
The Influence of Starter on the Flavor of Butter

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RESEARCH workers in the major butter-producing countries in the world have, for many years, studied the influence of starter on the flavor of butter. The use of cultures of selected bacteria in the commercial manufacture of butter dates back about 50 years. The Danish bacteriologist, Storch, in 1884, began investigations on the causes of defects in butter. He developed starters containing bacteria which produced a desirable flavor and aroma when grown in milk under favorable conditions. The first of his starters was used commercially in the manufacture of butter in 1888. The results of Storch's early work were published by the Royal Danish Agricultural and Veterinary College in 1890 (1). The aim of the early research work was to discover whether the use of starter, containing selected bacteria, in pasteurized cream would result in butter having fine flavor and aroma and good keeping quality. Storch demonstrated conclusively that the butter obtained from pasteurized cream that had been ripened by the use of a high quality starter had as fine a flavor and aroma as the best butter made when either buttermilk from a previous churning or naturally soured milk was used as starter.

The practice of using starter to ripen the cream for buttermaking has been adopted universally by the creameries in Denmark and is considered an important factor in making butter of a uniform quality. Danish butter is sold in England in competition with butter, made from sweet, unripened cream, from other countries. The English consumers like Danish butter and generally pay more for it (2) than for butter made from sweet, unripened cream, even when this butter comes from British colonies that are favored with much better grazing conditions than those available in Denmark.

It has been estimated that only about 25 percent of the butter manufactured in the United States is made from cream to which starter has been added prior to churning. Starter is used very little for the butter made in the 11 western states. In some of these states starter is not used at all because it is claimed that the consumers prefer butter made without starter. In Oregon about 25 percent of the butter manufactured is made from cream to which starter has been added. Ripening of the cream is not usually practiced.

The reasons for not using starter more extensively in buttermaking have been the following: (a) Lack of suitable equipment, (b) additional work and expense, (c) no higher price obtained for the butter, (d) lack of appreciation by the consumers of the flavor and aroma imparted to the butter by starter.

The wholesale butter merchants have generally advised the butter-makers in western United States to refrain from using starter. The most common reasons for giving this advice have been: (a) The buttermakers generally have used poor starter; (b) the flavor of the butter has shown too great variation; (c) an undesirable flavor often developed in the butter during storage.

At the Iowa Agricultural Experiment Station (3) it has been demonstrated that when a good-flavored starter was used the butter had a more desirable flavor than that made without starter. It was also shown that the keeping quality of the butter would not be impaired if the acidity of the cream at the time of churning was not allowed to go beyond a certain limit.

The extensive work by Hammer and his associates during the past quarter of a century has added much to our knowledge regarding the preparation and use of starter. The *Streptococcus lactis* organisms have been classified, and the aroma-producing citric-acid-fermenting streptococci, common in good starter, have been identified. Much valuable data have been obtained regarding the growth characteristics of the bacteria in starter, the changes they cause and the products that are formed in milk by them.

There is no doubt in the minds of many experienced creamerymen and butter dealers that the proper use of fine flavored starter in first-grade, neutralized sour cream and in sweet cream results in butter that scores higher in flavor than that made without starter. Since confidence had been lacking in the western buttermakers' ability to make good starter and to manufacture butter that showed uniformity in flavor from day to day and also possessed keeping quality, the Oregon Agricultural Experiment Station in 1930 outlined a research project on the subject of preparing and using starter in the manufacture of butter. It was recognized that if the objections to butter made with starter were to be overcome, it would be necessary for the buttermakers to make starter under controlled condi-

tions and to employ proper methods in using it with the cream so that the butter would have a superior flavor and aroma and a good keeping quality.

Very few of the creameries that were using starter in 1930 had adequate facilities for preparing mother starter or satisfactory equipment for proper temperature control of large lots of starter. Only the older butter-makers had experience in making starter. The work by Hammer and his associates had shown what conditions are essential in preparing good starter. It was necessary, therefore, to provide these conditions in the Oregon creameries if success in making starter was to be attained. Accordingly, simple, inexpensive equipment for making starter was designed and constructed, and an electric heater, equipped with a three-heat switch, was made for maintaining a uniform temperature of inoculated milk kept in starter cans.

