

YEAST AND MOLD COUNTS AND THEIR RELATION TO PASTEURIZATION OF CREAM FOR BUTTER MAKING PURPOSES¹

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I. INTRODUCTION

The yeast and mold content of finished butter is considered by some men² who are engaged in dairy work as an index to the efficiency of pasteurization of cream for butter making purposes and to the proper handling of the cream after this important process is completed. The laboratory of the American Association of Creamery Butter Manufacturers uses the yeast and mold count as an index to efficiency. They assume that when samples of butter show a low count, the product has been manufactured efficiently. From the biological standpoint it has been found that in plants³ producing butter with a high yeast and mold count lax methods of pasteurization and handling of cream prevail. In such plants the counts were lowered materially in the finished products by improving the process of manufacture in regard to the careful pasteurization and handling of the cream.

II. OBJECT

The purpose of this investigation was two-fold: first, to determine whether or not the yeast and mold count could be taken as an efficiency index to pasteurization and handling of cream for butter making purposes; and second, to determine the source of contamination when butter made from pasteurized cream has a high yeast and mold count.

¹ This article was prepared under the direct supervision of Dr. H. A. Ruehe and Dr. M. J. Prucha, Dairy Department, University of Illinois.

² Mr. F. W. Bouska and Mr. J. C. Brown (9) and Mr. T. H. Lund (4, 5, 6, 7, 8).

³ The plants are operated by members of The American Association of Creamery Butter Manufacturers and are located in various communities according to a personal interview with Mr. F. W. Bouska.

III. LITERATURE

There is little published data on yeasts and molds in creamery butter. Mr. T. H. Lund of Ontario Agricultural College, Guelph, Ontario (Canada), has shown that the yeast and mold count in butter is influenced by efficient pasteurization and he has suggested that such a count be adopted officially in determining whether butter is made from raw or from pasteurized cream. Lund has pointed out also, that even though the pasteurization process may be efficient, the cream can be contaminated in the subsequent handling by the use of yeast and mold infected churns or other equipment (5, 6, 8).

Few, if any, yeasts and molds or their spores can survive a temperature exposure of 145°F. for thirty minutes or 185°F. for thirty seconds. Such temperature exposures are those used ordinarily in pasteurizing cream for butter making. Both Dougherty (1) and Wells (2) have demonstrated that most yeasts are destroyed at a temperature of 61°C. (141.8°F.). Dougherty found only three yeasts which survived this temperature. Thom and Ayers (10) have shown that few molds or their spores in milk survive a temperature of 60°C. (140°F.) for thirty minutes and still less are able to withstand 62.8°C. (145°F.) for thirty minutes. Only three species of *Aspergillus* survived 62.8°C. for thirty minutes.

O. F. Hunziker (3) summarizes the efficiency of pasteurization in destroying yeasts and molds in butter. By this investigation, he showed that the efficiency of pasteurization in killing yeasts and molds was 78 per cent when a temperature exposure of 165°F. for thirty seconds was used, while at 185°F. for thirty seconds or 145°F. for thirty minutes (the latter two being the methods ordinarily used in creameries), the process was 99.9 per cent efficient.

Mr. F. W. Bouska has set the arbitrary standard of 30 as the maximum count of yeasts and molds in butter which has been made from efficiently pasteurized cream. However, a large percentage of the counts should be 10 or less (9).

The yeasts and molds, that are found in butter, include a variety of yeasts (not isolated individually) but the molds are mainly *Oidia (lactis)* (9).

IV. METHOD OF PROCEDURE

a. Whey agar

During the first five months of the investigation, whey agar was used as a medium for determining the yeast and mold counts. The whey agar was prepared as follows: 15 grams of shredded agar and 10 grams of "Difco" standardized bacto-peptone in 1 litre of whey. The whey was secured by adding 1 cc. of rennet extract (diluted to 40 cc. with cold water) to a gallon of skimmed milk, and after the coagulation was completed, the curd was filtered off through a double thickness of cheese cloth.

