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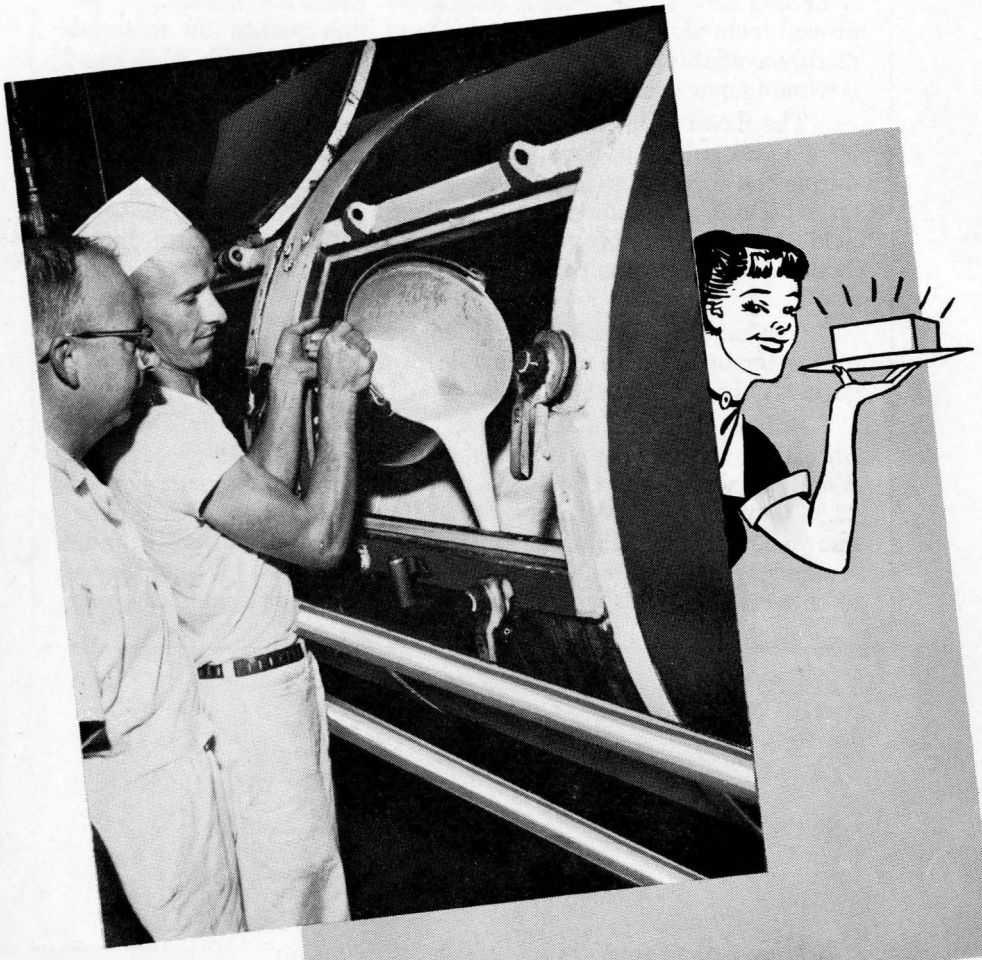

MANUFACTURE and Sale of Cultured *Butter*

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AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE, BROOKINGS

SUMMARY

Cultured butter, because of its pleasing and distinctive flavor, is finding new favor among consumers. Likewise, because of improved technology and an abundance of high quality raw materials readily available, it is now considered to be dependable butter and is winning new friends among butter dealers.

The flavor in cultured butter is produced by adding from 1 to 3% of a milk culture of flavor producing bacteria directly to the butter during the working process. This gives a pleasing flavor to the butter which is maintained or increases slightly when the butter is held at household refrigerator temperatures for periods of 1 or 2 months. It is also maintained for at least 6 months when stored at 0°F.

Consumers in Brookings and Sioux Falls showed a definite preference for butter with culture flavor over other butter and oleomargarine. Other consumer tests have given similar results.

Butter quality in South Dakota has shown marked improvement since 1950. In that year a survey showed 81% of the butter was Grade B and 19% was Grade C. In 1959 the results of a similar survey were 22.3% Grade AA and A, 55.1% Grade B and 22.6% Grade C. Further improvement is possible and probable. The use of culture in more of Grades AA and A might result in increased demand for these grades of butter. Sales of this kind of butter have been increasing in this area.

