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The correlation between the organisms found microscopically and the bacteriological deterioration of butter

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THE CORRELATION BETWEEN THE ORGANISMS FOUND MICROSCOPICALLY AND THE BACTERIOLOGICAL DETERIORATION OF BUTTER

BY

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INTRODUCTION

At the present time considerable emphasis is placed on the keeping quality of butter. Good keeping quality is one of the cardinal virtues of butter that is properly made and is indispensable in the successful marketing of the product. The purpose of producing butter with good flavor and aroma is to meet the demands of the consumer, but quality in butter is of value only if it is present at the time the butter is consumed, which may be several months after it is made. The consumer is also interested in butter that has good keeping quality so that the flavor will not materially change during the period of consumption. Butter of poor keeping quality is a cause of heavy financial losses to creameries and butter merchants. To avoid financial loss, due to poor keeping quality, various tests have been devised to give a general idea of the sanitary conditions under which the butter was made. These tests are supposed to give a general idea of the keeping quality. The mold and yeast count and the estimation of the numbers and kinds of bacteria present are methods used to determine keeping quality in a general way, but the relationship between numbers and kinds of microorganisms found in butter and its keeping quality has not been clearly established. A desirable test for keeping quality would be one that takes into consideration the general types of microorganisms responsible for deterioration and that gives butter plants

some fairly accurate advance information as to the probable keeping qualities of different churnings. Furthermore, a test that would indicate the reason for deterioration would be very helpful to plant operators in correcting defects.

OBJECT OF THE WORK

The primary object of the work was to determine whether or not it is possible to predict the keeping quality of butter with reasonable accuracy by a microscopic study of the flora. A practical method for determining keeping quality and for studying the changes in flavor score and microflora in butter was also developed.

HISTORICAL

Bouska(1), in investigating an outbreak of fishy butter, set aside a two-ounce sample from each churning in screw-capped, glass jars and observed the keeping quality. At first the samples were held at about 2°C., but this temperature was found too low, since the changes that occurred were not comparable with those occurring in channels of distribution. A temperature of 15.5°C. for two weeks was found to be better for determining the keeping quality. Bouska observed that butter properly made in centralized plants decreased about one point in flavor score in a two-week holding period, and had no pronounced bad flavor. Many hundred churnings were studied in this manner during a period of about two years; eventually the

keeping quality of the butter made in the plant became more stabilized.

Ruehle(8) devised a microscopic method for examining butter for microorganisms. He found the microscopic counts higher than plate counts and assumed that it was due to dead cells which could be seen under the microscope, but would not grow on plates. Ruehle did not include a study of the microscopic and plate counts in relation to the keeping quality of butter.

Bouska and Brown(2) reported that butter which has a good flavor when churned, but develops a bad flavor at low temperatures within a month, has poor keeping quality, and they suggested a rapid test made by storing a small sample at 15.5° to 21° C. When stored under these conditions, butter with poor keeping quality developed a bad flavor within three days, while butter with good keeping quality had a flavor score of 34 to 35 at the end of two weeks. They predicted the keeping quality in storage of 177 lots of butter from the numbers of yeasts and oidia found. A commercial judge also predicted the keeping quality of the same lots, but his predictions were based on the quality of the butter and his previous experience with the products from the creameries that made the butter. Bouska and Brown predicted that 39 of the 177 lots would keep well in storage, and the commercial judge predicted 83 lots would keep well. At the end of the storage period 5 (12.8 per cent) of the 39 lots which Bouska and Brown predicted would keep well had deteriorated badly, and 24 (28.9 per cent) of the 83 lots which the commercial judge predicted would

keep well had deteriorated badly. Bouska and Brown state that the number of yeasts and oidia are not a reliable index to the keeping quality of storage butter./ They also state that, other conditions being favorable, butter containing only a few yeasts and oidia has a better chance to keep on long distance shipments and in cold storage than butter containing large numbers of yeasts and oidia, and their records show further that creameries having the best commercial reputation for butter of good keeping quality have a product with low yeast and oidia counts.

Redfield(7) made a study of the yeasts and oidia in 91 samples of butter, both by a microscopic method and by a plate method. He found the microscopic counts very much higher than the plate counts. Redfield did not include a study of the relationship of microscopic and plate counts of yeasts and oidia to the keeping quality of the butter.

Sutton(9) devised a "bottle test" which consisted of placing samples of melted butter in erlenmeyer flasks and holding them at room temperature. The samples were examined at the end of one day, and again at the end of seven days. The butter sometimes developed a very definite abnormal odor, which he described as "decomposed", and he attributed this odor to a decomposition of the separated curd. Sutton mentioned two striking characteristics of the "decomposed" odor: the rapidity with which it may develop in a sample of butter of apparently satisfactory quality, and the apparent lack of correla-

tion between this condition and the bacterial content as judged by numbers and types which developed on nutrient agar. The results of the "bottle test" confirmed and supplemented those obtained by the plate count in that under normal circumstances no odor developed in samples containing less than 100,000 bacteria per ml., and an odor did develop in samples containing more than 500,000 bacteria per ml. Some high scoring butter developed definite off flavors when it was subjected to the "bottle test." Sutton recommended the "bottle test" for the detection of butter which would develop the "decomposed" odor, and as a means of checking the biological quality of butter.

Macy and Richie(5) obtained data on mold and yeast counts and keeping quality of 597 samples of butter held at different storage temperatures. They found no consistent relationship between the mold, or the yeast counts, and the quality of the fresh butter. Considered as a group, the samples of butter with the lower mold and yeast counts showed a tendency toward slightly better keeping quality than those with higher counts. The mold and yeast counts of individual samples did not serve as a reliable index to the keeping quality of the butter.

Demeter and Maier(3) examined more than 500 samples of sour pasteurized cream butter, which had been stored ten days at about 3°C. The study revealed that there was only a general relationship between high mold counts and low grade butter, and that this relationship held only for groups and not for individual samples except those with mold counts of more than 50,000 per ml. The yeast counts did not give any idea of the quality of the butter, and were of value only as a

means of checking the general sanitary conditions of the manufacturing plant. The total bacterial counts on lactose agar demonstrated in a general way that the higher the count the lower the grade, and the same thing was found true with the numbers of acidifying bacteria. No relationship could be detected between the numbers of non-acidifying bacteria and the quality except when the counts were extremely high. This same relationship was also noted with the numbers of caseolytic organisms. The most useful of all bacteriological determinations in relation to quality proved to be the total counts on casein agar. High grade butter usually showed a count less than 1,000,000 per ml., and never more than 2,000,000 per ml. A high count was practically always an indication of low grade butter, or at least indicated that something might go wrong with it bacteriologically in a short time. Demeter and Maier recommended casein agar as a good medium to show the presence of organisms not wanted in butter and the total count on casein agar also proved to be the best means of predicting the keeping quality.

GENERAL PROCEDURE

Samples of butter of varying quality were collected in two-ounce, glass-stoppered, sterile bottles from a large number of butter plants. Most of the plants were in Iowa, but a few were in other states. The original butter was scored and criticised for flavor and aroma by experienced judges on the basis of 45 points for perfect. Microscopic

slides were prepared from the samples, and the samples were also plated, after which they were placed in an incubator, and held at 21°C. for seven days. At the end of the holding period, the samples were again scored and criticised for flavor and aroma, and microscopic slides again made.

METHODS

The microscopic counts were made by the method devised by Hammer and Nelson(4). A small portion of each sample of butter was melted by carefully heating it to 45° C. in a beaker held in a hot water bath. Ten ml. of the melted butter were transferred to a separatory funnel by means of a pipette and centrifuged at 1,000 R. P. M. for a period not exceeding one minute in a machine in which, when in operation, the stop-cocks of the funnels were 14½ inches apart. The serum thus separated was drawn off into a short test tube, 0.01 ml. of the well-mixed sample of serum transferred to a clean microscopic slide and about three drops of sterile sedimented skimmilk added to the slide by means of a small capillary pipette. The serum and skimmilk were carefully mixed on the slide and spread over an area of eight square centimeters by means of a sterile needle bent at right angles. The slide was then allowed to dry while lying on a flat surface protected from flies and dust. The slide was stained for five minutes by Newman's one solution technique(6) (Formula No. 2) after which it was washed in water at room temperature, and allow-

ed to dry. The slide was then restained by placing it in an aqueous solution of methylene blue (30ml. of a saturated alcoholic solution of methylene blue in 100 ml. of distilled water) for a few seconds after which it was washed in water at room temperature and allowed to dry. Newman's one solution technique alone did not seem to stain some of the microorganisms sufficiently, due presumably to the fact that many cells were dead, but by restaining in aqueous methylene blue, the organisms seemed to stain very well.

The microscopic slides were examined under the oil immersion objective of a microscope having a field diameter of 0.146 mm. The numbers of organisms were estimated by (a) counting 6 to 12 fields and calculating the average number per field, (b) multiplying the average number per field by 8, which was the number of square centimeters in the preparation, (c) multiplying this product by the microscope factor, which was 600,000 for the microscope used, and (d) dividing by 9 to compute the organisms on the basis of the number per ml. of butter(4).

The plate counts were made by plating on beef infusion agar and incubating four days at 21° C.

The per cent salt was determined by diluting a 10 g. sample of butter with 250 ml. of warm distilled water and titrating 25 ml. of this solution (25ml. was equal to the salt in one gram of butter) against standard silver nitrate (2.906 grams per liter), using a 10 per cent solution of potassium chromate as an indicator. The silver nitrate was of such strength that each ml. used in titrating the

sample was equivalent to 0.1 per cent salt in the original butter.

PREDICTION OF KEEPING QUALITY

Before the experiment was begun, considerable preliminary work was conducted to determine the time and temperature of holding that would bring out the defects of butter. It was found that holding the samples at 21° C. for seven days in glass-stoppered bottles protected from light seemed to reveal the defects that the butter would develop under ordinary conditions, and consequently this time and temperature of holding were adopted.

The keeping qualities of the samples were predicted by a study of the microorganisms on the original slides, the prediction being made before the samples were rescored. The predictions were based on the types and numbers of organisms found on the original slides. The types and numbers of rods present seemed to be an index to the keeping qualities. If no rods, or only a relatively few rods, were found, the keeping quality was not questioned, especially if the rods were of the thick type. If many thin rods were present, the possibility of the butter keeping was greatly reduced, particularly when the thin rods were well stained, indicating that the organisms were alive. Clumps of well stained thin rods were almost a sure sign of deterioration. A very few well stained thin rods were generally sufficient to cause deterioration in unsalted butter, while salted butter seemed to require a larger number, due presumably to the inhibiting effect

of salt. In general, micrococci and yeasts did not seem to have any detrimental effect on the keeping quality, even when large increases took place, especially in unsalted butter.

Butter held at 21° C. for seven days would not be expected to retain its original flavor score in all cases, especially if the flavor score was very good. Therefore, after the holding period, a tolerance was allowed in flavor score. The tolerance allowed depended upon the original flavor score, more tolerance being allowed for the higher scores than for the lower scores. No sample was considered to have kept if an objectionable flavor developed during the holding period. For example, sample S8 (table 1) had a flavor score of 38.5 when received, and a flavor score of 37 after the seven day holding period; and sample S9 had a flavor score of 37 when received, and a score of 36 after the holding period. Both of these samples were considered to have kept because no objectionable flavor developed, even though there was a reduction in flavor scores. On the other hand, sample S46 had a flavor score of 36 when received, and a score of 34.5 after the holding period. It had developed protein decomposition, and, accordingly, was considered to have deteriorated.

EXPERIMENTAL

The samples of butter studied were divided into three groups, commercial salted butter, commercial unsalted butter, and exhibition

butter.

COMMERCIAL SALTED BUTTER

Three hundred and three samples of commercial salted butter from 72 plants were studied. Sixty-eight of the plants were in Iowa, and four were in other states. The results obtained are presented in table 1.

When received, the flavor scores of the samples ranged from 32 to 39. Two hundred samples had flavor scores of 37 or above, 98 samples had flavor scores ranging from 35 to 36.5 inclusive, and 5 samples had flavor scores below 35. The plate counts varied from 1,000 to 6,160,000, and the microscopic counts from 100,000 to 426,650,000 microorganisms per ml. The microscopic counts were always much higher than the plate counts, and the ratios between the two varied a great deal. Observation of the microscopic slides showed that the butter contained streptococci, micrococci, rods of various types, and occasionally, yeasts. Many of the streptococci occurred in pairs and chains, and were large and well stained. Some of the streptococci were presumably butter culture types. The most striking point about the microorganisms present was the predominance of streptococci and micrococci, especially in the butter with a relatively high flavor score.

At the end of the holding period 109 of the 303 samples had flavor scores of 37 or above, 133 samples had flavor scores ranging from 35 to

36.5 inclusive, and 61 samples had flavor scores below 35. The microscopic counts varied from 1,100,000 to 800,000,000 microorganisms per ml. One hundred eighty-one samples (59.7 per cent) had higher microscopic counts, and 122 samples (40.3 per cent) had lower microscopic counts at the end of the holding period than at the beginning. As a general rule, a large increase in organisms was associated with deterioration. The organisms on the slides made at the end of the holding period were similar to those on the original slides, except when considerable growth had taken place, in which case the predominating type sometimes changed. When the growth resulted in deterioration, rods predominated; and when the growth did not result in deterioration, micrococci generally predominated. Some partly autolyzed cells were found on the original microscopic slides, but they were more numerous and the autolysis more pronounced on the slides made after the holding period.

Of the 303 samples of commercial salted butter studied, the keeping quality was correctly predicted with 292 (96.4 per cent). Of these samples, 223 were predicted to keep, and did keep; and 33 were predicted not to keep and deteriorated. The keeping quality was questioned with 36, and they showed deterioration. Eleven samples (3.6 per cent) were not predicted correctly. Of these samples, the keeping quality was questioned with six (S7, S43, S68, S102, S205, S213), but they kept; four (S5, S85, S91, S184) were predicted to keep, but they deteriorated; and one (S216) was predicted to deteriorate, but it kept

moderately well.

The plate counts were only a general indication of the keeping quality. There were samples (for example, S80, S287, S289) with high plate counts that kept very well, and there were also samples (for example, S50, S130, S284) with relatively low plate counts, that deteriorated considerably.

Flavor Defects Developed in the Commercial Salted Butter During the Holding Period

Protein Decomposition, Cheesiness, and Putrid. Thirty-one (10 per cent) of the commercial salted samples (S1, S5, S11, S15, S20, S21, S28, S35, S39, S41, S42, S46, S50, S52, S54, S62, S74, S81, S91, S130, S138, S151, S191, S218, S246, S252, S255, S258, S262, S269, S274) developed protein decomposition, or cheesiness, or became putrid during the holding period. These flavor defects are so closely related that they were considered together.

When received, the samples which developed protein decomposition, or cheesiness, or became putrid had flavor scores ranging from 33.5 to 38. The plate counts varied from 6,000 to 3,750,000, and the microscopic counts from 3,450,000 to 426,650,000 microorganisms per ml. Rods of various types were seen on most of the original microscopic slides, and some of the rods were of the thin type, and occasionally appeared in clumps. Twenty-nine of the samples were predicted to deteriorate, and the remaining two were predicted to keep, largely because so few rods were found that deterioration was not considered likely.

At the end of the holding period, the samples had the following

flavor scores: two samples 31, three 32, six 33, five 33.5, six 34, two 34.5, six 35, and one 36. The microscopic counts varied from 6,950,000 to 640,000,000 microorganisms per ml. The microscopic counts of samples S5 and S91, which were predicted to keep, but deteriorated, were 55,450,000, and 400,000,000 per ml. respectively. The microscopic slides were characterized by rods of various types, especially the thin type, which was sometimes found in clumps.

Unclean. Nine samples (3 per cent) of the commercial salted butter (S200, S227, S228, S260, S284, S285, S288, S290, S302) developed an unclean flavor during the holding period.

When received, the samples that developed an unclean flavor had flavor scores ranging from 33.5 to 37. The plate counts varied from 1,000 to 1,750,000, and the microscopic counts from 7,450,000 to 240,000,000 microorganisms per ml. Rods were seen on all the original microscopic slides. All the samples were predicted to show deterioration.

At the end of the holding period, the samples had the following flavor scores: one sample 30, two 32, two 33, one 34.5, and three 35. The microscopic counts varied from 3,650,000 to 590,950,000 microorganisms per ml. Rods were conspicuous on all the microscopic slides and some of the rods were in clumps, indicating growth.

Rancid. Eight samples (2.6 per cent) of the commercial salted butter (S10, S60, S105, S122, S126, S136, S266, S268) developed rancidity during the holding period.

When received, the samples that developed rancidity had flavor scores ranging from 34.5 to 39. The plate counts varied from 32,500 to 1,960,000, and the microscopic counts from 32,550,000 to 240,000,000 microorganisms per ml. Rods of various types were seen on all the original microscopic slides, and some of the rods were in clumps, indicating growth. All the samples were predicted to show deterioration.

At the end of the holding period, the samples had the following flavor scores: six samples 33, one 34, and one 35. The microscopic counts varied from 22,150,000 to 693,350,000 microorganisms per ml. The microscopic slides were characterized by rods in clumps, which indicated growth. Five of the eight samples also contained yeasts.

Stale. Eight samples (2.6 per cent) of the commercial salted butter (S22, S66, S69, S125, S144, S145, S190, S243) developed a stale flavor during the holding period.

When received, the samples that developed a stale flavor had flavor scores ranging from 35 to 38. The plate counts varied from 4,000 to 2,400,000, and the microscopic counts from 6,800,000 to 85,850,000 microorganisms per ml. Rods were seen on all the original microscopic slides. All the samples were predicted to deteriorate.