Approximately 10 cc. of the above medium was used for each petri dish, and to this 1 cc. of a sterile 1 per cent tartaric acid solution was added for the purpose of inhibiting the growth of all organisms other than yeasts and molds. However, it is possible that some *Bulgaricus* bacteria may grow on such medium.

b. "Malt" agar

Later in the investigation, a medium made from ordinary malt drinks (often sold under the name of "near beer") was found to be more satisfactory for yeast and mold growth than the whey agar. The "malt" agar was made as follows: 15 grams of shredded agar was added to 400 cc. of the malt drink and 600 cc. of distilled water. This was heated to boiling and held at this temperature until the agar was dissolved. The medium was acidified just previous to pouring the plates by mixing 4 cc. of a sterile 5 per cent solution of lactic acid with 100 cc. of "malt" agar. This acidity was sufficient to inhibit the growth of organisms other than yeasts and molds. This medium was similar to that used by Mr. T. H. Lund, but varied in one of its ingredients. The agar prepared by Mr. Lund contained brewery wort (8), while in this investigation, brewery wort was not obtainable and the malt drink was substituted for it.

To obtain as complete data as possible, counts were run on butters which were made from both pasteurized and raw cream. In order to determine yeast and mold counts, every step in the butter making process was plated. In the case of the butter made from unpasteurized cream, counts were made on raw cream and butter. In the case of pasteurized cream, plates were made from raw cream, pasteurized cream, ripened cream, butter, buttermilk and starter. In all cases, except the butter, 1 cc. of the sample was plated by the ordinary procedure for using petri dishes. In the case of the butter, it was melted to the consistency of thick cream and 1 cc. was used for each count. The most rapid and luxurious growth of yeasts and molds was obtained by incubating the plates at 30°C. for a period of five days.

The sample of the raw cream was taken from the vat just previous to pasteurization. After the entire volume of cream was pasteurized, the cream in the vat was agitated and a sample was taken for plating. After pasteurization, the cream was cooled to 70°F. and 10 per cent starter was added. It was held at this temperature for one and one half to two hours and then the cream was cooled to the churning temperature and held over night. A sample of this ripened cream was taken just previous to churning. When the churning was completed and the butter worked, a representative sample (some butter from various parts of the churn) was taken and the plates were made. The sample of buttermilk was drawn from the gate of the churn immediately after the butter granules had gathered. In the case of the starter, the sample was taken after the starter was mixed thoroughly by stirring, and previous to its addition to the pasteurized cream. All of the above liquid samples were taken by using a sterile 100-cc. pipette. A sterile spoon was used for sampling the butter. The samples were placed in sterile ground-glass-stoppered bottles of 250 cc. capacity.

For the purpose of checking up on yeast and mold infected churns, the following procedure was carried out with three large churns (600 and 1000 pounds capacity) of the type used in commercial creameries and one small power churn (75 pounds capacity). In the case of the large churns, 20 gallons of boiled

water were put in the churn and it was revolved in fast gear for five minutes. The same method was used in rinsing the small churn except that 5 gallons of boiled water were used. In each case, a sample of the boiled water was plated to obtain a count, so that the increase in the microorganism content of the water after rinsing could be taken as the increase due to yeast and mold infected churns.

Plates were made from samples of starter secured from various creameries in the State of Illinois to determine the influence of average starters as a source of contamination in pasteurized cream. Yeast and mold determinations were made on each sample.

V. DISCUSSION OF DATA

As the results in table 1 indicate, the yeast and mold content may be reduced to a small number in the cream by pasteurization, whereas the butter may show an increase. This tends to show that the yeast and mold content can not be taken as an index for efficiency in pasteurization of raw cream. The increase of yeasts and mold in butter over that in the pasteurized cream is due, no doubt to the contamination in the subsequent handling of the cream.