Acknowledgements: Much credit is due Travis Manning, former Economist, South Dakota Agricultural Experiment Station, and co-leader of this project for his careful work in planning and executing certain phases of this research. The authors wish to express their appreciation to the following individuals and organizations for their cooperation in this study: Garmon Hesby, Farmers Cooperative Creamery, Volga; Warren Anderson, Farmers Cooperative Creamery, Madison; William and Lawrence Kallemeyn, Kallemeyn Dairy, Brookings; John Bibby, Brookings Creamery, Brookings; Dale Larson, American Dairy Association of South Dakota, Brookings; Wesley Noel and Everett Little, John Morrell and Company, Sioux Falls.

Manufacture and Sale of Cultured Butter

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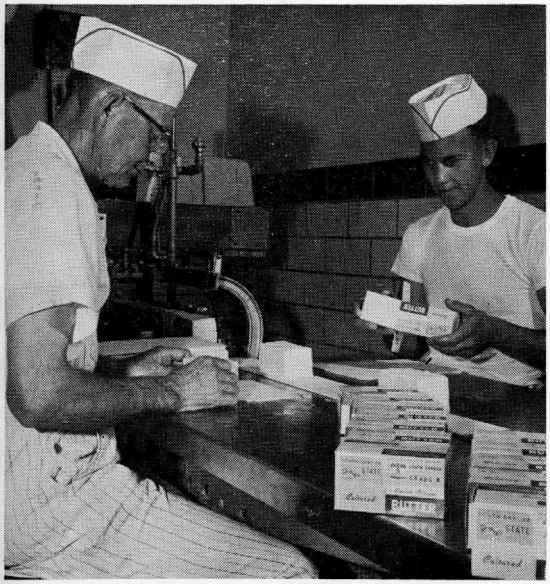
Nearly all of the highest quality butter manufactured in the United States in recent years has had a bland flavor, described by many as being flat and lacking in flavor. On the other hand, the lower grades have had an abundance of flavor, but not of the most desirable kind. Since these lower grades are usually manufactured from farm separated cream that is marketed twice weekly or less often, buttermakers have not been able to prevent various undesirable flavors from dominating the flavor of this type of butter. The work reported herein is an attempt to manufacture and merchandise the highest grades of butter (AA and A) with a desirable level of flavor of the type that is characteristic of fine butter. This has been done by the direct addition to the butter of a milk culture of bacteria capable of producing the desired flavor and aroma.

Cultured butter is packaged in special cartons.



Although there are possibly many chemical compounds that may contribute to the desirable flavor and aroma of fine butter, one of the main ones is diacetyl. This is produced from citrates that are normally present in milk by the action of the bacteria in butter cultures or starters as they are commonly known. A somewhat similar flavor and aroma may be obtained by adding a very small amount of diacetyl or a commercially prepared starter distillate.

The use of cultures in the manufacture of butter is not new. They

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were used rather extensively in the United States from 1920 to 1940. During the next 10 years their use diminished until very few factories were using them by 1950. Reasons for discontinuing the use of cultures were: (1) increased manufacturing costs were not offset by higher prices for butter, (2) difficulties of preventing contamination while propagating cultures in the creameries, (3) flavor of cultured butter was not uniform and keeping quality in storage was not dependable, and (4) drying buttermilk with higher acidity was a problem in some factories.

There was an appreciable increase in the amount of high quality sweet cream available for buttermaking at about the same period when the use of cultures was declining. This is the main reason that much of the highest quality butter was flat or lacking in flavor. However, due to improvements in technology which might make it possible to overcome most of the previous objections of using culture in butter, as well as the availability of high quality cream for buttermaking in South Dakota, it seemed logical to assume that the demand for butter could be increased by manufacturing and merchandising a product with a higher level of desirable flavor.

HISTORICAL

Although many articles on butter cultures have been published during the past 50 years, only a few that are directly related to the problems reported in this bulletin will be mentioned. Actually, the first commercial use of cultures in buttermaking dates back to about 1890 when Storch in Denmark, Weigmann in Germany, and Conn in the United States developed cultures of bacteria which produced desirable flavor and aroma when grown in milk. Prior to this time cultures or starters as they were commonly called were made by natural souring of milk. By 1897 the majority of butter factories in Denmark were using cultures. The bacteria that produce the flavor and aroma in cultures were identified in 1919 and many studies have been made since that time on factors affecting their activity and flavor producing ability. Hammer and co-workers at the Iowa Agricultural Experiment Station contributed much to the knowledge about cultures for butter and other milk products.

Culture Added to Cream

In the earlier work in which cultures were used in buttermaking, they were added to the cream after it had been pasteurized and cooled to 70°F. Flavor and aroma of the butter were controlled by allowing the cream to ripen to the desired acidity. The cream was then further cooled to retard the acidity development and held at this lower temperature until it was churned. Capper (1) reported that this and other manufacturing methods used at that time resulted in butter with poor keeping quality, which brought about the decline in the use of cultures. A modification in the above processing method which resulted in some improvement and gave better control was the addition of the

culture to the cream after it had been completely cooled or just prior to churning.