At the end of the holding period, the samples had the following flavor scores: one sample 33.5, five 34, one 35.5, and one 36. The microscopic counts varied from 4,650,000 to 320,000,000 microorganisms per ml. Rods were found on all the microscopic slides,

and they were frequently in clumps.

Bitter. Three samples (1 per cent) of the commercial salted butter (S51, S61, S184) developed a bitter flavor during the holding period.

When received, the samples that developed a bitter flavor had the following flavor scores: two samples 36, and the other 36.5. The plate counts varied from 21,500 to 656,000, and the microscopic counts from 18,300,000 to 52,250,000 microorganisms per ml. Rods were seen on all the original microscopic slides. Two of the samples were predicted to show deterioration, and the other sample was predicted to keep, mainly because so few rods were found that deterioration was not considered likely.

At the end of the holding period, the samples had the following flavor scores: one sample 34, and two 34.5. The microscopic counts varied from 8,400,000 to 58,650,000 microorganisms per ml. The microscopic count of the sample (S184) which was predicted to keep, but deteriorated, was 46,400,000 per ml. Rods were found on all the slides.

Objectionable Flavor, and Odor. Three samples (1 per cent) of the commercial salted butter (S44, S174, S217) developed an objectionable flavor and odor during the holding period. The flavor and odor of these samples were such that the judges could not give them a more definite criticism.

When received, the samples that developed an objectionable flavor and odor had the following flavor scores: two samples 36, and

the other 37. The plate counts varied from 16,000 to 1,280,000, and the microscopic counts from 18,850,000 to 38,950,000 microorganisms per ml. Rods were seen on all the original microscopic slides. All the samples were predicted to show deterioration.

At the end of the holding period, the samples had the following flavor scores: one sample 33.5, one 34, and the other 35. The microscopic counts varied from 41,250,000 to 123,750,000 microorganisms per ml. Rods were seen on all the slides.

Off Flavor. Three samples (1 per cent) of the commercial salted butter (S157, S167, S182) developed an off flavor during the holding period. The flavor and odor of these samples were such that the judges could not give them a more definite criticism.

When received, the samples that developed an off flavor had the following flavor scores: one sample 35.5, one 37, and the other 37.5. The plate counts varied from 25,000 to 2,310,000, and the microscopic counts from 18,650,000 to 69,150,000 microorganisms per ml. Rods were seen on all the original microscopic slides. All the samples were predicted to show deterioration.

At the end of the holding period, the samples had the following flavor scores: one sample 34, and two 35. The microscopic counts varied from 184,550,000 to 800,000,000 microorganisms per ml. Rods were found on all the slides.

Other Defects. Eight samples (2.6 per cent) of the commercial salted butter developed the following defects during the holding period: two samples (S170,S176) oily, one (S6) tallowy, one (S128)

fermented, one (S104) malty, one (S147) yeasty, one (S83) metallic, and one (S85) fishy.

When received, these samples had flavor scores ranging from 36 to 38.5. The plate counts varied from 11,000 to 386,500, and the microscopic counts from 4,200,000 to 93,350,000 microorganisms per ml. Rods were seen on all the original microscopic slides, except on the slide made from the sample which became fishy. All the samples were predicted to show deterioration, except the one which developed the fishy flavor.

At the end of the holding period, the samples had flavor scores ranging from 33 to 35. The microscopic counts varied from 6,650,000 to 89,050,000 microorganisms per ml. Rods were found on all the slides, except on the one made from the fishy sample. The microscopic count of the fishy sample was 89,050,000, and the slide was characterized by streptococci and yeasts. The absence of rods in this sample would seem to indicate that the fishy flavor was not due to the direct action of microorganisms.

General Observations on the Commercial Salted Butter

In general, when deterioration took place in the commercial salted butter, the slides very definitely showed the development of microorganisms. The samples which kept well showed little or no increase, and sometimes a decrease in the microscopic counts during the seven-day holding period.

The general appearance of the original microscopic slides was

an index to the probable quality of the raw material from which the butter was made. The microscopic slides prepared from butter which was churned from poor cream, as determined by the quality of the butter, showed many different types of organisms, such as rods, yeasts, and molds, which are expected to be found in poor raw material; while slides from butter which was made from good quality cream, as determined by the quality of the butter, showed only the types of microorganisms normally found in fresh sweet cream.

Large, well-stained, streptococci which occurred in pairs and short chains were seen in some of the samples. It was assumed that these were largely butter culture organisms. This assumption was substantiated by observing this morphologic type in butter churned from cream to which butter culture had been added, and not observing it in butter churned from cream to which no butter culture had been added.

Four samples (S28, S42, S62, S217) had a leaky body when received. All the samples were predicted to deteriorate because thin rods were present on the original slides, and all the samples did deteriorate badly.

Table 1.

CHANGES IN COMMERCIAL SALTED BUTTER HELD AT 21°

Sample	WHEN RECEIVED							
	Flavor & Aroma		Microorganisms per ml.		Microflora*	Keeping Quality Prediction made on Microflora		
	Score	Criticism	Plate Count	Microscopic Count				
S1	35	Unclean	41,500	42,650,000	Rods in clumps, st., yeasts.	Will not keep	+	
S2	38		43,000	6,350,000	St. in pairs and chains, mic.	Will keep	+	
S3	37		9,500	1,000,000	St. in pairs and chains, mic.	Will keep	+	
S4	37.5		31,000	7,100,000	St. in pairs and chains, thick rods.	Will keep	+	
S5	37.5		233,500	3,450,000	St., mic., few rods.	Will keep	-	
S6	37		43,500	4,200,000	St., mic., rods.	Question-able	+	
S7	37.5		126,000	2,550,000	St. in pairs and chains, rods.	Question-able	-	
S8	38.5		13,500	300,000	St. in pairs and chains, mic.	Will keep	+	
S9	37		24,500	746,000	St. in pairs and chains, mic.	Will keep	+	
S10	35		40,000	37,850,000	Rods in clumps, st., mic.	Will not keep	+	
S11	37		21,500	8,000,000	Rods in clumps, st. in pairs and chains.	Will not keep	+	

* b. c. - Butter culture types. mic. - Micrococci. st. - Streptoc

Table 1.

COMMERCIAL SALTED BUTTER HELD AT 21°C.

			AFTER 7 DAYS AT 21° C.			
Microflora*	Keeping Quality Prediction made on Microflora		Flavor & Aroma Score	Criticism	Microorganisms per ml. Microscopic Count	Microflora*
...s in clumps, st., ...sts.	Will not keep	+	33	Protein decomposition	320,000,000	Many rods of various types, mic.
... in pairs and ...ins, mic.	Will keep	+	37		9,350,000	St. in pairs and chains, mic.
... in pairs and ...ins, mic.	Will keep	+	36		2,400,000	St. in pairs and chains, mic.
... in pairs and ...ins, thick rods.	Will keep	+	37		6,550,000	St., thick rods, mic.
..., mic., few rods.	Will keep	-	33	Protein decomposition	55,450,000	Many rods in clumps, mic.
..., mic., rods.	Questionable	+	34.5	Tallowy	6,650,000	Rods, mic., st.
... in pairs and ...ins, rods.	Questionable	-	36.5		32,000,000	St. in pairs and chains, mic.
... in pairs and ...ins, mic.	Will keep	+	37		8,000,000	St. in pairs and chains, mic., rods.
... in pairs and ...ins, mic.	Will keep	+	36		14,950,000	St. in pairs and chains, mic., rods.
...is in clumps, st., ...s.	Will not keep	+	33	Rancid	51,200,000	Many rods in clumps, yeasts, mic.
...is in clumps, st. pairs and chains.	Will not keep	+	35	Protein decomposition	13,600,000	Many rods in clumps, st., yeasts.

mic. - Micrococci. st. - Streptococci.

+ - Sample predicted correctly.
- - Sample not predicted correctly.

Table 1 (continued)

S12	37		143,500	700,000	St. in pairs and chains, mic.	Will keep	+	36
S13	38.5		20,500	6,250,000	St. in pairs and chains, mic.	Will keep	+	37
S14	37		5,000	100,000	St. in pairs and chains.	Will keep	+	36
S15	35		794,500	53,350,000	Rods in clumps, mic.	Will not keep	+	31
S16	37		11,000	2,150,000	St., few rods.	Will keep	+	35
S17	38		18,500	27,200,000	St. in pairs and chains, b.c.	Will keep	+	36.5
S18	35	Stale	136,500	17,800,000	St. in pairs and chains, few rods.	Will keep	+	34.5
S19	38.5		78,000	4,650,000	St. in pairs and short chains, b.c.	Will keep	+	37
S20	35.5	Stale	194,000	24,900,000	Many rods, mic.	Will not keep	+	32
S21	37	Unclean	1,600,000	38,400,000	Rods in clumps, mic.	Will not keep	+	33.5
S22	35		5,500	23,450,000	Many rods in clumps, st., mic.	Will not keep	+	33.5
S23	37	Coarse	3,000	6,050,000	St. in pairs and chains.	Will keep	+	37
S24	36		25,000	16,000,000	St., mic., few rods.	Will keep	+	35.5
S25	37		17,500	8,550,000	St. in pairs and chains, b.c., rods.	Will keep	+	35.5
S26	38		76,500	6,400,000	St. in pairs and chains, b.c., rods.	Will keep	+	37

Table 1 (continued)

, in pairs and ains, mic.	Will keep	+	36		1,840,000	St. in pairs and chains, mic.
, in pairs and ains, mic.	Will keep	+	37		1,650,000	St. in pairs and chains, mic., rods.
, in pairs and ains.	Will keep	+	36		10,300,000	St. in pairs and chains, few rods.
ls in clumps, mic.	Will not keep	+	31	Cheesy	213,350,000	Many rods in clumps, mic., st.
.,few rods.	Will keep	+	35		6,400,000	St., mic., rods.
, in pairs and ains, b.c.	Will keep	+	36.5		1,100,000	St. in pairs and chains, b.c., rods.
, in pairs and ains, few rods.	Will keep	+	34.5		1,550,000	St. in pairs and chains, rods.
, in pairs and ort chains, b.c.	Will keep	+	37		12,250,000	St. in pairs and chains, b.c.
y rods, mic.	Will not keep	+	32	Protein decom-position	640,000,000	Rods in clumps, mic.
ls in clumps, mic.	Will not keep	+	33.5	Cheesy	320,000,000	Many rods in clumps, mic.
y rods in clumps, ., mic.	Will not keep	+	33.5	Stale	19,500,000	Many rods in clumps, mic. in clumps.
, in pairs and ains.	Will keep	+	37		2,400,000	St. in pairs and chains, very few rods.
., mic., few rods.	Will keep	+	35.5		106,650,000	St., mic., thick rods.
, in pairs and ains, b.c., rods.	Will keep	+	35.5		7,450,000	St. in pairs and chains, b.c.
, in pairs and ains, b.c., rods.	Will keep	+	37		4,600,000	St. in pairs and chains, b.c.

Table 1 (continued)

S27	35.5	Stale	51,500	6,650,000	St. in pairs and chains,	Will keep	+	35
S28	36	Stale leaky	750,000	22,100,000	St. in pairs, rods, yeasts.	Will not keep	+	33.5
S29	37		74,500	6,700,000	St. in pairs and chains,	Will keep	+	36
S30	37.5	Feed	45,500	9,300,000	St. in pairs and chains, b.c., mic.	Will keep	+	37.5
S31	38		12,500	12,800,000	St. in pairs and chains, b. c.	Will keep	+	37
S32	38.5		31,000	3,200,000	St. in pairs and chains.	Will keep	+	37
S33	38		1,050,000	11,900,000	St. in pairs and chains, b. c.	Will keep	+	37
S34	35	Stale briny	156,500	3,900,000	St., yeasts.	Will keep	+	34.5
S35	36	Stale	52,500	36,800,000	Rods, st. in pairs and chains, b.c.	Will not keep	+	34
S36	38		12,500	4,550,000	St. in pairs and chains.	Will keep	+	38
S37	37	Coarse	284,500	4,250,000	St. in pairs and chains, few rods.	Will keep	+	36.5
S38	38		38,000	15,100,000	St. in pairs and chains, b.c., few rods.	Will keep	+	37.5
S39	37	High acid	457,500	15,400,000	Rods, st. in pairs and chains, mic.	Questionable	+	35
S40	37.5		13,000	950,000	St. in pairs and chains.	Will keep	+	37
S41	35.5	Unclean	508,000	35,500,000	Rods, mic., st.	Will not keep	+	33

Table 1 (continued)

in pairs and ns,	Will keep	+	35		30,050,000	St. in pairs and chains, few rods, mic.
in pairs, rods, sts.	Will not keep	½	33.5	Protein decomposition	160,000,000	Many rods in clumps, mic.
in pairs and ins,	Will keep	½	36		5,350,000	St. in pairs and chains, few rods.
in pairs and ins, b.c., mic.	Will keep	+	37.5		4,250,000	St. in pairs and chains, mic.
in pairs and ins, b. c.	Will keep	+	37		8,100,000	St. in pairs and chains, b.c., few rods.
in pairs and ins.	Will keep	+	37		4,400,000	St. in pairs and chains,
in pairs and ins, b. c.	Will keep	+	37		33,250,000	St. in pairs and chains, mic.
, yeasts.	Will keep	+	34.5		6,950,000	St., few thick rods.
s, st. in pairs chains, b.c.	Will not keep	+	34	Protein decomposition	106,650,000	Many rods, st. in pairs and chains.
in pairs and ins.	Will keep	+	38		1,700,000	St. in pairs and chains.
in pairs and ins, few rods.	Will keep	+	36.5		15,900,000	St. in pairs and chains , mic., rods.
in pairs and ins,b.c., few rods.	Will keep	+	37.5		6,150,000	St. in pairs and chains.
s, st. in pairs chains, mic.	Questionable	+	35	Cheesy	80,000,000	Many rods in clumps, st., mic.
in pairs and ins.	Will keep	+	37		3,400,000	St. in pairs and chains, few rods.
s, mic., st.	Will not keep	+	33	Cheesy	266,650,000	Many rods in clumps, mic., st.

Table 1 (continued)

S42	36	Leaky	33,500	11,950,000	Rods, st. in pairs.	Question-able	+	3
S43	36	Burnt	43,000	48,000,000	Rods, st. in pairs and chains, mic.	Question-able	-	3
S44	37		1,280,000	18,850,000	Rods, st. in pairs chains, b.c., mic.	Question-able	+	3
S45	37.5		19,500	10,950,000	St. in pairs and chains, b.c.	Will keep	+	3
S46	36	Stale	19,500	29,250,000	Rods, st. in pairs and chains, yeasts.	Question-able	+	3
S47	37	Trifle unclean	142,500	24,550,000	St. in pairs and chains, b.c., rods.	Will keep	+	3
S48	38.5		23,000	1,350,000	St. in pairs and chains, b.c.	Will keep	+	3
S49	37		28,500	36,850,000	St. in pairs and chains, b.c.	Will keep	+	3
S50	36		22,500	45,350,000	Rods, st. in pairs and chains, b.c.	Question-able	+	3
S51	36		54,000	18,300,000	Rods, st. in pairs and chains.	Question-able	+	3
S52	36		341,000	14,650,000	Rods in clumps, st., mic.	Will not keep	+	3
S53	38		12,000	1,050,000	St. in pairs and chains.	Will keep	+	3
S54	37		725,000	17,600,000	Rods in clumps, st. in pairs and chains.	Will not keep	+	3
S55	37		13,000	22,400,000	St. in pairs and chains, b.c.	Will keep	+	3
S56	37.5		51,500	16,550,000	St. in pairs and chains, b.c.	Will keep	+	3

Table 1 (continued)

lods, st. in pairs.	Question-able	+	33.5	Putrid	213,350,000	Many rods some in clumps, st., yeasts.
lods, st. in pairs nd chains, mic.	Question-able	-	35		13,200,000	St. in pairs and chains, mic.
lods, st. in pairs hains, b.c., mic.	Question-able	+	35	Objection-able	41,250,000	Rods, mic., st.
t. in pairs and hains, b.c.	Will keep	+	37		8,000,000	St. in pairs and chains.
lods, st. in pairs nd chains, yeasts.	Question-able	+	34.5	Protein decom-position	16,000,000	Rods, st. in pairs and chains.
t. in pairs and hains, b.c., rods.	Will keep	+	36		32,550,000	St. in pairs and chains, mic., few rods.
t. in pairs and hains, b.c.	Will keep	+	37.5		5,550,000	St. in pairs and chains.
t. in pairs and hains, b.c.	Will keep	+	36		37,350,000	St. in pairs and chains, b.c.
lods, st. in pairs nd chains, b.c.	Question-able	+	33.5	Protein decom-position	80,000,000	Rods in clumps, st.
lods, st. in pairs nd chains.	Question-able	+	34.5	Bitter	8,400,000	Few rods, st. in pairs and chains.
ods in clumps, st., ic.	Will not keep	+	33.5	Cheesy	50,000,000	Many rods, st., mic.
t. in pairs and hains.	Will keep	+	37.5		2,950,000	St. in pairs and chains.
ods in clumps, st. n pairs and chains.	Will not keep	+	35	Protein decom-position	58,650,000	Rods, st., mic.
t. in pairs and hains, b.c.	Will keep	+	36.5		3,000,000	St. in pairs and chains, b.c.
t. in pairs and hains, b.c.	Will keep	+	36.5		8,550,000	St. in pairs and chains, b.c.