The equipment designed for mother starter included the following:

(a) A tank for pasteurizing and cooling jars of milk to be used for mother starter, (b) a simple sterilizer for sterilizing transfer tubes, (c) a water-jacketed incubator in which a temperature of 68° to 72° F. could be maintained during all seasons, and (d) an insulated box for cooling jars of starter in ice water. This equipment is fully described in a bulletin published by the Oregon Agricultural Experiment Station (4). Directions for preparing mother starter and large lots of starter are given in the bulletin. The equipment has been in daily use at the State College Creamery for five years. Three mother cultures always have been carried. The equipment has been found very satisfactory. The mother starters and the large lots of starter have without fail shown good coagulation every morning. Similar equipment is now used in several large creameries in the state.

Simultaneously with the development of equipment for the preparation of starter and the standardization of the methods of making starter in the Oregon creameries, experimental churnings were made to determine whether starter was of value in improving the flavor and aroma of butter. The starter culture used for these churnings was No. 122 developed by Hammer at the Iowa Agricultural Experiment Station. Through the courtesy of the Iowa State College Department of Dairy Industry a replacement culture was obtained once a month.

This work involved the manufacture of butter from a large number of lots of sweet cream over a period of nearly two years. A total of approximately 20,000 pounds of butter was made in 157 churnings.

In one series of churnings (5) butter was made from 93 different lots of cream; with 59 of these starter was used, while with 34 no starter was used. The butter was judged by creamerymen and by representatives of the United States Department of Agriculture and the Oregon State Department of Agriculture. A summary of the scores of the butter from the different churnings is shown in table 1.

In general, the butter made with starter scored higher than the butter made without starter. Even after storing the butter for one

TABLE 1. *Average scores and range of scores on fresh and stored butter made with and without starter*

59 churnings of butter made with starter
 34 churnings of butter made without starter

	Fresh butter		After one month at 35° to 45° F.			After six months at 0° to 10° F.		
	Range in scores	Average score	Range in scores	Average score	Average decrease in score	Range in scores	Average score	Average decrease in score
Butter made with starter	90.50-95.00	93.03	89.00-94.00	92.07	0.96	90.00-94.00	92.40	0.63
Butter made without starter	90.50-93.50	91.96	89.00-94.00	91.60	0.36	89.66-93.50	91.63	0.33
Difference in favor of butter made with starter		1.07		0.47			0.77	

month at from 35° to 45° F. and for six months at from 0° to 10° F., the average score of the butter made with starter was higher than that of butter made without starter. The chief comments of the judges on the butter made with starter were: "creamy flavor," "sweet and clean," "fine aroma," "fine flavor." Those on the butter made with no starter were: "flat," "lacking in character," "insipid," "tallowy." A frequency distribution of the scores of the fresh butter showed that 93.23 percent of the churnings made with starter scored 92 or above, whereas only 61.77 percent of those made without starter scored 92 or above.

In another series of churnings (6) 16 different lots of sweet cream were used. Each lot of cream was divided into four equal parts for the purpose of treating each differently before churning. All the cream was pasteurized at 150° F. for 30 minutes. One part was cooled and held cold until the time of churning, but to the other three starter was added. Eight percent starter was added to each lot. With one lot the starter was added after the pasteurized cream had been cooled to 70° F. It was held at this temperature until an acidity of 0.28 percent (serum acidity 0.42 percent) had been developed. The cream then was cooled quickly to below 40° F. and held at this temperature over night until churning the following morning. Starter was added to another lot after the cream had been cooled below 40° F. This cream was also held cold over night. The remaining lot of cream was cooled to below 40° F. and held cold over night without adding starter. Immediately before churning 8 percent starter was added to this cream. The butter was scored by the same judges who scored the previous 93 churnings. Table 2 shows a summary of the scores obtained.

The data confirmed the previously obtained results. Starter increased the score of the butter with each of the methods used. The improvement in quality was most pronounced when the cream was either ripened and then held cold over night or held cold for 16 hours after the addition of the starter without ripening. It was less pronounced when the starter was added immediately before churning. With the two first-mentioned methods the average score of the fresh butter was increased nearly one point.