Another method of using cultures, which was used occasionally by buttermakers a number of years ago, has been used with increasing frequency during the past few years. This is the direct addition of the culture to the butter rather than to the cream. Fabricius and Nelson (2), using this technique in a Wisconsin plant, reported a sharp increase in local sales of butter and a substantial increase in an out-of-state market. They were able to manufacture butter with a controlled amount of fine flavor, superior body and texture, and excellent keeping quality.

Frozen Cultures Developed

The development of the use of frozen cultures has helped to overcome some of the problems that buttermakers found very troublesome when cultures were propagated in the creameries. Farmer and Hammer (3) found that cultures could be held at -10°C. (14°F.) for two months and still give satisfactory results when transferred into properly pasteurized milk. Fabricius and Nelson (2) indicated that they had tried frozen cultures from a commercial laboratory with good results. Capper (1) suggested that it should be possible to freeze a good quality culture and use it in butter from two weeks to two months later. He also advanced the idea that by producing and freezing the culture in a central plant, it could be used in other plants with a minimum of costs. Martin and Cardwell (6) reported on the use of frozen cultures for inoculating the bulk cultures used in manufacturing cottage cheese.

Some attempts have been made to determine what kinds and the amount of flavor consumers desire in butter. Olson and Mann (7) reported on a consumer preference test conducted in Payne County, Oklahoma, in which 216 housewives cooperated in the study. They were given samples of the four grades of butter—AA, A, B, and C—and one of oleomargarine. On the basis of flavor they ranked them in this order: A, AA, B, oleomargarine, and Grade C butter. They stated, . . . "that the Grade AA was made without starter culture added and was characterized as 'flat' and 'tasteless' by several of the respondents. The Grade A, on the other hand, had considerable flavor and perhaps was more like the butter to which the people have been accustomed. This suggests that sweet cream butter made with a good starter culture would enjoy good acceptance." In a study conducted in Idaho, Hibbs (5) found that no grade of butter will please everyone, but sweet cream butter made with culture rated highest with consumers in that area. In this study consumers ranked the samples in the following order: Grade AA with culture, Grade B, Grade AA without culture, and Grade C.

EXPERIMENTAL

Consumer Preference Studies

Prior to 1950 much of the butter manufactured in South Dakota was considered by butter marketing firms to be of inferior quality. Because of this attitude and to obtain

more exact information, a survey was made by the South Dakota Experiment Station during the summer of 1950 and repeated in 1951. The results were reported by Feder *et al.* (4). The 1950 data showed that 81% of the butter was B Grade (90 score) and 19% was C Grade (89 score). Only slight changes were apparent in the 1951 data. At that time only an occasional churning of A or AA Grade was made and very small amounts of these grades were imported and sold within the state.

Soon after the results of these surveys were published, a quality improvement program was begun by a small group of creameries. This was followed in 1955 by a rather sudden change from the marketing of farm separated cream to whole milk. The whole milk was separated at the receiving plant where the cream was churned. The skim milk was hauled to drying plants where it was made into non-fat dry milk solids. Under this system the milk was cooled promptly on the farms and was hauled to the plants daily or every other day. This resulted in a great improvement in the quality of much of the cream available for butter making.

When it became evident that considerable quantities of high quality factory separated cream would soon be made into butter in eastern South Dakota, a research project was initiated in an attempt to determine the possibilities of increasing consumer demand for high quality butter with a distinctive butter flavor. The first study was set up to obtain information about consumer preferences for various grades of butter and oleomargarine. A randomized sample of 2% of the families in Brookings and Sioux Falls was used for a preliminary survey to obtain personal data, family characteristics, financial status, weekly consumption of fats and oils, and willingness to participate in a consumer panel. These factors were considered in the selection of 10 families in Brookings and 30 families in Sioux Falls to participate in a representative consumer panel. Since the results of these surveys have been summarized in a progress report by Rollag and Kristjanson (10) and in a mimeographed pamphlet by Rollag (9), they will be reviewed only briefly here.

Paired samples of four lots of butter and one of oleomargarine were given to each of the 40 families each week for 10 weeks. The families also received questionnaires which were filled out and returned the following week. Information was thus obtained on each of the paired samples (listed by code number) on their relative preferences for the spreads for use on hot breads, other table uses, on baked vegetables, for frying, for baking, and a summary preference based on overall flavor. Based on overall flavor, the samples with their total preference points were rated as follows: Grade A with culture 1,114, Grade A without culture 1,028, Grade B 1,017, Grade C 984, and oleomargarine 657. All of the butter samples were manufactured at the College dairy from the same lot of cream. The sample with culture contained 2% of a milk culture added directly to the but-

ter during the working process. The oleomargarine used in this test was a well known, nationally advertised brand purchased from a local distributor. Since the results of this survey indicated that consumers in Brookings and Sioux Falls prefer high quality butter with culture to the same grade without culture or to other grades, it appeared desirable to obtain additional information based upon their purchases in grocery stores.