Table 1 (continued)

S57	38		8,000	26,900,000	St. in pairs and chains, b.c., rods.	Will keep	
S58	38.5		10,500	32,000,000	St. in pairs and chains, b.c.	Will keep	
S59	38		32,500	4,850,000	St. in pairs and chains, b.c.	Will keep	
S60	36.5		48,000	36,000,000	Rods, st. in pairs and chains.	Will not keep	
S61	36.5		21,500	37,350,000	Rods, st. in pairs and chains.	Question-able	
S62	36	Leaky	235,500	16,150,000	Rods, st. in pairs and chains.	Will not keep	
S63	37		105,000	18,150,000	St. in pairs and chains, b.c.	Will keep	
S64	38		28,000	32,000,000	St. in pairs and chains, b.c., rods.	Will keep	
S65	38.5		153,000	22,400,000	St. in pairs and chains, b.c.	Will keep	
S66	36		2,400,000	48,000,000	Rods in clumps, st. in pairs and chains.	Will not keep	
S67	37		27,500	16,600,000	St. in pairs and chains, mic.	Will keep	
S68	34.5	Unclean	56,000	57,000,000	Rods in clumps, st. in pairs and chains.	Question-able	
S69	35.5	Briny	680,000	6,800,000	Some rods, st. in pairs.	Question-able	
S70	37	Trifle unclean	166,500	12,700,000	Rods in clumps, st. in pairs, mic.	Question-able	
S71	37	Trifle unclean	536,000	23,800,000	St. in pairs and chains, b.c., mic.	Will keep	

Table 1 (continued)

;t. in pairs and :hains, b.c., rods.	Will keep	37.5		27,100,000	St. in pairs and chains, few rods.
;t. in pairs and :hains, b.c.	Will keep	37.5		10,200,000	St. in pairs and chains.
;t. in pairs and :hains, b.c.	Will keep	37.5		9,350,000	St. in pairs and chains, few rods.
:ods, st. in pairs ind chains.	Will not keep	34	Rancid	22,150,000	Rods in clumps, mic., st.
:ods, st. in pairs ind chains.	Question-able	34	Bitter	58,650,000	Rods, st. in pairs and chains, yeasts.
:ods, st. in pairs ind chains.	Will not keep	33	Cheesy	80,000,000	Rods in clumps, st. in pairs and chains.
;t. in pairs and :hains, b.c.	Will keep	36.5		33,600,000	St. in pairs and chains, b.c.
;t. in pairs and :hains, b.c., rods.	Will keep	37.5		40,550,000	St. in pairs and chains, few rods.
;t. in pairs and :hains, b.c.	Will keep	37.5		13,900,000	St. in pairs and chains, few rods.
:ods in clumps, st. in pairs and chains.	Will not keep	34	Stale	112,000,000	Many rods in clumps, st. in pairs, mic.
;t. in pairs and :hains, mic.	Will keep	36		24,000,000	St. in pairs and chains, mic.
:ods in clumps, st. in pairs and chains.	Question-able	34.5		20,600,000	Rods, mic., st.
ome rods, st. in airs,	Question-able	34	Stale	4,650,000	Rods, st. in pairs.
Rods in clumps, st. in pairs, mic.	Question-able	35	Oily	15,450,000	Rods, st., mic.
St. in pairs and chains, b.c., mic.	Will keep	36		41,050,000	St., mic., few rods, few yeasts.

Table 1 (continued)

S72	38		45,500	12,550,000	St. in pairs and chains, b.c., mic.	Will keep	+	37
S73	35.5	Coarse	132,500	26,150,000	St. in pairs, few rods, mic.	Will keep	+	35
S74	36		53,000	20,000,000	Rods, st., b.c., mic.	Question-able	+	34
S75	38		25,000	10,650,000	St. in pairs and chains., b. c.	Will keep	+	37
S76	37.5		24,000	1,600,000	St. in pairs and chains.	Will keep	+	37
S77	37		31,000	2,650,000	St. in pairs.	Will keep	+	36
S78	37.5		22,000	43,000,000	St. in pairs and chains, b. c.	Will keep	+	36
S79	38		82,000	32,000,000	St. in pairs and chains, b. c.	Will keep	+	37
S80	37.5		2,800,000	25,600,000	St., mic., few rods.	Will keep	+	37
S81	36		196,000	12,250,000	Rods, st. in pairs, mic.	Will not keep	+	34
S82	38		12,000	1,900,000	St. in pairs.	Will keep	+	37
S83	37	High acid	11,000	57,400,000	Some rods, st. in pairs, b.c., mic.	Question-able	+	36
S84	38.5	High acid	231,000	17,300,000	St. in pairs.	Will keep	+	37
S85	36		95,000	93,350,000	St. in pairs and chains, b.c.	Will keep	-	33
S86	38		249,000	15,000,000	St. in pairs and chains, b. c.	Will keep	+	37

Table 1 (continued)

. in pairs and ains, b.c., mic.	Will keep	+	37.5		13,050,000	St., mic., few rods.
. in pairs, few ds, mic.	Will keep	+	35		28,450,000	St. in pairs, few rods, mic.
ds, st., b.c., mic.	Question-able	+	34	Protein decom-position	51,050,000	Rods, st., mic.
. in pairs and ains., b. c.	Will keep	+	37.5		2,150,000	St. in pairs and chains.
. in pairs and ains.	Will keep	+	37		9,050,000	St. in pairs and chains.
. in pairs.	Will keep	+	36.5		11,200,000	St., mic., few rods.
. in pairs and ains, b. c.	Will keep	+	36		56,800,000	St. in pairs and chains, few rods.
. in pairs and ains, b. c.	Will keep	+	37.5		25,750,000	St. in pairs, b. c., few rods.
., mic., few rods.	Will keep	+	37		112,000,000	Mic., st., few rods.
ds, st. in pairs, ic.	Will not keep	+	34	Protein decom-position	61,450,000	Rods, st. in pairs, mic.
. in pairs.	Will keep	+	37.5		9,000,000	St. in pairs.
ome rods, st. in airs, b.c., mic.	Question-able	+	35	Metallic	51,450,000	Some rods, st. in pairs, mic.
. in pairs.	Will keep	+	37.5		32,550,000	St. in pairs, mic., yeasts, few rods.
. in pairs and hains, b.c.	Will keep	-	33	Fishy	89,050,000	St. in pairs, b. c., yeasts.
. in pairs and hains, b. c.	Will keep	+	37		14,400,000	St. in pairs and chains, b. c., mic.

Table 1 (continued)

S87	35.5	Moldy	505,000	97,350,000	St. in pairs and chains, b.c.	Will keep	+	35
S88	36		77,500	27,250,000	St. in pairs and chains.	Will keep	+	36
S89	38.5		32,000	4,250,000	St. in pairs and chains.	Will keep	+	38
S90	37		70,500	5,400,000	St. in pairs.	Will keep	+	36
S91	38		87,500	8,250,000	St. in pairs and chains, few rods.	Will keep	-	34
S92	37		351,000	10,200,000	St. in pairs, mic.	Will keep	+	36
S93	35.5		34,000	21,850,000	St. in pairs, b. c.	Will keep	+	35
S94	38		129,000	32,600,000	St. in pairs and chains, b. c.	Will keep	+	37
S95	37		53,500	37,350,000	St. in pairs and chains, mic., few rods.	Will keep	+	38
S96	37.5		153,500	27,300,000	St. in pairs and chains, b. c.	Will keep	+	36
S97	37		97,000	70,400,000	St. in pairs and chains, b. c.	Will keep	+	36
S98	37		37,000	18,650,000	St. in pairs and chains, b. c.	Will keep	+	36
S99	38.5		46,500	17,050,000	St. in pairs and chains, b.c., mic.	Will keep	+	38
S100	37	Wintry	96,500	46,400,000	St. in pairs and chains.	Will keep	+	37
S101	37		24,000	4,150,000	St. in pairs, mic., very few rods.	Will keep	+	37

Table 1 (continued)

t. in pairs and hains, b.c.	Will keep	+	35.5		51,200,000	St. in pairs and chains, b. c., rods.
t. in pairs and hains.	Will keep	+	36		20,250,000	St. in pairs and chains, mic.
t. in pairs and hains.	Will keep	+	38		28,000,000	St. in pairs, mic., in clumps, few rods.
t. in pairs.	Will keep	+	36		8,150,000	St. in pairs.
t. in pairs and hains, few rods.	Will keep	-	34	Protein decom-position	400,000,000	Many thin rods in clumps, mic., yeasts.
t. in pairs, mic.	Will keep	+	36		19,200,000	St. in pairs, mic., few rods.
t. in pairs, b. c.	Will keep	+	35		28,350,000	St. in pairs, b. c., few rods.
t. in pairs and hains, b. c.	Will keep	+	37.5		14,700,000	St. in pairs and chains, b. c.,
t. in pairs and hains, mic., few rods.	Will keep	+	35.5		22,650,000	St. in pairs and chains, mic.,
t. in pairs and hains, b. c.	Will keep	+	36.5		9,600,000	St. in pairs and chains, b. c.
t. in pairs and hains, b. c.	Will keep	+	36.5		16,000,000	St. in pairs and chains, b. c., rods.
t. in pairs and hains, b. c.	Will keep	+	36		47,550,000	St. in pairs and chains, b.c., mic., rods.
t. in pairs and hains, b.c., mic.	Will keep	+	38		13,600,000	St. in pairs and chains, mic., yeasts.
t. in pairs and hains.	Will keep	+	37		26,650,000	St. in pairs and chains, mic., rods.
t. in pairs, mic., ery few rods.	Will keep	+	37		6,800,000	St. in pairs, mic., few rods.

Table 1 (continued)

S102	37	High acid	22,000	32,000,000	Rods in clumps, st. in pairs and chains.	Question-able	-	36
S103	36	Coarse	64,000	23,000,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S104	36		50,000	12,250,000	St. in pairs, few rods in clumps, mic.	Question-able	+	34
S105	38		86,500	34,650,000	St. in pairs and chains, b.c., rods.	Question-able	+	35
S106	37.5		31,000	29,850,000	St. in pairs and chains, b.c.	Will keep	+	36
S107	37.5		257,500	14,950,000	St. in pairs and chains, b.c., few rods.	Will keep	+	37
S108	37		247,000	17,050,000	St. in pairs, b.c.	Will keep	+	37
S109	37	Wintry	87,000	61,850,000	St. in pairs and chains, b.c., mic.	Will keep	+	35
S110	36	Coarse briny	215,500	7,750,000	St. in pairs, some rods.	Will keep	+	35
S111	37.5		122,000	8,250,000	St. in pairs, rods.	Will keep	+	37
S112	37		11,000	3,450,000	St. in pairs.	Will keep	+	36
S113	38		62,000	9,600,000	St. in pairs, mic., rods.	Will keep	+	37
S114	36		6,000	10,050,000	St. in pairs, few rods.	Will keep	+	35
S115	38	Wintry	11,000	6,450,000	St. in pairs, some rods.	Will keep	+	36
S116	37	High acid	17,000	53,250,000	St. in pairs and chains, b.c., rods.	Will keep	+	36

Table 1 (continued)

s in clumps, st. pairs and chains.	Question-able	-	36		27,450,000	St. in pairs and chains, rods.
in pairs and ins, b.c., mic.	Will keep	+	36		15,050,000	St. in pairs and chains, b.c., mic., rods.
in pairs, few s in clumps, mic.	Question-able	+	34	Malty	16,700,000	St. in pairs, mic., rods.
in pairs and ins, b.c., rods.	Question-able	+	35	Rancid	30,650,000	Rods in clumps, st. in pairs, mic.
in pairs and ins, b.c.	Will keep	+	36		17,600,000	St. in pairs and chains, b.c., few rods.
in pairs and ins, b.c., few rods.	Will keep	+	37.5		137,600,000	St. in pairs and chains, mic., rods.
in pairs, b.c.	Will keep	+	37		31,000,000	St. in pairs, mic. in clumps, yeasts, rods.
in pairs and ins, b.c., mic.	Will keep	+	35.5		320,000,000	Many mic., st. in pairs and chains, rods, yeasts.
in pairs, some s.	Will keep	+	35.		38,400,000	Mic. in clumps, rods, st. in pairs.
in pairs, rods.	Will keep	+	37		17,050,000	St. in pairs, mic., rods.
in pairs.	Will keep	+	36		8,800,000	St., mic. in clumps, rods.
in pairs, mic., s.	Will keep	+	37.5		7,350,000	St., rods.
in pairs, few s.	Will keep	+	35.5		23,450,000	St., mic., rods.
in pairs, some s.	Will keep	+	36		19,200,000	St., mic., rods.
in pairs and ains, b.c., rods.	Will keep	+	36		27,200,000	St., mic., rods.

Table 1 (continued)

S117	37		96,000	19,750,000	St. in pairs and chains, b.c., mic.	Will keep	*	36
S118	37		30,500	24,000,000	St. in pairs and chains, b.c., mic.	Will keep	*	36
S119	37.5		93,000	27,750,000	St. in pairs and chains, b.c., mic.	Will keep	*	36
S120	38		214,000	20,550,000	St. in pairs and chains, b.c., rods.	Will keep	*	37
S121	37	Burnt	207,500	24,300,000	St. in pairs and chains, b. c.	Will keep	*	36
S122	35		1,960,000	113,350,000	St., mic., rods in clumps.	Will not keep	*	33
S123	36	Coarse	81,000	19,250,000	St. in pairs and chains, mic., rods.	Will keep	*	35
S124	38		8,000	3,450,000	St. in pairs and chains, mic.	Will keep	*	37
S125	36	Coarse	6,500	85,850,000	Rods, st. in pairs and chains, b.c., mic.	Questionable	*	34
S126	35	Burnt	1,920,000	240,000,000	Many rods in clumps, st., mic.	Will not keep	*	33
S127	38		185,000	21,250,000	St. in pairs and chains, b.c.	Will keep	*	37
S128	37.5		12,500	14,400,000	St. in pairs and chains, b.c., rods.	Questionable	*	35
S129	36.5		3,700,000	95,450,000	St. in pairs and chains, b.c.	Will keep	*	36
S130	35	Oily	10,000	40,550,000	Rods, st., mic.	Will not keep	*	31
S131	39		800,000	55,000,000	St. in pairs and chains, b.c.	Will keep	*	38

Table 1 (continued)

in pairs and ins, b.c., mic.	Will keep	+	36		11,200,000	St. in pairs and chains, b.c., mic.
in pairs and ins, b.c., mic.	Will keep	+	36.5		12,800,000	St. in pairs and chains, b.c., mic.
in pairs and ins, b.c., mic.	Will keep	+	36.5		19,200,000	St. in pairs and chains, mic.
in pairs and ins, b.c., rods.	Will keep	+	37.5		20,700,000	St. in pairs and chains, b.c.
in pairs and ins, b. c.	Will keep	+	36		26,950,000	St. in pairs and chains, mic., rods.
, mic., rods in mps.	Will not keep	+	33	Rancid	240,000,000	Rods in clumps, st., mic., yeasts.
in pairs and ins, mic., rods.	Will keep	+	35.5		15,450,000	St. in pairs and chains, rods, mic.
in pairs and ins, mic.	Will keep	+	37.5		7,250,000	St. in pairs and chains, few rods.
ds, st. in pairs d chains, b.c., mic.	Questionable	+	34	Stale	320,000,000	Rods, st. in pairs and chains, mic.
ny rods in clumps, , mic.	Will not keep	+	33	Rancid	533,350,000	Many rods in clumps, st., mic., yeasts.
in pairs and ins, b.c.	Will keep	+	37.5		22,250,000	St. in pairs and chains, mic., rods.
in pairs and ins, b.c., rods.	Questionable	+	35	Fermented	11,200,000	Some rods, st. in pairs and chains, mic.
in pairs and ins, b.c.	Will keep	+	36.5		62,950,000	St. in pairs and chains, mic., rods.
ds, st., mic.	Will not keep	+	31	Putrid	37,850,000	Rods, st., yeasts.
in pairs and ins, b.c.	Will keep	+	38		640,000,000	Many mic., few rods, yeasts, st.

