0	"	"	37.5

All scoring was done by Prof. Erf and for the reasons already given, no attention was paid to anything but flavor, which was scored on the basis of 45 % for perfect.

This table shows in the first place that salt has very little or nothing to do with the flavor of butter produced. If it has it is so small that it need not be taken into account, for the demand for amount of salt is so different in localities, that we must suit our demand and let the effect of quality go.

In this set of churnings it will be interesting to note that the first pound, that is, the one containing the most water scored the lowest. I may state here that the water used in washing was not sterilized, but was filtered through six thicknesses of cheese cloth, and was as good or better than the average water used by the butter-maker over the country.

Too little water seemed to be as bad as too much water, about 12% proved to be the best. Where butter is sold directly after it is made, the percent of water can approach more nearly the limit, as it will not have time to effect the flavor, but butter that is to be held for any length of time should not contain too much moisture. This however will depend on kind of water used to wash butter, but unless water is sterilized, the above will prove correct.

High acid cream or low acid cream seemed to give the best results. The latter will not be true, however unless it is first class cream. Aside from the score given in table, a sample of each lot of high, medium and low acid cream butter was laid aside and scored comparingly, and the high acid had a decided advantage.

Churning No.2. was worked in a room where I had been testing for moisture, using amyl reagent. The butter absorbed some of this flavor and that may have had something to do with the low scoring of that lot, but it was the object of the Judge to score without reference to that particular odor or flavor.

The next lot of cream was separated into two lots. In one was put commercial lactic acid until acidity was up to .51%. In the other 30% starter was added and churned the following day. The object here was to determine whether the flavor was due to free acid present or whether it was due to the work of bacteria producing the acid. The cream had an acidity of .21% before and .51% after adding the starter.

In table No.2. some very interesting results may be noted. The lactic acid butter, though made under exactly the same conditions, as regards, temperature churned, washed and temperature of refrigerator, as the starter butter, had developed a decided fishy flavor which was greatest with the highest percent of salt. Here also, the best score shows that about 12% of water was the best, though it was not so marked in the lactic acid butter as it was where starter was used.

In the latter case the butter had a good aroma though not perfect, which showed that the bacteria put in had a large effect on keeping qualities.

The last two churnings were of the same cream as the two previous, and both had same amount of starter added (5%). One was ripened to .36% and the other to .52%.

Table No.2.

Date churned.	Percent acidity.	Oz. salt per lb. butter.	Percent water.	Temp. churned.	Date scored.	Score of flavor.
April 15, 1907.	Lactic acid. .51	1 oz.	12.0	56.	May 27.	36.0
"	"	"	11.5	"	"	35.0
"	"	"	11.0	"	"	35.0
"	"	"	10.5	"	"	36.0
"	"	1½	12.0	"	"	36.0
"	"	"	12.0	"	"	34.0
"	"	"	11.8	"	"	35.0
"	"	"	11.5	"	"	34.5
"	Starter	1 oz.	13.5	54	"	36.5
"	"	"	13.4	"	"	37.0
"	"	"	12.2	"	"	39.0
"	"	"	12.0	"	"	38.5
"	"	1½	14.0	"	"	36.0
"	"	"	12.8	"	"	37.0
"	"	"	12.5	"	"	37.5
"	"	"	12.0	"	"	38.5

Table No. 3.

Date churned.	Percent acidity.	Oz. salt per lb. butter.	Percent water.	Temp.F. churned.	Date churned.	Score of flavor.
April 16.	.56	1 oz.	13.4	55.	May 29.	37.5
"	"	"	12.4	"	"	38.5
"	"	"	11.6	"	"	38.0
"	"	"	11.0	"	"	38.0
"	"	1½	12.2	"	"	36.5
"	"	"	12.0	"	"	37.5
"	"	"	12.0	"	"	36.5
"	"	"	11.5	"	"	37.5
April 17.	.52	1 oz.	16.5	54	"	38.5
"	"	"	12.5	"	"	40.0 (y)
"	"	"	11.5	"	"	38.5
"	"	"	11.0	"	"	38.0
"	"	1½	16.0	"	"	40.0 (x)
"	"	"	13.0	"	"	38.5
"	"	"	12.0	"	"	39.0
"	"	"	11.0	"	"	38.0

Table No.3. gives the results of these churnings. It shows again that the samples with medium amount of water in nearly every case scored the highest. As will be seen by the table (X) & (y) scored the same, but it was noticeable that had the butter stood longer, sample marked (X) would have "gone off". It had a very rosy flavor, which was intensified by the large amount of water. Sample marked (y) seemed to be perfect in every respect, having a clean mild flavor. At the time of scoring it was impossible to discriminate between the two, but time would have decided in favor of sample (y).

Conclusions:

Salt is governed by the market demand and must be supplied accordingly, regardless of the small effect it has upon the flavor. It covers up the flavor and retards decomposition when used heavily and in such cases the butter may command a little higher price.

Water effects the keeping qualities to a great extent. The tables show that about 12% of water is the correct amount to have in the butter. It is possible, that if sterilized water was used in washing the percent of water could be higher without injuring the flavor of butter. This remains to be proven however, and since the average creamery has not the facilities for sterilizing, I may say that 12.0% is a safe limit.

The effect of acidity depends on how it is supplied. There is no benefit derived from the use of commercial lactic acid. Cream churned sweet keeps better than where ripened with lactic acid. High acid where starter is

used has the advantage over medium acid and low acid. This shows that the flavor and aroma in butter is caused by the action of the bacteria.

The conditions named must be adjusted to suit each lot of cream, but butter of much better keeping quality can be made of cream is ripened to about .5% acid, making butter of 12% water content and using 1 oz. of salt per pound of butter.