This retail store survey was made in Brookings, South Dakota from March 1957 to March 1958. Nine of the ten grocery stores participated in this study. A preliminary survey was run 11 weeks. This survey was designed to furnish information regarding the sales of the different brands of butter before the cultured butter was put in the stores. Inventory cards were filled out daily by the store management during the preliminary survey. During the experimental survey of 41 weeks, the inventories and sales of each brand were recorded by College personnel.

The cultured butter was made available for sale in all grocery stores on the beginning of the twelfth week. The first 22 weeks that the cultured butter was in the stores, the merchandising display used was a card 6 by 10 inches in size that would stand up near the butter counter stating: "It's the Flavor that Counts—Cultured Butter." On this card also, was a picture of the carton that was used. The local newspaper ran an 8 by 10 inch advertisement for 2 days. This advertisement had a picture of the display card with this slogan above it, "Look for this carton at your favorite Brookings grocery store." In connection with this, the local radio station advertised the cultured butter in a series of 1 minute spot announcements. These were broadcast each Monday, Wednesday, and Friday for 22 weeks.

At the thirty-fourth week of the survey a more extensive advertising program was used. A new carton was also introduced at this time. This new carton is still being used for the sale of cultured butter in Brookings and Volga, South Dakota.

The local newspaper carried several large advertisements which called attention to the new carton and the butter with fine distinctive flavor. The advertising was continued for 3 weeks. Merchandising material which included posters and banners describing cultured butter were put in the grocery stores. Several posters were placed in the windows of stores where they would attract the attention of consumers. Banners were used inside the stores near the butter displays.

The local radio station ran several commercial slogans as spot announcements describing the fine flavor of cultured butter and how people could tell the difference. These slogans were run from the thirty-fourth through the thirty-seventh week.

Data collected for 1 year, from March 4, 1957 to March 3, 1958, were compiled and gave the weekly sales of different brands of butter and the range of prices charged for each brand.

A description of the different

brands of butter (which were designated by number) sold in Brookings stores during the period of this study is shown in table 1.

The cultured butter and brand 2 were made by the same creamery and always had identical prices in all of the stores. The only difference in cartons between these two brands for the first 22 weeks of the experimental study was that the cultured butter had a sticker, "CULTURED FLAVOR," attached to the upper left hand corner. The similarity of the cartons may have been one cause for the drop in sales of brand 2 after the cultured butter was offered for sale.

The new carton for cultured butter was put into use on the thirty-fourth week. The sales of cultured butter increased appreciably, but after 2 weeks they gradually returned to their approximate previous level. This sharp increase may have been due more to a price reduction coupon than to the effect of the new carton. The week-end before the new carton was introduced on the market, 2,300 coupons were sent out to consumers in the Brookings area. Each coupon was valued at 5 cents toward the purchase of a pound of cultured butter. Of these 2,300 coupons, 408 were returned to the stores.

Brand 3 showed approximately 5% decline in sales when the cultured butter sales began. This decline probably was due to another higher grade, cultured butter, being offered for sale. The advertisement of cultured butter and brands 4 and 5 may have had some effect also. Brands 6 and 7 did not show any appreciable change in sales. This may be a result of the higher prices charged for these brands. Although brands 6 and 7 were of higher quality, the price differential of 4 to 8 cents over the cultured butter and 13 to 23 cents over brand 5 would be influential to the average consumer.

The fluctuations in sales of brands 4 and 5 probably were due largely to price changes. Brand 5 was used as a loss leader for 22 out of 41 weeks of the experimental study. Brand 4 was also used as a loss leader, but it was not used to the extent of brand 5. Only one store retailed brand 4 as described above; the other stores carried a fairly stable price on brand 4 in the range of 63 to 65 cents per pound. The price for cultured butter was stable ex-

Table 1. Description and Prices of Brands of Butter Sold in Brookings

Brand No.	Grade	Cultured	Package	Over-all price range
1	AA-A	Yes	Cartoned—Solids*	67-70c
2	AA-A	No	Cartoned—Solids*	67-70c
3	B-B	No	Cartoned—Solids*	67-69c
4	B-C	No	Parchment—Solid	57-68c
5	B-C	No	Parchment—Solid	55-65c
6	AA-A	No	Cartoned—Quarters	68-74c
7	AA-A	No	Cartoned—Quarters	76-78c

*Pound prints in quarters, but wrapped as a solid pound.

cept for two increases which were due to price increases in the over-all butter market.