Table 1 (continued)

S132	39		182,500	19,000,000	St. in pairs and chains, b.c., mic.	Will keep	+	37
S133	39		404,500	74,150,000	St. in pairs and chains, b.c., yeasts.	Will keep	+	37
S134	39		542,500	65,500,000	St. in pairs and chains, b.c., yeasts.	Will keep	+	37
S135	39		408,000	62,400,000	St. in pairs and chains, b.c.	Will keep	+	38
S136	39		1,680,000	59,300,000	St. in pairs and chains, b.c., rods.	Will not keep	+	38
S137	35		35,000	4,600,000	St. in pairs, mic., rods, yeasts.	Will keep	+	38
S138	36		1,200,000	426,650,000	Many rods, mic., yeasts, st.	Will not keep	+	38
S139	37	Briny	83,500	20,250,000	St. in pairs and chains.	Will keep	+	37
S140	37		11,500	7,450,000	St. in pairs and chains, few yeasts.	Will keep	+	37
S141	36		6,000	26,150,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S142	36	Wintry	8,000	135,450,000	St. in pairs and chains, b.c., rods.	Will keep	+	38
S143	35	High acid	480,000	20,800,000	St. in pairs and chains, mic., rods.	Will keep	+	38
S144	37	Briny	35,500	7,450,000	Rods, st., mic.	Question-able	+	38
S145	38		114,000	18,400,000	Rods, st. in pairs.	Question-able	+	38
S146	37.5	Wintry	61,000	2,500,000	St. in pairs, mic., rods.	Will keep	+	38

Table 1 (continued)

. in pairs and ains, b.c., mic.	Will keep	+	37		266,650,000	Mic., st., rods, yeast.
. in pairs and ains, b.c., yeasts.	Will keep	+	37		293,350,000	St., yeasts, mic., rods.
. in pairs and ains, b.c., yeasts.	Will keep	+	37		293,350,000	St., yeasts, mic., rods.
. in pairs and ains, b.c.	Will keep	+	38		393,350,000	St. in pairs and chains, mic., rods.
. in pairs and ains, b.c., rods.	Will not keep	+	33	Rancid	693,350,000	Many rods in clumps, st., mic., yeasts.
. in pairs, mic., ds, yeasts.	Will keep	+	35		25,250,000	St. in pairs, mic., rods.
ny rods, mic., asts, st.	Will not keep	+	33	Protein decomposition	106,650,000	Rods, mic., st., yeasts.
t. in pairs and ains.	Will keep	+	37		81,050,000	St., few yeasts, rods.
t. in pairs and ains, few yeasts.	Will keep	+	37		168,000,000	St., yeasts, few rods.
t. in pairs and hains, b.c., mic.	Will keep	+	36		16,000,000	St. in pairs, rods.
t. in pairs and hains, b.c., rods.	Will keep	+	35.5		29,350,000	St. in pairs, mic., rods.
t. in pairs and hains, mic., rods.	Will keep	+	35		22,400,000	St. in pairs, rods.
ods, st., mic.	Questionable	+	35.5	Stale	9,050,000	Some rods, mic., st.
ods, st. in pairs.	Questionable	+	36	Stale	266,650,000	Many rods, mic., st.
t. in pairs, mic., ods.	Will keep	+	37		86,400,000	St. in pairs, yeasts in clumps.

Table 1 (continued)

S147	38.5		386,500	83,200,000	Rods, many yeasts, st. in pairs, b. c.	Will not keep	+	
S148	36		668,000	19,350,000	St. in pairs, mic.	Will keep	+	
S149	38		7,000	1,900,000	St. in pairs, few mic.	Will keep	+	
S150	38		198,000	20,250,000	St. in pairs and chains, b.c.	Will keep	+	
S151	37.5		25,000	6,950,000	Rods, mic., st. in pairs.	Will not keep	+	
S152	38		12,500	32,000,000	St. in pairs and chains, b.c., mic.	Will keep	+	
S153	36		229,500	46,950,000	St. in pairs, mic., rods.	Will keep	+	
S154	37.5	Wintry	29,500	6,950,000	St. in pairs, few rods, few mic.	Will keep	+	
S155	38		31,000	19,100,000	St. in pairs, mic. in clumps, few rods.	Will keep	+	
S156	37	Briny	126,500	12,250,000	St. in pairs and chains, mic., rods.	Will keep	+	
S157	37		25,000	20,800,000	Rods, st. in pairs, mic.	Question-able	+	
S158	37.5		38,500	24,050,000	St. in pairs and chains, b.c.	Will keep	+	
S159	38		7,000	6,400,000	St. in pairs, few mic.	Will keep	+	
S160	38		67,000	85,350,000	St. in pairs and chains, b.c., mic.	Will keep	+	
S161	37.5		38,000	10,650,000	St. in pairs and chains, mic., rods.	Will keep	+	

Table 1 (continued)

s, many yeasts, in pairs, b. c.	Will not keep	+	34	Yeasty	135,450,000	Rods in clumps, mic., many yeasts.
in pairs, mic.	Will keep	+	36		12,800,000	St., mic. in clumps, few rods.
in pairs, few mic.	Will keep	+	37.5		2,950,000	St., mic., few rods.
in pairs and ins, b.c.	Will keep	+	37		54,950,000	St. in pairs, mic.
s, mic., st. in rs.	Will not keep	+	34.5	Protein decom-position	53,350,000	Rods in clumps, mic., st. in pairs.
in pairs and ins, b.c., mic.	Will keep	+	36.5		35,200,000	St. in pairs, mic.
in pairs, mic., s.	Will keep	+	35		74,650,000	St. in pairs, mic., yeasts, rods.
in pairs, few s, few mic.	Will keep	+	37		51,650,000	St. in pairs, mic., rods, yeasts.
in pairs, mic. clumps, few rods.	Will keep	+	37		14,950,000	St. in pairs, mic., yeasts, rods.
in pairs and ins, mic., rods.	Will keep	+	36.5		38,950,000	Mic. in clumps, st., rods.
s, st. in pairs, .	Question-able	+	35	Off flavor	184,550,000	Rods, mic., st. in pairs.
in pairs and ins, b.c.	Will keep	+	37		11,750,000	St., mic., few rods.
in pairs, few c.	Will keep	+	37		8,000,000	St. in pairs, few mic.
in pairs and ins, b.c., mic.	Will keep	+	36		111,450,000	St., mic., yeasts, rods.
in pairs and ins, mic., rods.	Will keep	+	36.5		59,200,000	St., mic., rods.

Table 1 (continued)

S162	36		21,000	25,700,000	St. in pairs and chains, b.c.	Will keep	+	36
S163	37.5		124,000	4,950,000	St. in pairs, mic., few rods.	Will keep	+	36
S164	38		12,000	6,400,000	St. in pairs, mic., few rods.	Will keep	+	37
S165	37	Cooked	4,500	16,800,000	St. in pairs, mic.	Will keep	+	37
S166	37	High acid	17,000	52,800,000	St. in pairs and chains, b.c.,mic.	Will keep	+	36
S167	35.5	Unclean	2,310,000	69,150,000	St. in pairs and chains, mic., rods.	Question-able	+	34
S168	38		42,000	11,200,000	St. in pairs and chains, very few rods.	Will keep	+	37
S169	36	Wintry	41,000	10,650,000	St. in pairs, mic., rods.	Will keep	+	35
S170	38		16,000	19,200,000	St. in pairs and chains, b.c., mic.	Will keep	+	38
S171	37		61,000	12,550,000	St. in pairs and chains, b.c., mic.	Will keep	+	37
S172	38		19,500	4,050,000	St. in pairs and chains.	Will keep	+	37
S173	37		640,000	25,600,000	St. in pairs and chains, b.c.	Will keep	+	37
S174	36	Burnt	16,000	38,950,000	Rods, mic., st. in pairs and chains.	Question-able	+	35
S175	37	Coarse	118,000	5,460,000	St. in pairs and chains, b.c., rods.	Will keep	+	36
S176	37		87,000	6,550,000	Rods, st. in pairs, mic.	Question-able	+	35

Table 1 (continued)

St. in pairs and chains, b.c.	Will keep	+	36		28,800,000	St. in pairs, mic., few rods.
St. in pairs, mic., few rods.	Will keep	+	36.5		4,450,000	St. in pairs.
St. in pairs, mic., few rods.	Will keep	+	37.5		5,500,000	St. in pairs, mic., rods.
t. in pairs, mic.	Will keep	+	37		9,850,000	St. in pairs, mic., few rods.
St. in pairs and chains, b.c.,mic.	Will keep	+	36.5		19,200,000	Yeasts, st. in pairs, mic., few rods.
St. in pairs and chains, mic., rods.	Question-able	+	34	Off flavor	800,000,000	Many rods in clumps, mic., st.
St. in pairs and chains, very few rods.	Will keep	+	37.5		12,250,000	St. in pairs, mic.
St. in pairs, mic., rods.	Will keep	+	35		13,350,000	St. in pairs, mic.
St. in pairs and chains, b.c., mic.	Will keep	+	38		26,650,000	St. in pairs and chains, mic., rods.
St. in pairs and chains, b.c., mic.	Will keep	+	37		12,250,000	St. in pairs and chains, yeasts, mic.
St. in pairs and chains.	Will keep	+	37.5		1,750,000	St. in pairs, mic.
St. in pairs and chains, b.c.	Will keep	+	37		14,950,000	St. in pairs, mic., few rods.
Rods, mic., st. in pairs and chains.	Question-able	+	33.5	Objection-able	59,750,000	Rods, mic., yeasts, st. in pairs.
. in pairs and chains, b.c., rods.	Will keep	+	36		54,400,000	St. in pairs, rods, mic.
Rods, st. in pairs, mic.	Question-able	+	35	Oily	11,750,000	Rods, st. in pairs.

Table 1 (continued)

S177	37	High acid	41,000	56,000,000	St. in pairs and chains, b.c., rods.	Will keep	+	37
S178	38		43,000	6,450,000	St. in pairs and chains, mic.	Will keep	+	37
S179	38.5		112,000	37,600,000	St. in pairs and chains, b.c., rods.	Will keep	+	38
S180	37	Briny	32,500	38,400,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S181	38		61,000	13,350,000	St. in pairs and chains, b.c., rods.	Will keep	+	37
S182	37.5		377,000	18,650,000	Rods, mic., yeasts, st. in pairs, b.c.	Will not keep	+	38
S183	37		126,500	6,600,000	St. in pairs and chains, mic., rods.	Will keep	+	36
S184	36		656,000	52,250,000	St. in pairs and chains, b.c., rods.	Will keep	-	34
S185	38		111,500	28,800,000	St. in pairs and chains, b.c., mic.	Will keep	+	37
S186	37	Coarse	80,000	5,400,000	St. in pairs and chains, mic., rods.	Will keep	+	36
S187	38		169,500	56,000,000	St. in pairs and chains, b.c.	Will keep	+	37
S188	38		105,500	25,050,000	St. in pairs and chains, b.c., rods.	Will keep	+	37
S189	38		62,500	21,850,000	St. in pairs and chains, mic.	Will keep	+	37
S190	36	Cooked	32,500	51,750,000	Rods, st., mic.	Questionable	+	34
S191	35	High acid	213,000	52,250,000	Rods, st. in pairs and chains, mic.	Questionable	+	34

Table 1 (continued)

in pairs and ains, b.c., rods.	Will keep	+	37		61,850,000	St. in pairs, mic., rods, yeasts.
in pairs and ains, mic.	Will keep	+	37		5,350,000	St. in pairs, mic., few rods.
in pairs and ains, b.c., rods.	Will keep	+	38		48,550,000	Mic., yeasts in clumps, st. in pairs, rods.
in pairs and ains, b.c., mic.	Will keep	+	36		37,850,000	St. in pairs and chains, b.c., yeasts.
in pairs and ains, b.c., rods.	Will keep	+	37		20,000,000	St. in pairs, mic., rods, yeasts.
ls, mic., yeasts, in pairs, b.c.	Will not keep	+	35	Off flavor	293,350,000	Rods in clumps, st. in pairs, mic., yeasts.
in pairs and ains, mic., rods.	Will keep	+	36		73,050,000	Mic., rods in clumps, st.
in pairs and ains, b.c., rods.	Will keep	-	34.5	Bitter	46,400,000	St. in pairs, rods, mic.
in pairs and ains, b.c., mic.	Will keep	+	37.5		8,000,000	St. in pairs and chains, b.c., mic.
in pairs and ains, mic., rods.	Will keep	+	36		4,650,000	St. in pairs, mic.
in pairs and ains, b.c.	Will keep	+	37		35,200,000	St. in pairs and chains, b.c., mic.
in pairs and ains, b.c., rods.	Will keep	+	37		7,300,000	St. in pairs, mic., rods.
in pairs and ains, mic.	Will keep	+	37.5		12,000,000	St. in pairs and chains, mic., few rods.
ls, st., mic.	Questionable	+	34	Stale	25,050,000	Rods, st. in pairs and chains, mic.
ls, st. in pairs and ains, mic.	Questionable	+	34	Protein decomposition	166,400,000	Rods, yeasts in clumps, st.

Table 1 (continued)

S192	36		99,000	19,750,000	St. in pairs and chains, b.c., mic.	Will keep	+	35
S193	35.5	Stale	46,000	23,200,000	St. in pairs, mic., few rods.	Will keep	+	35
S194	38		141,000	9,600,000	St. in pairs, mic. in clumps, few rods.	Will keep	+	37
S195	37	Feed	5,000	9,600,000	St. in pairs, mic., rods.	Will keep	+	36
S196	36		1,750,000	24,550,000	St. in pairs, mic. in clumps.	Will keep	+	36
S197	38		39,500	19,200,000	St. in pairs and chains, b. c.	Will keep	+	38
S198	37		87,000	10,150,000	St. in pairs, mic., few rods.	Will keep	+	37
S199	36		184,500	25,600,000	St. in pairs and chains, mic., few rods.	Will keep	+	35
S200	36	High acid	980,000	43,200,000	Rods, st. in pairs and chains, b.c., mic.	Question-able	+	34
S201	37		380,000	60,800,000	St. in pairs, b.c., mic., rods.	Will keep	+	3
S202	36.5		181,000	29,350,000	St. in pairs, b.c., rods.	Will keep	+	3
S203	36		230,000	19,200,000	St. in pairs, mic., rods.	Will keep	+	3
S204	37.5		59,500	13,850,000	St. in pairs, mic., rods.	Will keep	+	3
S205	36		246,500	60,250,000	Rods, st. in pairs, b.c., mic.	Question-able	-	3
S206	37.5		18,500	5,550,000	St. in pairs, few rods.	Will keep	+	3

Table 1 (continued)

in pairs and ins, b.c., mic.	Will keep	+	35		37,050,000	St. in pairs and chains, b.c., mic.
in pairs, mic., rods.	Will keep	+	35.5		58,650,000	St. in pairs, mic., yeasts in clumps.
in pairs, mic. in mps, few rods.	Will keep	+	37.5		14,400,000	St. in pairs, mic. in clumps, few rods.
in pairs, mic., s.	Will keep	+	36		13,850,000	St. in pairs, few rods, few yeasts.
in pairs, mic. clumps.	Will keep	+	36		168,550,000	St. in pairs, rods, mic.
in pairs and ins, b. c.	Will keep	+	38		78,400,000	Mic., yeasts in clumps, rods.
in pairs, mic., rods.	Will keep	+	37		28,700,000	St. in pairs, rods, few mic.
in pairs and ins, mic., few rods.	Will keep	+	35		11,650,000	St. in pairs, rods.
s, st. in pairs chains, b.c., mic.	Question-able	+	34.6	Unclean	24,550,000	Rods, mic., st., few yeasts.
in pairs, b.c., rods.	Will keep	+	37		17,050,000	St. in pairs, rods, yeasts, mic.
in pairs, b.c., s.	Will keep	+	36.5		27,200,000	St. in pairs and chains, rods, mic.
in pairs, mic., s.	Will keep	+	35.5		50,150,000	St., mic., rods.
in pairs, mic., s.	Will keep	+	37.5		16,000,000	St., rods.
s, st. in pairs, mic.	Question-able	-	35.5		32,000,000	St., mic., rods.
in pairs, few rods.	Will keep	+	36		4,250,000	St., mic.

Table 1 (continued)

S207	32	Vegetable	22,000	6,950,000	St. in pairs, mic. in clumps.	Will keep	+	32
S208	37		38,000	75,750,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S209	37.5		5,500	5,350,000	St. in pairs and chains, mic.	Will keep	+	37
S210	37		55,000	17,600,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S211	37		27,000	6,950,000	St. in pairs and chains, b.c., mic.	Will keep	+	37
S212	36		46,000	84,250,000	St. in pairs and chains, b.c., mic.	Will keep	+	35
S213	36		29,500	28,600,000	Rods, St. in pairs and chains, b.c., mic.	Question-able	-	35
S214	38		119,000	5,850,000	St. in pairs and chains, mic., rods.	Will keep	+	37
S215	37		38,000	11,750,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S216	38		1,400,000	30,950,000	Rods in clumps, st., mic., yeasts.	Will not keep	-	37
S217	36	Leaky	136,500	21,850,000	Rods, st. in pairs, mic.	Question-able	+	34
S218	37		296,500	29,850,000	Rods, st. in pairs and chains, mic.	Will not keep	+	32
S219	36	Coarse	73,500	60,800,000	St. in pairs and chains, mic., rods.	Will keep	+	36
S220	36		6,000	44,800,000	St. in pairs and chains, b.c., rods.	Will keep	+	35
S221	36		141,500	51,200,000	St. in pairs, mic., rods.	Will keep	+	35

Table 1 (continued)

. in pairs, mic. clumps.	Will keep	+	32		31,450,000	St. in pairs, mic., rods.
. in pairs and ains, b.c., mic.	Will keep	+	36		92,250,000	St. in pairs and chains, mic., rods.
. in pairs and ains, mic.	Will keep	+	37		12,750,000	St. in pairs, mic., rods, yeasts.
. in pairs and ains, b.c., mic.	Will keep	+	36		30,400,000	Mic. in clumps, st., few rods.
. in pairs and ains, b.c., mic.	Will keep	+	37		16,000,000	St. in pairs and chains, mic., rods.
. in pairs and ains, b.c., mic.	Will keep	+	35		36,250,000	Mic. in clumps, st. in pairs, rods.
ods, . in pairs and ains, b.c., mic.	Question-able	-	36		6,950,000	St. in pairs and chains, b.c., rods.
. in pairs and ains, mic., rods.	Will keep	+	37		42,150,000	Mic. in clumps, rods, st. in pairs.
. in pairs and ains, b.c., mic.	Will keep	+	36.5		69,350,000	St. in pairs, mic. in clumps, rods.
ds in clumps, st., c., yeasts.	Will not keep	-	37		221,850,000	Rods, mic., yeasts.
ds, st. in pairs, c.	Question-able	+	34	Objection-able	125,750,000	Rods, mic. in clumps, yeasts in clumps, st.
ds, st. in pairs d chains, mic.	Will not keep	+	32	Cheesy	6,950,000	Rods, st., mic.
t. in pairs and ains, mic., rods.	Will keep	+	35.5		65,050,000	St. in pairs, mic., rods.
t. in pairs and ains, b.c., rods.	Will keep	+	35.5		16,550,000	St. in pairs, b.c., mic., rods.
t. in pairs, mic., rods.	Will keep	+	35		88,000,000	St. in pairs, rods, mic.