There was no marked decrease in the scores of the butter made with or without starter during a one-month holding period at from 35° to 45° F. A decrease was observed, however, in the average score of the butter made by each of the four methods when the butter was stored for six months at from 0° to 10° F. The average decrease in score of the control samples was 0.57 and the average decreases for the butter made with starter were: 1.15 when the cream was ripened, 0.74 when starter was added and the cream held cold 16 hours, and 0.95 when starter was added immediately before churning. The average scores of the butter made with starter, at the end of six months, were 0.30, 0.66, and — 0.06 points in favor of the butter made with starter, in the order just given, than the average score of the butter made without starter.

TABLE 2. *Influence of various methods of using starter on the scores of fresh and stored butter*

Average of 16 trials

	Control No starter added			Starter added; cream ripened to 0.42% serum acidity		
	Fresh	Stored		Fresh	Stored	
		1 month 35°-45°F.	6 months 0°-10°F.		1 month 35°-45°F.	6 months 0°-10°F.
Average score	92.41	92.53	91.84	93.29	92.99	92.14
Average decrease after storage		+0.12	0.57		0.30	1.15
Difference in favor of butter made with starter				0.88	0.46	0.30

	Starter added and cream held cold 16 hours			Starter added to cream imme- diately before churning		
	Fresh	Stored		Fresh	Stored	
		1 month 35°-45°F.	6 months 0°-10°F.		1 month 35°-45°F.	6 months 0°-10°F.
Average score	93.24	93.18	92.50	92.73	92.55	91.78
Average decrease after storage		0.06	0.74		0.18	0.95
Difference in favor of butter made with starter	0.83	0.65	0.66	0.32	0.02	-0.06

Approximately 100,000 pounds of butter are made annually in the State College Creamery. Starter always is added to the cream, and the cream is ripened to a serum acidity of 0.42 to 0.44 percent. About 15,000 to 20,000 pounds of butter are stored during the summer months for consumption during the fall months. No objectionable flavor has ever developed in the butter made during the past six years when starter has been used. The demand for the butter always has been good.

It is well known that when butter is sent to a contest, starter is used with the majority of the churnings. The scores of butter made with starter usually average higher than those made without starter. The following data conclusively show this:

*Cold Storage Contest, National Creamery Buttermakers' Association,
St. Paul, Minnesota, 1924 (7)*

	Into storage Average score	Out of storage (4 months) Average score
68 churnings made with starter	93.44	92.90
48 churnings made without starter	<u>92.51</u>	<u>92.03</u>
Difference in favor of butter made with starter	0.93	0.87

*Cold Storage Contest, National Creamery Buttermakers' Association,
Cleveland, Ohio, 1928 (8)*

	Into storage Average score	Out of storage (4 months) Average score
165 churnings made with starter	92.95	92.82
50 churnings made without starter	<u>92.30</u>	<u>92.21</u>
Difference in favor of butter with starter	0.65	0.61

Pacific International Dairy Products Show, Portland, Oregon, 1931 (9)

	Average score
28 churnings made with starter	93.54
16 churnings made without starter	<u>92.14</u>
Difference in favor of butter made with starter	1.40

*Oregon Butter and Ice Cream Makers' Annual Convention, Corvallis,
Oregon, 1932 (10)*

	Average score
29 churnings made with starter	93.13
11 churnings made without starter	<u>92.46</u>
Difference in favor of butter made with starter	0.67

Pacific International Dairy Products Show, Portland, Oregon, 1933 (11)

	Average score
44 churnings made with starter	92.80
11 churnings made without starter	<u>91.00</u>
Difference in favor of butter made with starter	1.80

Pacific International Dairy Products Show, Portland, Oregon, 1935 (12)

	Average score
70 churnings made with starter	93.20
10 churnings made without starter	<u>92.40</u>
Difference in favor of butter made with starter	0.80

A total of nearly two billion pounds of creamery butter is consumed annually in the United States. Butter is sold in competition with various fats of both animal and vegetable origin, some in the form of butter substitutes. The annual per capita consumption of butter, which is known as a food of high energy and vitamin value, has increased during the past few

years. Butter should have a desirable flavor and aroma, however, for the consumer to relish it, and should have a waxy body and a pleasing color. As buyers are becoming more and more critical, low-grade butter in the future will be difficult to sell. The responsibility of the American butter-makers lies in the manufacture of the finest quality of butter possible from the grade of cream available. They necessarily will have to make butter of the quality the market demands. Will the trend show a demand for butter of an insipid flavor or will it be for butter of the degree of flavor preferred by the connoisseurs at the various scoring contests?

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