The fluctuation of prices on brands 4 and 5 may have affected the sales of butter in chain stores. The four chain stores sold 7,190 pounds of cultured butter and a total of 62,237 pounds of all brands while the five independent stores sold 2,492 and 15,078 pounds respectively during the experimental period. The percentage of all sales for cultured butter was 11.55 for the chain stores while in the independent stores it was 16.53. The frequent lower prices of brands 4 and 5 in the chain stores thus appears to have caused an increase in the sales of these brands and a reduction in the sales of cultured butter.

Another preference test was made at the 1959 convention of the State Dairy Association. Four small churnings of butter were made from the same cream at the College dairy plant for this test. The No. 1 control contained no added flavor from diacetyl or culture, the No. 2 contained some added diacetyl, the No. 3 and No. 4 had culture added at the rates of 2% and 4% respectively. All of these samples had an official USDA score of 93 or Grade AA. There were 22 persons (buttermakers and their wives) who participated in this flavor preference test. They were asked to rate the four samples in order of their preference for flavor only. In computing the results of this test, first placings received 4 points, second placings 3 points, third placings 2 points and fourth placings 1 point. The results of this test are as follows:

	Control	Diacetyl added	2% Culture	4% Culture
Diacetyl mgm./100 gm.	.0032	.0318	.0080	.0148
Preference points	47	50	64	59

The data indicate that these people, who are not professional butter judges but are familiar with butter quality, preferred butter with flavor to the control without flavor added and they preferred the sample with 2% culture over the 4%. Both of the cultured butters were preferred over the sample containing the purified diacetyl produced synthetically. Reasons for this preference are not definitely known; further work is needed to determine the level of diacetyl flavor that is most desirable.

Diacetyl contents were determined on each sample of butter in this trial by the method of Prill and Hammer (8) with a modification using a Coleman Universal Spectrophotometer Model 14 for measuring color intensities. There was a very small amount of diacetyl in the control sample and nearly 10 times as much in the sample to which diacetyl had been added. Perhaps it should also be pointed out that the amount of diacetyl in this culture was not as high as it should have been for best flavor.

Keeping Quality of Cultured and Non-Cultured Butter

Even though cultured butter may have superior flavor when fresh to the non-cultured product, its keeping qualities in storage, in grocery stores and in the home refrigerator must be as good or better if it is to be accepted by butter dealers. Also, much new evidence will be required to change the older generally accepted idea that the keeping quality of cultured butter is not dependable and may be inferior. The prelimin-

ary work reported herein indicates that cultured butter made from high quality cream with good equipment under carefully controlled ditions will have excellent keeping quality.

The first keeping quality trial was made on the butter used in the consumer preference tests. This butter was manufactured in two creameries in this area. The bulk cultures were prepared at the College dairy and their use in the two plants was supervised by a member of the College Staff. The butter samples were scored when fresh, after being held 1 week at 70° F., and 1 month in a refrigerator at 38° F. A summary of these results is presented in table 2. Since these comparisons of cultured and non-cultured butter were not made from the same cream, only the difference in score of the fresh and stored samples could be considered. Although the number of samples is very small, there does seem to be an indication that the keeping quality of the cultured butter is a little better than that of the non-cultured product.

In the second trial two churnings of butter were made from high quality cream, one containing 2% culture and the other without culture. These churnings were packed in 64 pound boxes and were placed in commercial storage, where they were held at −1° F. for 8 months. A box from each lot was removed at the end of each month for scoring, keeping quality tests, and other analyses. The original score of both churnings was 93 (AA Grade). At the end of the 8 month period the scores of both churnings remained at 93. All of the 70°F. 1-week keeping quality tests showed no change in score and were considered as being very satisfactory. This test made under practical commercial conditions indicates equal keeping quality of cultured and non-cultured butter.

A third storage test was designed to compare the effects of different levels of culture on the keeping quality of butter. Three small churnings from the same lot of high quality cream were made in the College dairy plant. Butter with no culture, 2% culture, and 5% culture was prepared and stored in 1-pound prints at temperatures of 70, 38, and 0° F. for periods of 2 weeks, 10 weeks, and 10 months, respectively. Results of the scorings for flavor are presented in table 3.