Table 1 (continued)

S222	38		10,000	8,800,000	St. in pairs and chains, b.c., mic.	Will keep	+	36.
S223	38		41,500	5,950,000	St. in pairs and chains, b.c., rods.	Will keep	+	37.
S224	38		27,000	10,650,000	St. in pairs and chains, b.c., mic.	Will keep	+	37.
S225	37.5		45,000	12,800,000	St. in pairs and chains, b.c., mic.	Will keep	+	37.
S226	37.5		165,000	14,400,000	St. in pairs and chains, b.c.,mic.	Will keep	+	37
S227	37		1,000	7,450,000	Rods, st. in pairs.	Question-able	+	35
S228	35	Unclean	24,000	240,000,000	Many rods in clumps, mic., st. in pairs.	Will not keep	+	30
S229	38		36,500	7,450,000	St. in pairs and chains, b.c., mic.	Will keep	+	38
S230	37.5		51,500	6,400,000	St. in pairs, mic.	Will keep	+	37.
S231	35	Stale	218,000	27,200,000	St. in pairs, rods, mic.	Will keep	+	34.
S232	35.5	Stale	3,500	42,650,000	St. in pairs and chains, b.c., rods.	Will keep	+	35
S233	35	Stale	6,000	45,350,000	St. in pairs and chains, b.c., rods.	Will keep	+	35
S234	37		61,500	7,450,000	St. in pairs and chains, b.c.	Will keep	+	37
S235	37		183,500	6,400,000	St. in pairs and chains, b.c., rods.	Will keep	+	36
S236	37.5		10,000	8,000,000	St. in pairs and chains, b.c., mic.	Will keep	+	36.

Table 1 (continued)

in pairs and ns, b.c., mic.	Will keep	+	36.5		4,800,000	St. in pairs, mic.
in pairs and ns, b.c., rods.	Will keep	+	37.5		4,250,000	St. in pairs and chains, b.c., rods, mic.
in pairs and ns, b.c., mic.	Will keep	+	37.5		5,850,000	St. in pairs and chains, mic., rods.
in pairs and ns, b.c., mic.	Will keep	+	37.5		12,200,000	St. in pairs and chains, rods, mic.
in pairs and ns, b.c.,mic.	Will keep	+	37		10,650,000	St. in pairs, mic., rods.
, st. in pairs.	Question-able	+	35	Unclean	2,650,000	Rods, st.
rods in clumps, , st. in pairs.	Will not keep	+	30	Very unclean	226,150,000	Many rods, st., mic.
in pairs and ns, b.c., mic.	Will keep	+	38		24,550,000	Mic. in clumps, yeasts, rods, st. in pairs.
in pairs, mic.	Will keep	+	37.5		6,000,000	Mic. in clumps, st. in pairs.
in pairs, rods,	Will keep	+	34.5		37,350,000	Mic. in clumps, rods, st. in pairs.
in pairs and ns, b.c., rods,	Will keep	+	35		28,800,000	St. in pairs, rods, mic.
in pairs and ns, b.c., rods.	Will keep	+	35		17,600,000	St. in pairs and chains, b.c., rods, mic.
in pairs and ns, b.c.	Will keep	+	37		10,150,000	St. in pairs and chains, b.c., rods.
in pairs and ns, b.c., rods.	Will keep	+	36		7,350,000	St. in pairs, mic., few rods.
in pairs and ns, b.c., mic.	Will keep	+	36.5		8,550,000	Mic., st., rods.

Table 1 (continued)

S237	36	Cooked	35,000	13,850,000	St. in pairs and chains, mic.	Will keep	+	35
S238	37		50,000	13,950,000	St. in pairs and chains, b.c., rods.	Will keep	+	36
S239	36.5		40,000	13,700,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S240	36		46,000	23,700,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S241	37.5		449,000	10,150,000	St. in pairs and chains, b.c.	Will keep	+	37
S242	35		321,000	22,400,000	St. in pairs, rods.	Will keep	+	34
S243	35.5		4,000	42,150,000	St. in pairs, rods.	Question-able	+	34
S244	38		33,000	12,800,000	St., mic.	Will keep	+	37
S245	38		10,000	7,450,000	St. in pairs and chains, b.c., rods.	Will keep	+	37
S246	38		6,000	4,800,000	Rods, st.	Will not keep	+	35
S247	36.5		35,500	31,450,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
S248	35		12,500	34,650,000	St. in pairs and chains, b.c., mic.	Will keep	+	34
S249	37		112,000	7,450,000	St. in pairs, mic.	Will keep	+	36
S250	35	Briny	286,000	16,550,000	St. in pairs, rods, mic.	Will keep	+	3
S251	37	Coarse	83,000	17,600,000	St. in pairs, mic., rods.	Will keep	+	3

Table 1 (continued)

t. in pairs and hains, mic.	Will keep	+	35		21,850,000	St. in pairs and chains, mic., rods.
t. in pairs and hains, b.c., rods.	Will keep	+	36		7,500,000	St. in pairs and chains, rods, mic.
t. in pairs and hains, b.c., mic.	Will keep	+	36.5		12,300,000	St. in pairs and chains, yeasts, mic.
t. in pairs and hains, b.c., mic.	Will keep	+	36		16,950,000	St. in pairs and chains, mic., yeasts.
t. in pairs and hains, b.c.	Will keep	+	37		3,750,000	St. in pairs and chains, rods, yeasts.
t. in pairs, rods.	Will keep	+	34.5		6,950,000	St., rods.
t. in pairs, rods.	Question-able	+	34	Stale	19,750,000	St., mic., rods.
t., mic.	Will keep	+	37		5,850,000	St. in pairs and chains, rods, mic.
t. in pairs and hains, b.c., rods.	Will keep	+	37.5		14,950,000	Mic., rods, st.
ods, st.	Will not keep	+	35	Protein decom-position	128,550,000	Many rods, mic., st.
t. in pairs and hains, b.c., mic.	Will keep	+	36		28,800,000	St. in pairs, b.c., mic., rods.
t. in pairs and hains, b.c., mic.	Will keep	+	34.5		22,950,000	St. in pairs and chains, rods, mic.
t. in pairs, mic.	Will keep	+	36.5		7,450,000	St. in pairs, mic., yeasts, rods.
t. in pairs, rods, ic.	Will keep	+	35		34,650,000	Mic., rods, st. in pairs.
t. in pairs, mic., ods.	Will keep	+	37		7,450,000	Mic., st. in pairs.

Table 1 (continued)

S252	37		102,000	47,450,000	Rods, st.	Questionable	+	35
S253	37		37,000	7,450,000	St. in pairs and chains, h.c.	Will keep	+	36.
S254	35		48,000	19,750,000	St. in pairs and chains, h.c.	Will keep	+	35
S255	38		3,750,000	18,150,000	St. in pairs and chains, rods.	Questionable	+	36
S256	37		339,000	45,350,000	St. in pairs and chains, h.c., mic.	Will keep	+	36
S257	38		35,500	24,550,000	St. in pairs and chains, h.c., rods.	Will keep	+	37.
S258	35.5		16,000	42,650,000	Rods, mic., st.	Questionable	+	34
S259	38		10,500	5,850,000	St. in pairs and chains, mic.	Will keep	+	37
S260	36.5		223,000	32,550,000	St. in pairs and chains, rods, mic.	Questionable	+	33
S261	36.5		1,470,000	42,450,000	St. in pairs and chains, h.c., rods.	Will keep	+	35.
S262	33.5	Stale	44,000	21,250,000	Many rods, st. in pairs and chains.	Will not keep	+	32
S263	35.5		58,000	49,600,000	St. in pairs and chains, mic., rods.	Will keep	+	35
S264	38.5		128,500	5,950,000	St. in pairs and chains, rods.	Will keep	+	38
S265	38		92,000	27,750,000	St. in pairs and chains, h.c., mic.	Will keep	+	37
S266	35	Unclean	80,500	32,550,000	Many rods, st. in pairs.	Will not keep	+	33

Table 1 (continued)

›ds, st.	Question-able	+	35	Protein decom-position	43,200,000	Rods, st. in pairs, mic.
t. in pairs and ains, h.c.	Will keep	+	36.5		11,750,000	St. in pairs and chains, mic., rods.
t. in pairs and ains, h.c.	Will keep	+	35		9,600,000	St. in pairs and chains, b.c., mic.
t. in pairs and ains, rods.	Question-able	+	36	Protein decom-position	181,850,000	Many rods, st. in pairs and chains.
t. in pairs and ains, h.c., mic.	Will keep	+	36		27,750,000	St. in pairs and chains, b.c., mic.
t. in pairs and ains, h.c., rods.	Will keep	+	37.5		42,150,000	St. in pairs, mic., rods.
›ds, mic., st.	Question-able	+	34	Protein decom-position	156,000,000	Rods, mic., st. in pairs.
t. in pairs and ains, mic.	Will keep	+	37		7,450,000	Mic., st. in pairs, rods.
t. in pairs and ains, rods, mic.	Question-able	+	33	Unclean	590,950,000	Many rods, mic. in clumps, st.
t. in pairs and ains, b.c., rods.	Will keep	+	35.5		90,650,000	Mic., rods, st.
ny rods, st. in irs and chains.	Will not keep	+	32	Protein decom-position	22,400,000	Many rods, st. in pairs and chains.
t. in pairs and ains, mic., rods.	Will keep	+	35		27,750,000	St. in pairs and chains, mic., rods.
t. in pairs and ains, rods.	Will keep	+	38		4,550,000	St. in pairs and chains, mic.
t. in pairs and ains, b.c., mic.	Will keep	+	37.5		37,600,000	St. in pairs and chains, mic., yeasts.
ny rods, st. in irs.	Will not keep	+	33	Rancid	35,750,000	Many rods, mic. in clumps, yeasts.

Table 1 (continued)

S267	38.5		28,000	7,750,000	St. in pairs and chains, rods.	Will keep	↑	37
S268	34.5	Stale	32,500	57,600,000	Rods, st. in pairs and chains.	Question-able	↑	33
S269	34.5	Stale	8,000	46,950,000	Rods, st. in pairs and chains.	Question-able	↑	33
S270	35		144,000	125,350,000	St. in pairs and chains, mic.,rods.	Will keep	↑	34
S271	37		47,000	4,550,000	St. in pairs, mic., rods.	Will keep	↑	37
S272	38		29,000	4,250,000	St. in pairs, mic.	Will keep	↑	38
S273	38		31,000	6,150,000	St. in pairs and chains, mic., rods.	Will keep	↑	38
S274	38		109,000	8,550,000	Rods in clumps, mic., st. in pairs.	Will not keep	↑	35
S275	37		10,500	18,300,000	St. in pairs and chains, mic., rods.	Will keep	↑	36
S276	38		225,000	85,850,000	St. in pairs and chains, rods.	Will keep	↑	37
S277	36		211,500	101,850,000	St. in pairs and chains, rods.	Will keep	↑	35
S278	36		64,500	45,350,000	St. in pairs and chains, mic.	Will keep	↑	35
S279	38.5		137,000	11,200,000	St. in pairs, mic., rods.	Will keep	↑	37.
S280	37		251,000	9,050,000	St. in pairs and chains.	Will keep	↑	36
S281	38		202,500	12,000,000	St. in pairs and chains, mic.	Will keep	↑	37

Table 1 (continued)

, in pairs and ains, rods.	Will keep	+	37.5		7,450,000	St. in pairs and chains, mic., rods.
ls, st. in pairs l chains.	Question-able	+	33	Rancid	116,800,000	Many rods, mic. in clumps, st. in pairs.
ls, st. in pairs l chains.	Question-able	+	33	Cheesy	58,200,000	Many rods, st. in pairs.
, in pairs and ains, mic.,rods.	Will keep	+	34.5		195,750,000	St. in pairs and chains, mic., rods.
. in pairs, mic., ls.	Will keep	+	37		5,350,000	St. in pairs, mic., rods.
. in pairs, mic.	Will keep	+	38		36,250,000	Many mic., st. in pairs, rods.
. in pairs and ains, mic., rods.	Will keep	+	38		9,600,000	St. in pairs, mic., few rods.
ls in clumps, mic., . in pairs.	Will not keep	+	55	Protein decom-position	11,150,000	Rods, mic., yeasts, st. in pairs.
. in pairs and ains, mic., rods.	Will keep	+	36		24,550,000	Mic.in clumps, st., rods, yeasts.
. in pairs and ains, rods.	Will keep	+	37.5		36,800,000	St. in pairs, mic., rods.
. in pairs and ains, rods.	Will keep	+	35		54,400,000	St. in pairs, mic.
. in pairs and ains, mic.	Will keep	+	35		31,450,000	St. in pairs and chains, mic., rods.
. in pairs, mic., ls.	Will keep	+	37.5		14,950,000	St. in pairs, mic., few rods.
, in pairs and ains.	Will keep	+	36		9,600,000	St. in pairs, mic.
. in pairs and ains, mic.	Will keep	+	37		19,750,000	St. in pairs, mic.

Table 1 (continued)

S282	37		144,000	19,200,000	St. in pairs and chains, few rods.	Will keep	+	36
S283	38		307,000	9,600,000	St., mic., few rods.	Will keep	+	37
S284	36		1,000	10,150,000	Rods, st. in pairs and chains.	Will not keep	+	32
S285	37		1,260,000	30,950,000	Rods, st. in pairs and chains.	Question-able	+	35
S286	36.5		6,160,000	40,000,000	St. in pairs and chains, mic.	Will keep	+	35
S287	36.5		1,890,000	13,850,000	St. in pairs and chains.	Will keep	+	36
S288	36.5		1,750,000	19,750,000	Rods, st. in pairs and chains.	Will not keep	+	33
S289	36.5		4,430,000	8,550,000	St. in pairs and chains.	Will keep	+	35
S290	37		10,500	20,250,000	Rods, st. in pairs and chains, b.c., mic.	Will not keep	+	35
S291	37.5		39,000	10,150,000	St. in pairs and chains, b.c.	Will keep	+	36
S292	37		143,000	17,600,000	St. in pairs and chains, b.c., mic.	Will keep	+	37
S293	36		320,500	42,150,000	St. in pairs and chains, mic., rods.	Will keep	+	36
S294	37		8,000	39,450,000	St. in pairs and chains, mic., rods.	Will keep	+	36
S295	38		47,500	6,650,000	St. in pairs and chains, mic., rods.	Will keep	+	37
S296	36		335,000	26,150,000	St. in pairs and chains, mic., rods.	Will keep	+	35

Table 1 (continued)

. in pairs and ains, few rods.	Will keep	+	36.5		18,650,000	St. in pairs, mic.
., mic., few rods.	Will keep	+	37		9,050,000	Mic., st. in pairs, few rods.
ds, st. in pairs d chains.	Will not keep	+	32	Unclean	9,050,000	Rods, st. in pairs, mic.
ds, st. in pairs d chains.	Question-able	+	35	Unclean	17,600,000	Rods, st. in pairs, mic.
. in pairs and ains, mic.	Will keep	+	35.5		33,050,000	St. in pairs and chains, mic.
. in pairs and ains.	Will keep	+	36.5		16,550,000	St. in pairs, mic.
ds, st. in pairs d chains.	Will not keep	+	33	Unclean	50,150,000	Many rods, st. in pairs and chains.
. in pairs and ains.	Will keep	+	35.5		9,850,000	St. in pairs and chains.
ds, st. in pairs d chains, b.c.,mic.	Will not keep	+	35	Unclean	10,650,000	Rods, st. in pairs and chains, b.c.
. in pairs and ains, b.c.	Will keep	+	36.5		8,000,000	St. in pairs and chains, b.c.
. in pairs and ains, b.c., mic.	Will keep	+	37		18,650,000	St. in pairs and chains, mic.
. in pairs and ains, mic., rods.	Will keep	+	36		53,850,000	Mic., rods, st. in pairs and chains.
. in pairs and ains, mic., rods.	Will keep	+	36.5		33,600,000	St. in pairs and chains, rods, mic.
. in pairs and ains, mic., rods.	Will keep	+	37		13,350,000	St. in pairs and chains, rods, mic.
. in pairs and ains, mic., rods.	Will keep	+	35.5		13,850,000	St. in pairs and chains, mic.

Table 1 (continued)

S297	38		50,000	9,050,000	St. in pairs and chains, mic.	Will keep	*	38
S298	37.5		33,000	10,650,000	St. in pairs and chains, mic., rods.	Will keep	*	37
S299	37.5		45,500	9,600,000	St. in pairs and chains,	Will keep	*	37.
S300	36		252,000	19,200,000	St. in pairs and chains, mic., rods.	Will keep	*	35
S301	38		57,500	7,450,000	St. in pairs and chains, mic., rods.	Will keep	*	37.
S302	33.5	Stale	63,000	25,050,000	Many rods, mic., st. in pairs and chains.	Question-able	*	32
S303	37		4,200,000	73,300,000	St. in pairs and chains, mic., rods.	Will keep	*	36

Table 1 (continued)

in pairs and ins, mic.	Will keep	+	38		11,750,000	St. in pairs and chains, mic.
in pairs and ins, mic., rods.	Will keep	+	37		8,550,000	Mic., few st. in pairs.
in pairs and ins,	Will keep	+	37.5		18,100,000	St. in pairs and chains, few rods.
in pairs and ins, mic., rods.	Will keep	+	35		25,600,000	Mic., few st. in pairs.
in pairs and ins, mic., rods.	Will keep	+	37.5		12,250,000	St. in pairs, mic.
y rods, mic., st. pairs and chains.	Question-able	+	32	Unclean	30,400,000	Many rods, mic.
in pairs and ins, mic., rods.	Will keep	+	36		17,600,000	St. in pairs and chains, mic., rods.