Although the yeast and mold content in butter cannot be taken as an efficiency index to pasteurization, the data points to the fact that it can be considered as an efficiency index to the entire butter making process. This is true if we adopt a maximum count of 30 (Mr. F. W. Bouska's standard) yeast and mold colonies as efficient. In table 1, there are only five samples of butter out of a total of twenty-five with a higher count than 30. Three of the five contained a small number of yeasts and molds above the maximum or 30. When the maximum is passed, the cause of the high count can be traced to inferior starter or to unsterile apparatus, especially to yeast and mold infected churns.

The results indicate that a large percentage of the counts in butter show a decrease over the pasteurized cream, yet the ripened cream carries a higher count than either. The buttermilk shows a decided increase over the above counts, and this tends to in-

dicates that a large number of the yeasts and molds are not incorporated in the butter but are washed out in the buttermilk.

The flash method of pasteurization (where a temperature exposure of 185°F. for thirty seconds is used) was found to be 99.9 per cent efficient in killing yeasts and molds. This compares favorably with the results obtained by Hunziker (3). The percentage of the decrease from the raw cream to the finished butter is found in table 2. The percentage of decrease in yeasts and

TABLE 1
Yeast and mold counts in pasteurized cream butter

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	NUMBER OF SAMPLES					
	Raw cream	Pasteur- ized cream	Ripened cream	Butter	Buttermilk	Starter
0	0	0	0	1	0	5
1-5	0	9	2	4	0	2
6-10	0	3	1	4	4	0
11-30	0	8	8	11	2	2
31-50	0	1	2	3	4	1
51-100	0	1	2	1	1	0
101-500	0	2	0	1	0	0
501-1,000	0	0	1	0	1	0
1,001-5,000	2	0	1	0	1	3
5,001-10,000	0	0	0	0	0	0
10,001-50,000	6	0	0	0	0	0
50,001-75,000	3	0	0	0	0	0
75,001-100,000	1	0	0	0	0	0
100,001-150,000	4	0	0	0	0	0
Above 150,000	9	0	0	0	0	0

molds is smaller, as a rule, than it is after pasteurization. This points directly to the fact that the cream may be efficiently pasteurized and later recontaminated.

It has been suggested by Mr. Lund that the yeast and mold counts be taken as a method for distinguishing pasteurized from unpasteurized cream butter. The results in table 1 show that cream may be efficiently pasteurized but later recontaminated. In comparing table 1 with table 3, it is shown that yeast and mold counts cannot be used effectively. Table 1 shows that cream which has been pasteurized may carry a high count in the butter.

This may be due to inefficient pasteurization but the main cause is recontamination in the subsequent handling. In table 3, it is shown that unpasteurized cream butter had a lower count of yeasts and molds than in some cases of pasteurized cream butter.

TABLE 2
Yeast and mold reduction

PERCENTAGE RANGE	NUMBER OF SAMPLES	
	Pasteurization efficiency	Decrease from raw cream to butter
99.9 and over	11	12
99.95-99.98	7	7
99.90-99.94	5	2
99.80-99.89	2	0
99.50-99.79	0	2
99.00-99.49	0	0
Under 99.00	0	2

TABLE 3
Yeast and mold counts in unpasteurized cream butter

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	YEASTS AND MOLDS	
	Raw cream	Butter
0-75	0	0
76-150	0	1
151-500	0	2
501-1,000	2	0
1,001-5,000	1	1
5,001-10,000	0	2
10,001-25,000	1	1
25,001-35,000	0	1
35,001-50,000	3	0
Above, 50,000	1	0

There is no doubt but that the churn is a source of contamination for the finished butter. It is a difficult task to rid the churn of yeasts and molds by ordinary methods, i.e. using hot water followed by steam. The churn will harbor these organisms in the pores of the wood, boxings, cracks and similar places where treatment is almost impossible.