The data in table 3 indicate superior keeping quality of the butter with 2% culture at 70° F. for 1 week and again after 2 weeks. Likewise

Table 2. Keeping Quality of Cultured and Non-Cultured Butter Manufactured in Two Creameries

Storage conditions	Cultured 4 samples		Non-cultured 3 samples		Cultured 3 samples		Non-cultured 3 samples	
	Av. score	Change	Av. score	Change	Av. score	Change	Av. score	Change
Fresh	92.20		91.00		92.60		92.23	
70° F. 1 week	92.00	−0.20	90.50	−0.50	92.20	−0.40	90.30	−1.93
38° F. 1 month	91.75	−0.45	90.66	−0.34	92.20	−0.40	90.30	−1.93

Table 3. Effects of Different Amounts of Culture on the Keeping Quality of Butter Held at Three Temperatures

Storage conditions	Average scores		
	No culture	2% culture	5% culture
Fresh butter	93.0	93.0	93.0
1 week at 70° F.	92.0	93.0	92.0
2 weeks at 70° F.	91.5	92.0	91.0
4 weeks at 38° F.	92.0	92.0	91.5
10 weeks at 38° F.	91.0	91.5	91.1
4 months at 0° F.	92.0	92.5	92.1
10 months at 0° F.	92.0	92.5	91.1

when the butter was held at 38° F. and at 0° F. the sample with the 2% culture showed a very slight advantage over the control and over the 5% sample. Although the addition of 2% culture to the butter resulted in somewhat improved keeping quality, the addition of 5% had the reverse effect.

Diacetyl determinations were made on these butter samples at different times during the storage tests. The results are shown in figure 1. Although the fresh butter containing 5% culture did not show as much diacetyl as would be expected, it did increase rather rapidly at each of the storage temperatures. There was also some increase at the 2% level and a very slight increase in the control sample. There was a rather sharp increase in diacetyl in each of the samples held at 70° F. indicating that there was considerable growth of bacteria at this temperature. The samples held at 38° F. showed a slight increase during the first month and then maintained rather constant values during the next two and one-half months. The

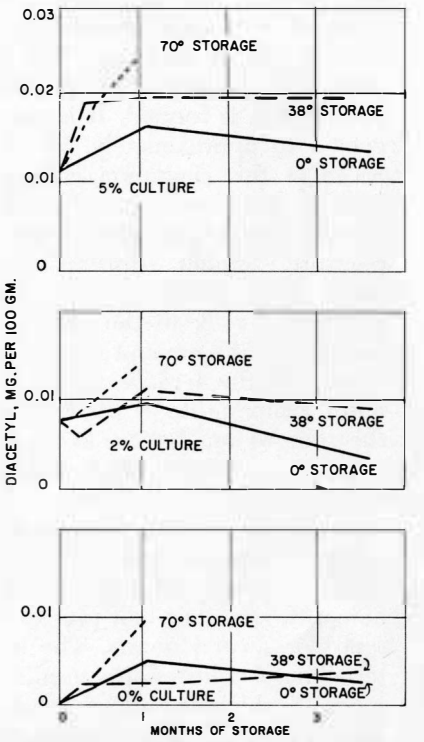


Fig. 1. EFFECT OF STORAGE TEMPERATURE ON DIACETYL CONTENTS OF BUTTER CONTAINING 0, 2, and 5% CULTURE.

samples stored at 0° F. showed less increase at first which was followed by slight declines .

Preparation Of Bulk Cultures From Frozen Intermediates

Cultures for butter and cheese are normally propagated as follows:

1. The original culture is purchased from a commercial laboratory specializing in preparation of cultures. This is usually a powder, but it may be a liquid if the time in transit is only a few days and it is to be used immediately.
2. The original culture is transferred into a small amount (approximately 100 milliliters) of sterile milk or milk that has been pasteurized at a high temperature, such as, 190° F. for 1 hour. This is allowed to incubate at 70° F. until a coagulum is formed. It is then cooled to approximately 35° F. Some of this coagulum is used later to inoculate another bottle of milk pasteurized at high temperature. Similar transfers are made nearly every day from the coagulated milk to the pasteurized milk. The amount of inoculum is usually 1 to 2%, the incubator temperature is 70°F. and the time of incubation 15 to 17 hours. These daily transfers are known as mother cultures.
3. The mother cultures are used to prepare intermediate cultures which may be needed in various amounts, from one-half pint to a quart or several quarts. The intermediate cultures are used to inoculate the bulk cultures which are used in the manufacture of butter or other products.

Good laboratory facilities and well trained technicians are needed to handle mother cultures successfully. Since these conditions are not found in the majority of creameries and other dairy processing plants, the handling of mother cultures has not been satisfactory in most cases and the resulting quality of the cultures has been questionable. If the intermediate cultures could be supplied to the plants, the bulk cultures could be prepared with a minimum of difficulty and expense. Since previous work had indicated that cultures could be frozen and used at later periods, some trials were made in which intermediate cultures were frozen and used for the preparation of bulk cultures after varying periods of time.