COMMERCIAL UNSALTED BUTTER

Ninety-three samples of commercial unsalted butter from 13 plants in northern Iowa were studied. The results obtained are presented in table 2.

When received, the samples ranged from 34.5 to 38.5 in flavor score. Eighty-two samples had flavor scores of 37 or above, 10 samples had flavor scores ranging from 35 to 36.5 inclusive, and one sample had a flavor score of 34.5. The plate counts varied from 1,000 to 50,600,000, and the microscopic counts from 2,950,000 to 256,000,000 microorganisms per ml. The microscopic counts were always much higher than the plate counts, and there was no regular ratio between the two. The microorganisms on the slides were streptococci, micrococci, rods of various types, yeasts, and occasionally, molds. Streptococci and micrococci usually predominated. Many of the streptococci occurred in pairs and chains of varying lengths; sometimes the chains contained as many as 100 cells. The streptococci were commonly large and well-stained, and many of them were presumably butter culture types.

At the end of the holding period, 42 of the 93 samples had flavor scores of 37 or above, 25 samples had flavor scores ranging from 35 to 36.5 inclusive, and 26 samples had flavor scores

below 35. The microscopic counts varied from 3,750,000 to 763,200,000 microorganisms per ml. Eighty-two samples (89.2 per cent) had higher microscopic counts, and 11 (11.8 per cent) had lower microscopic counts at the end of the holding period than at the beginning. The organisms on the slides made at the end of the holding period were commonly similar to those on the original slides, although when considerable growth had taken place, the predominating type sometimes changed. It was common to find considerable growth, even when very little deterioration had taken place. In case growth had occurred without much deterioration, the conspicuous organisms were generally micrococci, but long chains of partly autolyzed streptococci were sometimes seen also. If deterioration had taken place, thin rods were the predominating type.

Of the 93 samples of commercial unsalted butter studied, the keeping quality was correctly predicted with 74 (79.6 per cent). Of these samples, 35 were predicted to keep, and did keep; 15 were predicted not to keep, and deteriorated; and the keeping quality was questioned with 24, and they showed deterioration. Nineteen samples (20.4 per cent) were not predicted correctly. Of these, nine (U8, U16, U20, U28, U33, U44, U55, U61, U62) were questioned, but did not develop any definite defects, eight (U26, U34, U35, U45, U50, U56, U63, U86) were predicted to deteriorate, but failed to show much reduction in flavor score, and the remaining two samples (U3, U7) were predicted to keep, but showed considerable deterioration. The plate counts were only a fair index to the keeping quality.

There were samples (for example U55 and U91) with very high plate counts that kept well, and there were other samples (for example U49, U74, and U80) with comparatively low plate counts that showed considerable deterioration.

Flavor Defects Developed in the Commercial Unsalted Butter During the Holding Period

Protein Decomposition, and Cheesiness. Twenty-four samples (25.8 per cent) of the commercial unsalted butter (U5, U12, U13, U14, U21, U27, U30, U31, U37, U39, U40, U48, U49, U51, U52, U54, U57, U59, U60, U72, U81, U83, U87, U93) developed protein decomposition, or cheesiness during the holding period.

When received, the samples which developed protein decomposition or cheesiness had flavor scores ranging from 35.5 to 38.5. The plate counts varied from 30,000 to 50,600,000, and the microscopic counts from 4,800,000 to 256,000,000 microorganisms per ml. Many rods of different types characterized some of the microscopic slides, while on other slides comparatively few rods were seen. All the samples were predicted to deteriorate.

At the end of the holding period, the samples had the following flavor scores: one sample 32, five 33, one 33.5, five 34, two 34.5, three 35, four 35.5, and three 36. The microscopic counts varied from 18,650,000 to 751,450,000 microorganisms per ml. Rods, especially thin rods, were very conspicuous on all the microscopic slides. The rods

were very often found in clumps, indicating growth.

Objectionable Flavor and Odor. Four samples (4.3 per cent) of the commercial unsalted butter (U15, U18, U74, U78) developed an objectionable flavor and odor during the holding period. The judges could not give these samples a more definite criticism due to the peculiarity of the flavor and odor developed.

When received, the samples that developed an objectionable flavor and odor had the following flavor scores: one sample 36, one 36.5, one 38, and one 38.5. The plate counts varied from 1,000 to 4,600,000 and the microscopic counts from 16,550,000 to 97,600,000 microorganisms per ml. Rods were seen on all the microscopic slides. All the samples were predicted to show deterioration.

At the end of the holding period, the samples had the following flavor scores: two samples 30, one 34, and one 35.5. The microscopic counts varied from 176,000,000 to 599,450,000 microorganisms per ml. Rods were seen on all the slides, and sometimes appeared in clumps.

Unclean. Three samples (3.2 per cent) of the commercial unsalted butter (U75, U76, U80) developed an unclean flavor during the holding period.

When received, the samples that developed an unclean flavor had the following scores: two samples 37, and one 36.5. The plate counts ranged from 45,000 to 14,350,000, and the microscopic counts from 18,650,000 to 56,550,000 microorganisms per ml. Rods were seen on all the microscopic slides. All the samples were predicted to deteriorate.

At the end of the holding period, the samples had the following

flavor scores: two samples 34, and one 34.5. The microscopic counts varied from 148,800,000 to 763,200,000 microorganisms per ml. Rods, especially thin rods, were very conspicuous on all the microscopic slides.

Fermented. Three samples (3.2 per cent) of the commercial unsalted butter (U9, U10, U19) developed a fermented flavor during the holding period.

When received, the samples which developed a fermented flavor had the following flavor scores: one sample 36.5, one 37.5, and one 38. The plate counts varied from 312,500 to 13,500,000, and the microscopic counts from 30,950,000 to 106,600,000 microorganisms per ml. Rods were seen on all the microscopic slides. All the samples were predicted to show deterioration.

At the end of the holding period, the samples had the following flavor scores: one sample 34, and two 35. The microscopic counts ranged from 53,950,000 to 533,350,000 microorganisms per ml. Rods were conspicuous on all the microscopic slides.

Other Defects. Seven samples (7.5 per cent) of the commercial unsalted butter developed the following defects during the holding period: two samples (U6, U7) rancid, two (U23, U53) stale, one (U3) tallowy, one (U32) fruity, and one (U4) fishy.

When received, these samples had flavor scores ranging from 34.5 to 38. The plate counts varied from 180,000 to 4,450,000, and the microscopic counts from 9,050,000 to 87,800,000 microorganisms per ml. Rods were conspicuous on the original microscopic slides,

except the ones made from the tallowy sample and the fishy sample, on which just a few rods were seen. Five of the seven samples were predicted to show deterioration.

At the end of the holding period, the samples had flavor scores ranging from 33 to 35. The microscopic counts varied from 30,400,000 to 666,650,000 microorganisms per ml. Rods were numerous on all the slides, except those made from the samples which became tallowy or fishy. The relatively small numbers of rods, especially thin rods, found on these two slides indicated that rods were probably not involved in the deterioration.

General Observations on the Commercial Unsalted Butter

With certain samples of the commercial unsalted butter, extensive development of microorganisms took place, and the butter still kept well. When development occurred without much deterioration in flavor score, the types of organisms present were generally micrococci, streptococci, yeasts, and occassionally a few molds. If rods were found in samples which had kept well, they were generally of a large thick type. In no case did a sample keep well when small thin rods developed conspicuously in it.

Organisms, presumably butter culture types, could be distinguished in unsalted butter by their large size, the occurrence in pairs and chains, and the deep blue color indicating that the cells were alive. It was not uncommon to find these streptococci in chains as

long as 100 cells. Long chains were not observed in salted butter. It was assumed from the appearance of these long chains that butter culture organisms can grow in unsalted butter, and this observation was confirmed by finding this morphologic type in unsalted butter churned from cream to which butter culture had been added, and not in finding it in unsalted butter churned from cream to which no butter culture had been added.

In comparing the growth in the commercial unsalted samples with salted samples, it was evident that salt had a very definite inhibiting effect on the microorganisms in butter. This was taken into consideration in making predictions. In salted butter well-stained thin rods had to be present in larger numbers than in unsalted butter in order to cause deterioration during the holding period. In unsalted butter, a very few well-stained thin rods would generally result in deterioration.

The commercial unsalted butter was not as uniform in keeping quality as the commercial salted butter, due presumably to a greater chance for the growth of organisms in the absence of salt.

Molds were seen occasionaly on the slides made after the holding period. The molds could be observed on the slides before they could be seen in the butter without magnification.

Table 2.

CHANGES IN COMMERCIAL UNSALTED BUTTER HELD AT 21

WHEN RECEIVED								
Sample	Flavor & Aroma		Microorganisms per ml.		Microflora*	Keeping Quality Prediction Made on Microflora		S
	Score	Criticism	Plate Count	Microscopic Count				
U1	36.5	Slightly moldy	535,500	20,800,000	St., b.c. in pairs and chains, yeasts, molds.	Will keep	+	3
U2	38.5		855,000	9,400,000	St. in pairs and short chains, mic.	Will keep	+	3
U3	38		1,230,000	13,750,000	St. in pairs and chains, few rods.	Will keep	-	3
U4	34.5	Moldy mealy	2,850,000	87,800,000	St. in pairs and chains b.c., mic., rods.	Questionable	+	3
U5	37.5		1,080,000	55,450,000	Rods, st. in pairs and short chains, b.c.	Questionable	+	3
U6	38		3,200,000	72,550,000	Many rods, st. in pairs and chains, b.c.	Will not keep	+	3
U7	37		1,170,000	59,200,000	St. in pairs and chains b.c., few rods.	Will keep	-	3
U8	37.5		2,390,000	98,150,000	St. in pairs and chains, b.c., rods,	Questionable	-	3
U9	37.5		312,500	30,950,000	St. in pairs and chains, b.c., few rods.	Questionable	+	3
U10	36.5	Tainted	4,921,000	74,650,000	St. in pairs and short chains, b.c., rods.	Will not keep	+	3
U11	38		3,990,000	54,200,000	St. in pairs and long chains, b.c., mic.	Will keep	+	3

* b.c. - Butter culture types. mic. - Micrococci. st. - Streptococci.

Table 2.

COMMERCIAL UNSALTED BUTTER HELD AT 21° C.

			AFTER 7 DAYS AT 21° C.			
Microflora*	Keeping Quality Prediction Made on Microflora		Flavor & Aroma		Microorganisms per ml. Microscopic Count	Microflora*
			Score	Criticism		
, b.c. in pairs and ins, yeasts, molds.	Will keep	+	36		37,850,000	Yeasts in clumps, st., b.c., molds.
in pairs and short ins, mic.	Will keep	+	36		32,450,000	St., b.c. in pairs and chains, yeasts.
in pairs and chains, rods.	Will keep	-	34	Tallowy	30,400,000	St. in pairs and chains, rods.
in pairs and chains ., mic., rods.	Questionable	+	33	Fishy	124,800,000	St. in pairs and chains, b.c., mic., rods.
s, st. in pairs and rt chains, b.c.	Questionable	+	32	Cheesy	310,950,000	Many rods, st. in pairs and chains, mic.
y rods, st. in pairs chains, b.c.	Will not keep	+	33	Rancid	373,350,000	Many rods, st. in pairs and short chains.
in pairs and chains ., few rods.	Will keep	-	35	Rancid	133,350,000	Rods, st. in pairs and chains, molds.
in pairs and chains, ., rods.	Questionable	-	36		164,450,000	St. in pairs and short chains, b.c., rods.
in pairs and chains, ., few rods.	Questionable	+	35	Fermented	53,950,000	Rods, yeasts, molds.
in pairs and short ains, b.c., rods.	Will not keep	+	34	Fermented	265,050,000	Rods, mic., yeasts.
in pairs and long ins, b.c., mic.	Will keep	+	37.5		75,750,000	St., b.c., mic., few rods.

c. - Micrococci. st. - Streptococci.

+ - Sample predicted correctly.
- - Sample not predicted correctly.

Table 2 (continued)

U12	38		647,000	52,250,000	St. in pairs and short chains, b.c., rods.	Will not keep	+	35
U13	38		2,451,000	122,650,000	St. in pairs and short chains, b.c., rods.	Question-able	+	34
U14	38		1,030,000	90,650,000	St. in pairs and chains b.c., mic., some rods.	Question-able	+	34
U15	38		4,600,000	97,600,000	Rods, St. in pairs and chains, b. c., mic.	Will not keep	+	34
U16	38		2,520,000	45,850,000	St. in pairs and chains,b.c.,mic.,rods.	Question-able	-	36
U17	38.5		4,410,000	96,550,000	St. in pairs and chains,b.c.,mic.	Will keep	+	37
U18	38.5		3,710,000	67,750,000	St. in pairs and chains,b.c.,rods.	Question-able	+	35
U19	38		13,500,000	106,600,000	St. in pairs and chains, b.c.,mic.,rods.	Question-able	+	35
U20	38		79,500	9,050,000	St. in pairs and chains,rods,mic.	Question-able	-	37
U21	37.5		17,500,000	37,350,000	Many rods, mic., st., yeasts.	Will not keep	+	34
U22	38.5		6,800,000	44,800,000	St. in pairs and chains, b.c.	Will keep	+	37
U23	36		180,000	20,250,000	St. in pairs and chains b.c., mic., rods.	Will not keep	+	34
U24	38		138,000	3,750,000	St. in pairs, mic., few rods.	Will keep	+	37
U25	37.5		20,000	2,950,000	St. in pairs, mic..	Will keep	+	37
U26	38.5		60,000	22,400,000	St. in pairs and chains b.c., mic., few rods.	Will not keep	-	37

Table 2 (continued)

in pairs and short ins, b.c., rods.	Will not keep	+	33	Protein decom-position	253,350,000	Many rods, st. in pairs and chains, yeasts
in pairs and short ins, b.c., rods.	Question-able	+	34	Protein decom-position	165,350,000	Rods, st., b. c., many yeasts.
in pairs and chains ., mic., some rods.	Question-able	+	34	Cheesy	346,650,000	Many r ods, st., b. c., yeasts.
s, in pairs and ins, b. c., mic.	Will not keep	+	34	Objection-able	373,350,000	Many rods, st., b.c., yeasts.
in pairs and ins, b.c., mic., rods.	Question-able	-	36		109,350,000	St. in pairs and chains b.c., mic., rods.
in pairs and ins, b.c., mic.	Will keep	+	37		160,000,000	St. in pairs and chains b.c., mic., yeasts, rods.
in pairs and ins, b.c., rods.	Question-able	+	35.5	Objection-able	176,000,000	Rods, st. in pairs and chains, b.c., molds.
in pairs and ins, b.c., mic., rods.	Question-able	+	35	Fermented	533,350,000	Rods, st. in pairs and chains, b.c., yeasts.
in pairs and ins, rods, mic.	Question-able	-	37		63,450,000	St., b.c., mic., rods.
y rods, mic., st., sts.	Will not keep	+	34	Cheesy	693,350,000	Many rods, st., mic.
in pairs and ins, b.c.	Will keep	+	37.5		54,400,000	St. in pairs and chains b.c., few rods.
in pairs and chains ., mic., rods.	Will not keep	+	34	Stale	666,650,000	Many rods, st., b.c., few yeasts.
in pairs, mic., rods.	Will keep	+	37.5		58,650,000	St., mic., few rods.
in pairs, mic.,	Will keep	+	37		33,600,000	St., mic., few rods.
in pairs and chains ., mic., few rods.	Will not keep	-	37.5		163,200,000	St. in pairs and chains b.c., mic., yeasts.