From table 1, it can be seen that the churn is a source of contamination. The total yeast and mold count in the butter and in the buttermilk is greater than the count of the ripened cream previous to being run into the churn. This difference must be due to the churn either through direct contamination or the breaking up of clumps by agitation. During the churning process, the agitation is sufficient to break clumps into several parts, and this is no doubt a factor in causing the large increase in yeast and mold counts in the butter and buttermilk over that in the ripened cream.

TABLE 4
Yeast and mold counts in churn rinsings

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	NUMBER OF SAMPLES OF YEASTS		NUMBER OF SAMPLES OF MOLDS		NUMBER OF SAMPLES OF INCREASE DUE TO CHURN	
	Check on water	Number in rinse water	Check on water	Number in rinse water	Yeasts	Molds
0	12	1	10	0	1	1
1-5	2	4	4	6	4	5
6-10	0	2	0	0	2	0
11-50	0	3	0	3	3	3
51-100	0	0	0	0	0	0
101-500	0	1	0	3	1	3
501-5000	0	2	0	1	2	1
Above 5000	0	1	0	1	1	1

In table 4, the results show the effect of the churn in yeast and mold contamination. In studying this table, it must be remembered that in this investigation 20 gallons of rinse water were used in a churn in which ordinarily 200 gallons of cream were churned. Therefore if the rinse water shows a count of 20 yeast and molds per cubic centimeter it would mean the addition of only 1 yeast and mold colony per cubic centimeter if 200 gallons of cream were used.

The ripened cream shows an increase of yeasts and molds over the pasteurized cream (table 1). This may have been due to any one or all of four causes: (1) vat contamination; (2) breaking up of colonies by agitation in the vat; (3) increase due to growth or multiplication; and (4) the starter used. Steaming the vat for thirty minutes apparently killed all of the organisms. At least

plates made from water which had been sterilized and then used to rinse the vat did not show a yeast or mold colony. The agitation in the vat is slow and probably has little effect in breaking up clumps of yeasts and molds. Counts made upon cream before and after agitation confirmed this opinion. After pasteurization was completed and the starter was added, the cream was cooled to 45°F. to 50°F. (depending on the season of the year) and held over night. The tendency of such a low temperature would be to inhibit multiplication of all organisms.

At first, the starter was thought to be the main source of contamination. However, the average starter is low in yeast and mold content (table 5) and plays a rather unimportant part when

TABLE 5
Yeast and mold counts in starters

COUNTS OF YEASTS AND MOLDS PER CUBIC CENTIMETER	NUMBER OF SAMPLES	
	Yeasts	Molds
0	17	11
1-3	6	12
4-7	2	3
8-12	1	0
13-18	2	1
19-25	0	1
Above 25	0	0

we consider that ordinarily only 10 per cent starter (20 gallons in 200 gallons of ripened cream) was used in the plant where this investigation was carried out. For example, if 20 gallons of starter containing 20 yeast and mold colonies per cubic centimeter are diluted to 200 gallons with cream, it would mean an addition of one colony per cubic centimeter in the cream. None of the starters plated (table 5) contained as many as 20 yeast and mold colonies per cubic centimeter and eleven contained none. This tends to show that the starter may be considered a negligible factor in contamination except in rare cases when an inferior grade of starter is used. In table 1 there are four examples of highly contaminated starter, but the butter in two cases out of the four shown will come within the standard of 30 yeast and mold colonies per cubic centimeter of butter.

VI. CONCLUSIONS

1. The yeast and mold count of finished butter cannot be taken as an efficiency index to pasteurization. However, if a standard of 30 colonies is set as the maximum count of these in the finished butter, it can be considered as an efficiency index to the entire butter making process.

2. The data point to the fact that the yeast and mold count cannot be taken as an effective method for determining whether butter is made from raw or from pasteurized cream.

3. The churn may be one of the greatest sources of contamination of the cream after pasteurization.

4. The cream may be contaminated when starter is used, but this source of yeasts and molds has little effect on the final count in the butter except in rare cases when an extremely inferior grade of starter is added to the cream.

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