In the first experiment two freshly made bulk cultures were used. Quantities of somewhat less than 1 pint were placed in pint-size polyethylene freezer locker bags. These bags of culture were then frozen and kept within a temperature range of 0°F. to -10°F. After time intervals of 7, 21, 36, and 50 days, bulk cultures were prepared from these frozen intermediates. To determine the effects of freezing and low temperature storage the following tests were made on the frozen culture and on the bulk culture prepared from the frozen samples: titratable acidity, volatile acidity, and diacetyl. The volatile acidities were determined on steam distillates of the cultures. Diacetyl was determined by the method previously described. Results of these tests are presented in table 4.

The results given in table 4 indi-

cate that bulk cultures prepared from frozen intermediates are quite satisfactory from the standpoint of flavor constituents. There was some decrease in diacetyl in the bulk cultures prepared from 50-day old frozen cultures. Since the titratable acidities were somewhat lower in these instances, it is evident that there was some loss in activity. Probably another hour or two of incubation would have given more flavor development along with increased acidity.

Since the freezing and subsequent thawing caused a definite separation of whey and curd, it was not possible to obtain uniform, representative samples for the tests on frozen cultures. This probably explains some of the variation in the results on these samples.

Since there was some loss in the activity of the frozen cultures during the period of storage, two factors that might possibly be of some importance were investigated. Cultures were frozen at -68°F. and compared with those frozen in the range of 0°F. to -10°F. There seemed to be little or no advantage in using the lower temperature. Skim milk and homogenized whole milk were compared as media for propagating and freezing the cultures. There was no apparent difference in the activity of the cultures, but the flavor was better when the homogenized milk was used.

The results of these trials using frozen cultures were sufficiently encouraging to warrant further study. A more convenient container seemed very desirable. This problem was solved satisfactorily by using wax coated paper milk cartons having a capacity of one-third quart. These cartons are convenient to fill, seal, freeze, and hold in frozen storage. Frozen culture stored in the paper milk cartons have been used during the past two years for pre-

Table 4. Analysis of Frozen Cultures and the Bulk Cultures Resulting from These Frozen Intermediates

Determination	Sample	Days held at 0° F. 0	7	21	36	50
Culture No. 2						
Diacetyl, mgm./ 100 gm.	Frozen	.0788	.1612	.1616	.1261	.0612
	Bulk	.1244	.1668	.1644	.2288	.0602
Votatile acids, ml. 0.1 N NaOH/100 ml.	Frozen	7.60	6.80	8.00	7.15	7.90
	Bulk	7.40	6.10	9.90	8.70	6.35
Titratable acids*	Bulk	0.88	0.94	0.95	0.92	0.85
Culture No. X						
Diacetyl, mgm./ 100 gm.	Frozen	.0664	.0708	.1672	.0924	.1284
	Bulk	.0652	.1352	.0764	.0904	.0620
Volatile acids, ml. 0.1 N NaOH/100 ml.	Frozen	7.50	9.80	8.80	7.55	8.50
	Bulk	8.10	8.20	9.55	8.75	9.45
Titratable acids*	Bulk	0.91	1.00	0.99	0.90	0.83

*Calculated as per cent lactic acid. Representative samples could not be obtained for this test from the frozen culture.

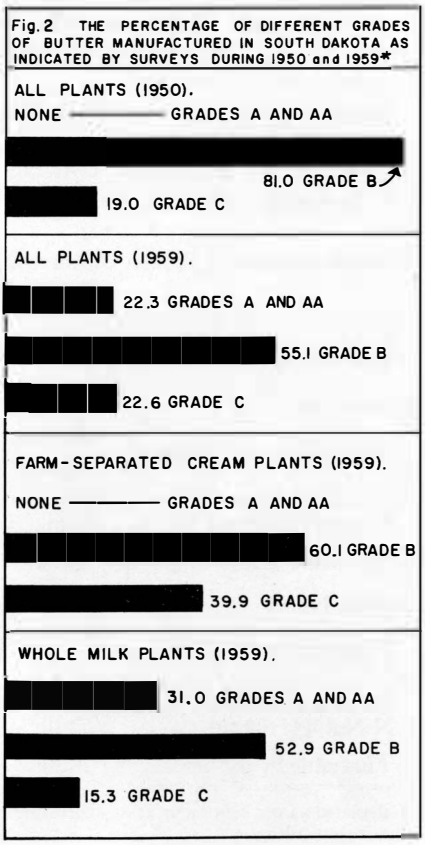
paring bulk cultures that were to be used for manufacturing butter and cottage cheese by plants in and near Brookings. All of the cultures prepared in this manner have been satisfactory for the manufacture of these products.