Table 2 (continued)

U27	36		30,000	90,650,000	Many rods in clumps, st.	Will not keep	+	33
U28	38.5		560,000	13,350,000	St. in pairs and chains, b.c.,rods,mic.	Question-able	-	38
U29	38.5		5,200,000	20,350,000	St. in pairs and chains,b.c.,mic.	Will keep	+	38
U30	38		1,175,000	39,450,000	Many rods, mic., st.	Will not keep	+	36
U31	38		3,350,000	42,650,000	St. in pairs and chains, b.c.,mic.,rods.	Question-able	+	36
U32	38		4,450,000	9,050,000	Rods, mic., few st.	Will not keep	+	34
U33	38.5		1,340,000	34,150,000	St. in pairs and chains,b.c., few rods.	Question-able	-	37
U34	38		28,350,000	150,400,000	Many rods, b.c., mic.	Will not keep	-	36
U35	38		1,540,000	26,150,000	St. in pairs and chains, mic., rods.	Will not keep	-	37
U36	37.5		910,000	65,600,000	St. in pairs and chains, b.c.,mic.,rods.	Will keep	+	37
U37	38.5		50,600,000	134,400,000	Many rods, st. in pairs, b.c., mic.	Will not keep	+	33
U38	38.5		120,000	11,450,000	St. in pairs and chains, b.c.,mic.	Will keep	+	37
U39	37.5		1,220,000	45,850,000	St. in pairs and chains,b.c.,rods,mic.	Question-able	+	35
U40	37.5		5,900,000	29,350,000	St. in pairs and chains,b.c.,mic.,rods.	Question-able	+	35
U41	38.5		50,000	18,100,000	St. in pairs and chains, b.c.,mic.,rods.	Will keep	+	38

Table 2 (continued)

y rods in clumps,	Will not keep	+	33	Cheesy	714,650,000	Many rods in clumps, yeasts, st., mic.
. in pairs and ains, b.c.,rods,mic.	Question-able	-	38		108,250,000	St. in pairs and chains,b.c.,mic.,rods.
. in pairs and ains,b.c.,mic.	Will keep	+	38		45,350,000	St. in pairs and chains, b.c.,mic.
ny rods, mic., st.	Will not keep	+	36	Protein decom-position	188,800,000	Many rods, mic., st., yeasts.
. in pairs and ains, b.c.,mic.,rods.	Question-able	+	36	Protein decom-position	174,950,000	Many rods, st., mic.
ds, mic., few st.	Will not keep	+	34	Fruity	301,350,000	Rods, mic., yeasts.
. in pairs and ains,b.c., few rods.	Question-able	-	37		80,000,000	St.,b.c., mic., yeasts.
ny rods, b.c., mic.	Will not keep	-	36		201,050,000	Many thick rods, mic., st.
. in pairs and ains, mic., rods.	Will not keep	-	37		26,650,000	Thick rods, mic., st. in pairs.
. in pairs and ains, b.c.,mic.,rods.	Will keep	+	37		153,600,000	St. in pairs and chains, mic., b.c.,rods
ny rods, st. in irs, b.c., mic.	Will not keep	+	33	Protein decom-position	220,250,000	Many rods, mic., st., b.c.
. in pairs and ains, b.c.,mic.	Will keep	+	37.5		3,750,000	St. in pairs and chains, mic., few rods.
. in pairs and ains,b.c.,rods,mic.	Question-able	+	35	Protein decom-position	65,600,000	Rods, st. in pairs and chains,b.c., mic.
. in pairs and ains,b.c.,mic.,rods.	Question-able	+	35.5	Protein decom-position	24,550,000	Rods, st. in pairs and chains,b.c.,mic.
. in pairs and ains, b.c.,mic.,rods.	Will keep	+	38		12,800,000	St. in pairs and chains,mic., rods.

Table 2 (continued)

U42	38		4,800,000	80,550,000	St. in pairs and chains, b.c.,mic.,rods.	Will keep	+	37
U43	38		330,000	53,850,000	St. in pairs and chains,b.c., few rods.	Will keep	+	38
U44	38.5		5,150,000	45,800,000	St. in pairs and chains, few clumps ,rods	Question-able	-	37
U45	38		119,000	131,200,000	St. in pairs and short chains, mic.,rods.	Will not keep	-	37
U46	38.5		270,000	24,000,000	St. in pairs and chains,b.c.,mic.,rods.	Will keep	+	38
U47	48		400,000	29,350,000	St. in pairs and chains, b.c.	Will keep	+	37
U48	38		765,000	17,050,000	St. in pairs and chains,b.c., some rods.	Question-able	+	34
U49	38		50,000	4,800,000	St. in pairs and chains,b.c.,mic.,rods.	Question-able	+	34
U50	38		3,400,000	16,550,000	St. in pairs and chains,b.c.,rods,mic.	Will not keep	-	37
U51	37.5		60,000	22,950,000	St. in pairs and chains,b.c.,rods,mic.	Question-able	+	35
U52	37		60,000	16,950,000	St. in pairs and chains,b.c.,rods,mic.	Question-able	+	34
U53	37		310,000	35,200,000	St. in pairs and chains,b.c.,rods,mic.	Question-able	+	35
U54	38		1,455,000	13,350,000	St. in pairs and chains,b.c.,rods,mic.	Question-able	+	35
U55	38		28,450,000	45,350,000	St. in pairs, rods, mic.	Question-able	-	37
U56	38.5		22,650,000	29,850,000	St. in pairs, rods, mic.	Will not keep	-	37

Table 2 (continued)

in pairs and ins, b.c.,mic.,rods.	Will keep	+	37		26,650,000	St. in pairs and chains, yeasts, rods.
in pairs and ins,b.c., few rods.	Will keep	+	38		48,000,000	St. in pairs and chains, b.c,mic.,rods.
in pairs and ins, few clumps ,rods	Question-able	-	37		96,550,000	St. in pairs, b.c., mic., few thick rods.
in pairs and rt chains, mic.,rods.	Will not keep	-	37.5		378,650,000	St. in pairs and chains, rods, mic.
in pairs and ins,b.c.,mic.,rods.	Will keep	+	38		23,450,000	St. in pairs and chains,b.c.,mic.,rods.
in pairs and ins, b.c.	Will keep	+	37		83,200,000	St. in pairs and chains,b.c.,mic.,rods.
in pairs and ins,b.c., some rods.	Question-able	+	34	Cheesy	36,800,000	Many rods, st., b.c., mic.
in pairs and ins,b.c.,mic.,rods.	Question-able	+	34.5	Cheesy	18,650,000	Many rods, st. in pairs and chains,b.c.
in pairs and ins,b.c.,rods,mic.	Will not keep	-	37		245,350,000	Many thick rods, st., mic.
in pairs and ins,b.c.,rods,mic.	Question-able	+	35	Protein decom-position	57,600,000	Many rods, st. in pairs,b.c.,yeasts,mic.
in pairs and ins,b.c.,rods,mic.	Question-able	+	34	Protein decom-position	182,950,000	Many rods,st. in pairs b.c., molds,mic.,
in pairs and ins,b.c.,rods,mic.	Question-able	+	35	Stale	245,350,000	Rods, st. in pairs and chains, mic.
in pairs and ins,b.c.,rods,mic.	Question-able	+	33	Protein decom-position	85,350,000	Many rods, st. in pairs and chains,b.c.
in pairs, rods, c.	Question-able	-	37.5		187,200,000	Many thick rods, mic.
in pairs, rods, c.	Will not keep	-	38.5		155,750,000	Many thick rods, mic.

Table 2 (continued)

U57	38		34,300,000	57,600,000	St. in pairs, rods, mic.	Will not keep	+	35
U58	38		1,080,000	38,400,000	St. in pairs and chains, b.c.,rods,mic.	Will keep	+	37
U59	37.5		370,000	6,400,000	St. in pairs and chains, b.c.,rods,mic.	Question-able	+	38
U60	35.5		72,500	10,750,000	St. in pairs and chains,b.c., rods.	Question-able	+	33
U61	38		635,000	6,400,000	Rods, mic.	Question-able	-	37
U62	38.5		1,065,000	12,800,000	Many rods, mic.	Question-able	-	37
U63	38		1,120,000	13,350,000	Many rods, molds, yeasts.	Will not keep	-	37
U64	38		1,200,000	29,850,000	St., b.c.	Will keep	+	37
U65	38		345,000	42,650,000	St. in pairs and chains, b.c.,rods.	Will keep	+	37
U66	38.5		5,350,000	32,000,000	St. in pairs and chains,mic., few rods.	Will keep	+	38
U67	38		240,000	18,650,000	St. in pairs and chains,b.c.,mic.	Will keep	+	37
U68	38		3,400,000	49,600,000	St. in pairs and chains, b.c.,mic.	Will keep	+	37
U69	38.5		275,000	19,750,000	St. in pairs and chains,b.c.	Will keep	+	37
U70	38.5		1,650,000	26,150,000	St. in pairs and chains, mic.	Will keep	+	37
U71	38		760,000	8,000,000	St., mic.	Will keep	+	37

Table 2 (continued)

, in pairs, rods, .	Will not keep	+	35.5	Protein decom-position	179,750,000	Many thin rods, mic.
, in pairs and ains, b.c.,rods,mic.	Will keep	+	37		43,200,000	St. in pairs and chains,mic.,few rods.
, in pairs and ins, b.c.,rods,mic.	Question-able	+	35.5	Cheesy	60,250,000	Many rods, st. in pairs,b.c., mic.
, in pairs and ains,b.c., rods.	Question-able	+	33.5	Protein decom-position	145,800,000	Many rods, st. in pairs and chains,b.c.
ls, mic.	Question-able	-	37.5		69,800,000	Many thick rods, mic., yeasts.
ny rods, mic.	Question-able	-	37.5		169,600,000	Many thick rods, mic.
ny rods, molds, asts.	Will not keep	-	37		107,700,000	Many thick rods, st., mic., yeasts.
., b.c.	Will keep	+	37.5		43,750,000	St. in chains, b.c., mic., yeasts, molds.
, in pairs and ains, b.c.,rods.	Will keep	+	37.5		38,850,000	St. in pairs and chains,yeasts, rods.
. in pairs and ains,mic., few rods.	Will keep	+	38		30,400,000	St. in pairs and chains,b.c., mic.,rods.
. in pairs and ains,b.c.,mic.	Will keep	+	37.5		17,600,000	St. in pairs and chains,b.c., few rods.
. in pairs and ains, b.c.,mic.	Will keep	+	37.5		48,000,000	St. in pairs and chains,b.c., mic.,rods.
t. in pairs and hains,b.c.	Will keep	+	37.5		61,350,000	St. in pairs and chains,b.c.,rods.
. in pairs and ains, mic.	Will keep	+	37		45,350,000	St., yeasts, mic., rods.
., mic.	Will keep	+	37		109,850,000	St. in pairs and chains,b.c.,mic.,rods.

Table 2 (continued)

U72	38		40,550,000	253,050,000	Many rods, mic., st.	Will not keep	+	33
U73	38		5,050,000	20,800,000	St. in pairs and chains, b.c., mic.	Will keep	+	36
U74	36		1,000	15,550,000	St. in pairs and chains, rods.	Question-able	+	30
U75	37		6,510,000	44,800,000	St. in pairs and chains, rods.	Question-able	+	34
U76	36.5		14,350,000	56,550,000	St. in pairs and chains, rods.	Question-able	+	34
U77	36.5		2,170,000	13,600,000	St. in pairs and chains.	Will keep	+	35
U78	36.5		3,080,000	22,400,000	St. in pairs and chains, rods.	Question-able	+	30
U79	36.5		3,780,000	10,650,000	St. in pairs and chains.	Will keep	+	35
U80	37		45,000	18,650,000	St. in pairs and chains, b.c., rods, mic.	Question-able	+	34
U81	37.5		58,500	13,850,000	St. in pairs and chains, b.c., rods, mic.	Will not keep	+	34
U82	38		515,000	17,600,000	St. in pairs and chains, b.c., mic., rods.	Will keep	+	37
U83	38		1,410,000	28,250,000	St. in pairs and chains, b.c., rods, mic.	Question-able	+	35
U84	37.5		11,110,000	43,200,000	St. in pairs and chains, b.c., few rods.	Will keep	+	37
U85	37.5		6,350,000	24,150,000	St. in pairs and chains, b.c., mic., rods.	Will keep	+	37
U86	38		10,700,000	18,150,000	Rods, st. in pairs.	Will not keep	-	37

Table 2 (continued)

y rods, mic., st.	Will not keep	+	33	Cheesy	605,200,000	Many rods, mic., st., yeasts.
in pairs and ins.b.c.,mic.	Will keep	+	36.5		16,550,000	St. in pairs and chains,b.c.,mic., rods.
in pairs and ins. rods.	Question-able	+	30	Objection-able	483,200,000	Many rods, mic., st.
in pairs and ins. rods.	Question-able	+	34.5	Unclean	763,200,000	Many rods, mic., st. in pairs.
in pairs and ins. rods.	Qnestion-able	+	34	Unclean	231,300,000	Many rods, mic., st. in pairs and chains.
in pairs and ins.	Will keep	+	35.5		107,850,000	St. in pairs and chains, rods.
in pairs and ins. rods.	Question-able	+	30	Objection-able	599,450,000	Many rods, mic., st. in pairs and chains.
in pairs and ins.	Will keep	+	35.5		86,950,000	St. in pairs and chains.
in pairs and ins. b.c.,rods,mic.	Question-able	+	34	Unclean	148,800,000	Many rods, st. in pairs and chains,b.c.,mic.
in pairs and ins,b.c., rods,mic.	Will not keep	+	34.5	Protein decom-position	137,600,000	Many rods, mic., st. in pairs and chains,b.c.
in pairs and ins,b.c.,mic.,rods.	Will keep	+	37.5		37,650,000	St. in pairs and chains,b.c.,mic.,rods.
in pairs and ins,b.c.,rods,mic.	Question-able	+	35	Protein decom-position	571,200,000	Many rods, mic.,yeasts, st. in pairs and chains.
in pairs and ins,b.c.,few rods.	Will keep	+	37		673,600,000	St. in pairs and chains, mic., rods.
in pairs and ains,b.c.,mic.,rods.	Will keep	+	37.5		430,400,000	St. in pairs and chains, mic.,few rods.
s, st. in pairs,	Will not keep	-	37		480,550,000	Many thick rods, mic., st. in pairs and chains.

Table 2 (continued)

U87	38		22,000,000	66,150,000	Rods, st. in pairs and chains.	Will not keep	+	3
U88	38		505,000	19,750,000	St. in pairs and chains,b.c.,few rods.	Will keep	+	3
U89	38.5		360,000	16,550,000	St. in pairs and chains,b.c.	Will keep	+	3
U90	38		5,750,000	22,950,000	St. in pairs and chains,b.c., mic.,rods	Will keep	+	3
U91	37		20,800,000	222,400,000	St. in pairs and chains, mic., rods.	Will keep	+	3
U92	38		5,150,000	23,450,000	St. in pairs and chains,mic., rods.	Will keep	+	3
U93	38		28,200,000	256,000,000	Rods, mic., st. in pairs and chains.	Will not keep	+	3

Table 2 (continued)

ls, st. in pairs and ains.	Will not keep	+	36	Protein decom-position	751,450,000	Many rods, st. in pairs and chains.
. in pairs and ains,b.c.,few rods.	Will keep	+	37		27,200,000	St. in pairs and chains,b.c.,mic.
. in pairs and ains,b.c.	Will keep	+	38		50,950,000	St. in pairs and chains, b.c., rods.
. in pairs and ains,b.c., mic.,rods	Will keep	+	36.5		42,650,000	St. in pairs and chains,mic., few rods.
. in pairs and ains, mic., rods.	Will keep	+	36.5		429,550,000	St. in pairs and chains, rods, yeasts.
. in pairs and ains,mic., rods.	Will keep	+	38		27,750,000	St. in pairs and chains,mic., rods.
ls, mic., st. in irs and chains.	Will not keep	+	35.5	Protein decom-position	294,950,000	Many rods, st. in pairs and chains,mic.

EXHIBITION BUTTER

Fifty-three samples of exhibition butter were studied. The samples were taken from the tubs exhibited at educational butter scoring contests conducted by the Dairy Industry Department, Iowa State College. Fifty-one samples were from butter plants in Iowa, and two were from plants in other states. The results obtained are presented in table 3.

When received, the samples ranged from 35 to 40 in flavor scores. Forty-four samples scored 37 or above, and the other nine samples had flavor scores ranging from 35 to 36.8 inclusive. The salt content of the samples ranged from 0.37 to 2.27 per cent. The plate counts varied from 4,000 to 21,600,000, and the microscopic counts from 2,300,000 to 209,050,000 microorganisms per ml. The microscopic counts were always much higher than the plate counts, and there was no regular relationship between the two. The microorganisms on the original microscopic slides consisted of streptococci, micrococci, rods of various types, and yeasts, with streptococci and micrococci usually predominating. The streptococci were in pairs, short and long chains, and some of the cells were large and well stained, and were presumably butter culture types.

At the end of the holding period, 24 of the 53 samples had flavor scores of 37 or above, 17 had flavor scores ranging from 35 to 36.5

inclusive, and the remaining 12 had flavor scores below 35. The microscopic counts varied from 2,150,000 to 485,350,000 microorganisms per ml. Forty-nine samples (92.5 per cent) showed higher microscopic counts and four samples (7.5 per cent) showed lower microscopic counts at the end of the holding period than at the beginning. The organisms on the microscopic slides made at the end of the holding period were very similar to those found on the original slides. The predominating types depended very largely on whether or not deterioration took place. If appreciable deterioration had taken place, the predominating types were rods, especially thin rods, while if little or no deterioration had taken place, the predominating types were streptococci, or micrococci. Very often partly autolyzed pairs and chains of streptococci, which were apparently butter culture types, were seen. It was not uncommon to see yeasts, some of them showing buds, indicating growth.

Of the 53 samples of exhibition butter studied, the keeping quality was correctly predicted with 45 (84.9 per cent). Of these, 28 samples were predicted to keep, and did keep. Nine were predicted not to keep, and deteriorated considerably, and the keeping quality of eight was questioned, and they showed deterioration. Eight samples (15.1 per cent) were not predicted correctly. Of these samples, six (E19, E28, E37, E38, E40, E52) were questioned, but kept moderately well, and two (E16, E18) were predicted to keep, but deteriorated considerably. The per cent salt in the samples that deteriorated ranged from 0.37 to 2.27.

The plate counts were only a general indication of the keeping quality of the samples. Some samples (for example, E4, E17, E31, E45) kept moderately well, even though the plate counts were high, while other samples (for example, E18, E42) showed poor keeping quality with relatively low plate counts.

Flavor Defects Developed in the Exhibition Butter During the Holding Period

Protein Decomposition and Cheesiness. Sixteen samples (30.2 per cent) of the exhibition butter (E15, E16, E18, E21, E25, E32, E33, E35, E36, E39, E41, E42, E47, E48, E50, E53) developed protein decomposition, or cheesiness during the holding period.