The Changing Butter Industry In South Dakota

The survey reported by Feder *et al* (4) showed that 81% of the butter manufactured in South Dakota during the summer of 1950 was Grade B and 19% was Grade C. Following the change from marketing farm separated cream to whole milk a rapid improvement occurred. To ascertain the extent of this change a similar survey was made during the summer of 1959. The results obtained are presented with those of 1950 in figure 2. Groups A and B of the chart show an over-all picture of the improvement. Notice that in 1959, 22.3% of the butter was in the top grades of AA and A, while in 1950 there was no butter in these grades. There was a sharp drop in the amount of Grade B butter in 1959 and comparatively little change in the amount of Grade C.

When the 1959 data are broken down by types of plants, it will be observed that all of the improvement occurred in the whole milk plants. Actually the plants that received only farm separated cream were making poorer quality butter than all of the plants did in 1950.

A further increase in the amount of Grades AA and A is easily possible. All of the plants receiving whole milk also receive some farm separated cream. Many times it may be more convenient to mix the cream from these two sources than to churn them separately. However, this system of blending sour cream and sweet cream nearly always results in Grade B butter. The stronger flavors in the sour cream will be the predominant flavors appearing in the butter. This type of butter was found frequently in the 1959 study. Since many of the plants now receive more than 50% of their butterfat in the form of whole milk, the percentage of Grades AA and A butter could be increased—probably doubled—by churning this cream separately.



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RECOMMENDED PROCEDURE FOR PREPARING BULK CULTURE FROM FROZEN CULTURE

1. Select fresh good quality whole milk, preferably homogenized, that is known to be free of antibiotics or other inhibitory substances.
2. Add sodium citrate at a rate of 10 grams per gallon of milk.
3. Heat the milk in a 10 gallon stainless steel can to 190°F. for one hour and cool to exactly 70°F.
4. Thaw the frozen culture at room temperature or in luke warm water, just enough so that it will slip from the opened carton when it is inverted.
5. Add the frozen culture to the 70°F. milk and allow to stand for about 30 minutes.
6. Stir the inoculated milk thoroughly and keep it at 70°F. about 16 hours. The titratable acidity of the culture at this time should be about 0.85%. It should have a pleasant characteristic aroma.
7. Cool the culture by circulating cold water and hold at refrigeration temperature (40°F.) until ready for use. This should not be more than 3 or 4 days.

Take every precaution to prevent contamination of the milk and culture with foreign bacteria. The can used must be clean. A strong chlorine solution, 200 ppm, should be used for the thermometer and stirring

rod used in the milk and culture. The carton containing the frozen culture must be opened very carefully with scissors or a sharp knife to avoid contamination from the exterior surface.

RECOMMENDED MANUFACTURING PROCEDURE FOR CULTURED BUTTER

1. Use fresh factory separated cream. Pasteurize the cream at 165° to 170°F. for 30 minutes.
2. After pasteurization, cool the cream to approximately 40°F., and hold over-night.
3. The next morning, adjust the cream temperature for correct churning and then pump it into the churn.
4. After the cream is in churn, add the butter coloring. The amount of coloring required to produce about the same shade of color as naturally present in early summer butter will vary with the season of the year.
5. Churn the cream. The churning process should take approximately 45 minutes.
6. After churning is completed, drain off the buttermilk.
7. Wash the butter granules with approximately 40°F. water and allow the butter to chill for a few minutes.
8. Drain the wash water from the churn and work the butter until no excess water remains.
9. Run a moisture test to determine the amount of water that remains in the butter.
10. Make calculations to determine the amount of water, salt and culture to add.
11. Add the needed amounts of water, salt and culture. These should be worked-in until the butter is dry and free of excess moisture.
12. The butter is then ready for boxing and printing.

The recommended amount of culture to use is 2% of the expected weight of butter. An example to demonstrate how the calculation can be made for adding culture, salt and water is shown using a churning of 5,000 pounds of 30% cream.

The desired composition for butter with culture added is 80.2% butterfat, 16.8% moisture, 2.0% salt, and 1.0% curd which gives a total of 100%.

Moisture, Salt, and Culture Calculations

5000 x 0.30 = 1500 pounds of butterfat
1500 x 1.24 = 1860 pounds of expected butter
1860 x 0.13 (1st moisture test) = 241.8 pounds of water in the unfinished butter
1860 x 0.168 = 312.5 pounds of water that should be in the finished butter
312.5 - 241.8 = 70.7 pounds of additional water needed
1860 x 0.02 = 37.2 pounds each of salt and culture to add
37.2 x 0.90 = 33.5 pounds of water in culture
70.7 - 33.5 = 37.2 pounds of water needed in addition to that present in the culture.