When received, the samples had flavor scores ranging from 36 to 40. The per cent salt varied from 0.37 to 1.96. The plate counts ranged from 34,000 to 14,700,000, and the microscopic counts from 5,580,000 to 190,950,000 microorganisms per ml. The original microscopic slides were characterized by rods of various types. Some of the slides showed only a few rods, while others showed many rods, some of which were of the thin type, and in clumps. Fourteen of the samples were predicted to deteriorate, and two (E16 and E18) were predicted to keep. These two samples showed very few rods of any type at the original examination, but apparently conditions were favorable for deterioration.

At the end of the holding period, the samples had the following flavor scores: six samples 33, one 33.5, two 34, three 35, one 35.5,

two 36, and one 37. The microscopic counts varied from 35,750,000 to 613,350,000 microorganisms per ml. The microscopic counts of the two samples which were predicted to keep, but deteriorated, were 234,650,000 and 458,650,000. Rods of various types were numerous on all the microscopic slides and thin rods were especially conspicuous and were especially conspicuous and were often seen in clumps indicating growth. Some of the microscopic slides contained molds.

Other Defects. Three samples (5.7 per cent) of the exhibition butter developed the following defects during the holding period: one sample (E13) unclean, one (E49)strong, and one (E51) stale. The flavor of the sample which was criticised as strong was such that it could not be described more definitely by the judges.

When received, these samples had the following flavor scores: two samples 36.5, and one 37. The per cent salt ranged from 0.46 to 2.27. The plate counts varied from 86,000 to 21,600,000, and the microscopic counts from 23,650,000 to 209,050,000 microorganisms per ml. Rods were seen on all the original microscopic slides, and all the samples were predicted to deteriorate.

At the end of the holding period, the samples had the following flavor scores: two samples 33, and one 35. The microscopic counts varied from 33,350,000 to 485,350,000 microorganisms per ml. Rods were very conspicuous on all the microscopic slides, and were sometimes present in clumps.

General Observations on the Exhibition Butter

Some of the samples of exhibition butter showed a pronounced development of microorganisms, and the butter still kept well. When development took place without much deterioration, the types of organisms seen on the microscopic slides made after the holding period were generally micrococci, streptococci, large thick rods, yeasts, and occasionally, molds.

Large streptococci occurring in pairs, and short and long chains were commonly observed in the exhibition butter, and were assumed to be largely butter culture types.

A larger percentage of the samples of exhibition butter developed protein decomposition, or cheesiness during the holding period than of either of the other two groups of samples studied. A possible cause of this is the practice in some butter plants of pasteurizing cream from which exhibition butter is made at a low temperature in order to retain the delicate flavor in the finished product. This low pasteurization temperature may permit a considerable number of organisms to survive the exposure, and thus seriously contaminate the butter which is made from the cream.

In one case, it was noticed that the original slides prepared from two supposedly different samples of exhibition butter were very similar when examined under the microscope. The slides attracted

attention because both showed an unusually large number of yeasts, and about the same numbers and distribution of streptococci and micrococci. Because of the similarity of the two slides, it was considered that the samples were probably duplicates. The records showed that the samples were exhibited by plants only a few miles apart, and on inspection of the samples, it was found that the flavor, texture, and color were identical. The Kohman analyses showed that the samples had the same percentage of fat, moisture, and salt. The various data indicated that the samples were duplicates.

Molds were sometimes observed on the slides made after the holding period. The molds could be seen on the slides before they could be seen in the butter without magnification.

Table 3.

CHANGES IN EXHIBITION BUTTER HELD AT 21°

Sample	WHEN RECEIVED							
	Flavor & Aroma		Per Cent Salt	Microorganisms per ml.		Microflora*	Keeping Quality	
	Score	Criticism		Plate Count	Microscopic Count		Prediction made on Microflora	S
E1	39		0.80	144,500	13,850,000	St., b.c. types in pairs, mic.	Will keep	
E2	39		1.60	30,000	16,250,000	St., b.c., types in pairs, mic.	Will keep	
E3	39		1.23	21,000	11,200,000	St., mic., few rods.	Will keep	
E4	40		0.70	1,410,000	26,650,000	St., b.c. in pairs and chains, mic.	Will keep	
E5	39.7		1.55	868,000	19,200,000	St., b.c., some mic.	Will keep	
E6	39		0.79	2,100,000	41,600,000	St., b.c. in pairs and chains, mic.	Will keep	
E7	39.3		0.82	904,000	13,350,000	St., b.c. in pairs and chains, mic.	Will keep	
E8	37		1.17	165,500	22,950,000	St., b.c., mic.	Will keep	
E9	37		1.61	186,000	43,200,000	St., b.c. in pairs and short chains.	Will keep	
E10	38	Trifle coarse & sticky	1.46	252,500	14,650,000	St., b.c. in pairs and chains, mic.	Will keep	
E11	37	Cooked	1.87	79,000	13,400,000	B.c., in pairs and short chains, mic.	Will keep	

* b.c. - Butter culture types. Mic. - Micrococci. st. - Streptococci.

Table 3.

GES IN EXHIBITION BUTTER HELD AT 21° C.

Microflora*	Keeping Quality Prediction made on Microflora		AFTER 7 DAYS AT 21° C. Flavor & Aroma Score	Criticism	Microorganisms per ml. Microscopic Count	Microflora*
St., b.c. types in pairs, mic.	Will keep	+	38		54,400,000	Mic., rods, st.
St., b.c., types in pairs, mic.	Will keep	+	37.5		133,350,000	Rods, mic., st.
St., mic., few rods.	Will keep	+	37.5		128,000,000	Rods, mic., st.
St., b.c. in pairs and chains, mic.	Will keep	+	38		33,750,000	Mic., st., few rods, few yeasts.
St., b.c., some mic.	Will keep	+	37.5		42,950,000	Mic., rods, yeasts.
St., b.c. in pairs and chains, mic.	Will keep	+	37		74,950,000	Mic., rods, st., yeasts.
St., b.c. in pairs and chains, mic.	Will keep	+	37.5		48,000,000	Mic., st., rods, yeasts.
St., b.c., mic.	Will keep	+	37		29,050,000	Mic., few st., some rods, yeasts.
St., b.c. in pairs and short chains.	Will keep	+	36.5		36,250,000	St., mic., few rods.
St., b.c. in pairs and chains, mic.	Will keep	+	36.5		34,150,000	Mic., yeasts, few rods.
B.c., in pairs and short chains, mic.	Will keep	+	36.5		4,650,000	Mic. in clumps, st. in pairs.

pcocci. st. - Streptococci. + - Sample predicted correctly.
- - Sample not predicted correctly.

Table 3. (continued)

E12	38		1.97	161,000	35,050,000	B.C. in pairs and short chains, mic.	Will keep	+	37
E13	36.5	Coarse briny burnt	2.27	86,000	23,650,000	Rods, St., in pairs and chains, b.c.,mic.	Question-able	+	35
E14	38	Wintry	1.22	292,500	29,350,000	B.C. in pairs and chains, mic.	Will keep	+	37
E15	37	Stale milky	0.49	2,870,000	148,900,000	Rods, b.c. in pairs and chains, mic.	Will not keep	+	33
E16	38.5		1.70	960,000	25,300,000	B.C. in pairs and short chains, rods.	Will keep	-	35
E17	37	Yeasty	1.35	1,080,000	12,250,000	B.C. in pairs and chains, rods, mic.	Will keep	+	36
E18	38		1.22	34,000	5,850,000	St. in pairs and chains, mic., rods.	Will keep	-	35
E19	36	Burnt coarse	1.92	304,000	26,850,000	St. in pairs and short chains, mic.	Question-able	-	35
E20	35	Metallic burnt leaky	1.08	181,500	22,400,000	St. in pairs and short chains, mic.	Will keep	+	35
E21	38	Trifle leaky	0.83	1,050,000	24,000,000	St. in pairs and chains, mic., rods.	Question-able	+	34
E22	38.3		0.46	167,500	14,400,000	St. in pairs and chains, b.c.,rods.	Will keep	+	35
E23	38		1.53	103,500	8,800,000	B.C. in pairs and chains, mic., rods.	Will keep	+	35
E24	38		1.64	30,500	4,250,000	St. in pairs and short chains, mic.	Will keep	+	35
E25	39		0.70	291,500	17,050,000	St. in pairs and short chains, rods.	Will not keep	+	38
E26	39.5		0.55	53,500	25,750,000	St., b.c.	Will keep	+	37

Table 3. (continued)

B.C. in pairs and short chains, mic.	Will keep	+	37.5		52,900,000	B.C. in pairs and chains, mic., rods.
Rods, St., in pairs and chains, b.c.,mic.	Questionable	+	35	Unclean	33,350,000	Rods, st., in pairs and chains, mic.
B.C. in pairs and chains, mic.	Will keep	+	37.5		124,000,000	Rods, mic., yeasts.
Rods, b.c. in pairs and chains, mic.	Will not keep	+	33	Cheesy	613,350,000	Rods, molds, yeasts, mic.
B.C. in pairs and short chains, rods.	Will keep	-	33.5	Cheesy	234,650,000	Rods, molds, yeasts, mic.
B.C. in pairs and chains, rods, mic.	Will keep	+	36		50,150,000	Mic., yeasts, rods.
St. in pairs and chains, mic., rods.	Will keep	-	35	Protein decomposition	458,650,000	Many rods, mic., yeasts.
St. in pairs and short chains, mic.	Questionable	-	35		52,550,000	St. in pairs and chains, mic., rods.
St. in pairs and short chains, mic.	Will keep	+	35		110,150,000	Many mic., yeasts, some rods.
St. in pairs and chains, mic., rods.	Questionable	+	34	Protein decomposition	485,350,000	Many rods, mic., molds, yeasts.
St. in pairs and chains, b.c., rods.	Will keep	+	37.5		56,000,000	Many mic., b.c., yeasts, some rods.
B.C. in pairs and chains, mic., rods.	Will keep	+	37		49,050,000	Short thick rods, mic., yeasts.
St. in pairs and short chains, mic.	Will keep	+	37		43,200,000	Mic., yeasts, few short thick rods.
St. in pairs and short chains, rods.	Will not keep	+	35	Protein decomposition	133,350,000	Many rods, mic., yeasts, st., molds.
St., b.c.	Will keep	+	37.5		45,350,000	Mic., st., yeasts, few rods.

Table 3. (continued)

E27	38		0.91	367,500	10,650,000	B.C. in pairs and chains, few rods.	Will keep	+
E28	38.6		0.96	308,500	19,750,000	Few rods in clumps, b.c. in pairs.	Question-able	-
E29	38.3	Leaky body	1.00	400,000	20,800,000	St. in pairs and chains.	Will keep	+
E30	38.5		0.70	96,000	22,150,000	St. in pairs and short chains.	Will keep	+
E31	38		0.18	1,750,000	9,800,000	St. in pairs and short chains, rods.	Will keep	+
E32	38.5		0.76	473,000	16,850,000	Rods in clumps, mic., yeasts.	Will not keep	+
E33	37	Leaky body	0.50	1,155,000	35,050,000	Rods, yeasts, b.c., mic.	Will not keep	+
E34	37	Stale	1.15	4,000	2,300,000	B.C., few rods.	Will keep	+
E35	37	Leaky body	0.50	1,870,000	41,600,000	Rods, yeasts, st. in pairs, mic.	Will not keep	+
E36	39.3		0.53	4,550,000	95,450,000	Many rods, mic., yeasts, st.	Will not keep	+
E37	36.5	Sour	0.95	280,000	44,800,000	Rods, st., mic.	Question-able	-
E38	36.8	Unclean	0.94	281,500	45,350,000	Rods, few st., mic.	Question-able	-
E39	39.7		1.67	1,400,000	43,200,000	Rods, mic., st.	Question-able	+
E40	35.3		1.75	259,000	20,250,000	Rods, mic., st.	Question-able	-
E41	37.5	Off flavor	0.65	840,000	33,600,000	Rods, mic.	Question-able	+

Table 3. (continued)

B.C. in pairs and chains, few rods.	Will keep	+	37		18,650,000	Mic., some yeasts, some rods.
Few rods in clumps, b.c. in pairs.	Question-able	-	37		160,000,000	Thick rods, mic.
St. in pairs and chains.	Will keep	+	37		320,000,000	St., yeasts, few rods.
St. in pairs and short chains.	Will keep	+	37.5		80,000,000	St. in pairs and chains, mic., rods.
St. in pairs and short chains, rods.	Will keep	+	37.5		93,750,000	Mic., few yeasts, st., few rods.
Rods in clumps, mic., yeasts.	Will not keep	+	35.5	Protein decom-position	117,550,000	Many rods, yeasts, mic., st.
Rods, yeasts, b.c., mic.	Will not keep	+	33	Cheesy	320,000,000	Many rods, mic., few st., yeasts.
B.C., few rods.	Will keep	+	37		2,150,000	St., few mic., few rods.
Rods, yeasts, st. in pairs, mic.	Will not keep	+	33	Cheesy	320,000,000	Many rods, yeasts, mic., st.
Many rods, mic., yeasts, st.	Will not keep	+	33	Protein decom-position	426,650,000	Many rods, few st., yeasts.
Rods, st., mic.	Question-able	-	35.5		122,650,000	Mic., rods, st., yeasts.
Rods, few st., mic.	Question-able	-	36		122,650,000	Mic., rods, st., yeasts.
Rods, mic., st.	Question-able	+	36.5	Protein decom-position	165,350,000	Rods, yeasts, mic.
Rods, mic., st.	Question-able	-	34.5		155,350,000	Rods, mic., st.
Rods, mic.	Question-able	+	33	Protein decom-position	346,650,000	Many rods, yeasts, mic.

Table 3. (continued)

E42	40		0.97	82,500	24,000,000	St. in pairs and chains, mic., rods.	Questionable	+
E43	39.7		0.77	19,500	16,150,000	St. in pairs and short chains, b.c.	Will keep	+
E44	39.5		1.11	965,000	41,600,000	B.C. in pairs and short chains.	Will keep	+
E45	39.3		0.55	1,410,000	17,600,000	St. in pairs and chains, mic.	Will keep	+
E46	39.3		0.58	120,000	22,950,000	St. in pairs and chains, mic.	Will keep	+
E47	38.5		1.23	255,000	12,800,000	Rods, st. in pairs and chains, mic.	Questionable.	+
E48	38		0.96	1,180,000	18,650,000	St. in pairs and chains, mic., rods.	Questionable	+
E49	37	Milky brine	0.53	12,660,000	209,050,000	Rods, mic.	Will not keep	+
E50	37	Stale	0.37	14,700,000	190,950,000	Rods, yeasts, st.	Will not keep	+
E51	36.5	Stale milky	0.46	21,600,000	185,600,000	Rods, yeasts, mic.	Will not keep	+
E52	36		1.70	154,000	26,650,000	Rods, st., mic.	Questionable	-
E53	36		1.96	990,000	19,200,000	St. in pairs and chains, mic., rods.	Questionable	+

Table 3. (continued)

0	St. in pairs and chains, mic., rods.	Question-able	+	36	Cheesy	75,200,000	Many rods, st., mic., yeasts.
0	St. in pairs and short chains, b.c.	Will keep	+	38.5		71,450,000	Mic., st., yeast.
0	B.C. in pairs and short chains.	Will keep	+	33		70,400,000	St., mic., few rods.
0	St. in pairs and chains, mic.	Will keep	+	37.5		97,050,000	Mic., st., few rods.
0	St. in pairs and chains, mic.	Will keep	+	37.5		97,600,000	Mic., st., few rods, few yeasts.
0	Rods, st. in pairs and chains, mic.	Question-able.	+	36	Cheesy	56,550,000	Rods, mic., st., yeasts.
0	St. in pairs and chains, mic., rods.	Question-able	+	35	Cheesy	80,550,000	Many rods, mic., st., few yeasts.
0	Rods, mic.	Will not keep	+	33	Strong	485,350,000	Rods, mic., st.
0	Rods, yeasts, st.	Will not keep	+	33	Protein decom-position	167,450,000	Many rods, mic., st.
0	Rods, yeasts, mic.	Will not keep	+	33	Stale	186,133,000	Rods of various types, st., yeasts.
0	Rods, st., mic.	Question-able	-	35		41,600,000	Rods, mic., st.
0	St. in pairs and chains, mic., rods.	Question-able	+	34	Cheesy	35,750,000	Rods, mic., yeasts.

THE CHANGES IN NUMBERS OF BUTTER CULTURE ORGANISMS IN BUTTER HELD AT 21° C.

The changes in the numbers of butter culture organisms in butter held at 21° C. were studied in 16 samples: eight samples were salted, and the other eight were unsalted. The samples were procured from the Department of Dairy Industry, Iowa State College, and represented commercial churnings. The cream was pasteurized in the late afternoon, about 10 per cent of butter culture added, and then held below 10° C. until the next morning, when it was churned. The butter samples were taken directly from the churn. The unsalted samples were taken immediately after the first moisture tests were made, which was after the butter had been worked a few revolutions following the draining of the wash water, and the salted samples were taken at the completion of the working process. The salted samples were, accordingly, the same as the unsalted samples, except for the salt and a higher percentage and a more even distribution of moisture.

Both plate and microscopic counts were made immediately after churning, after one day, after two days, and after seven days. In the plate counts the colonies were divided into two groups, namely, colonies that were apparently streptococci, and colonies that were apparently not streptococci. In the microscopic count, the cells were likewise divided into two groups, namely, cells that were apparently

streptococci, and cells that were apparently not streptococci. The results obtained on the salted butter are given in table 4, and those on the unsalted butter in table 5.

With the salted butter, the plate counts of the organisms producing colonies suggestive of streptococci varied from 8,500 to 449,000 per ml. immediately after churning, from 7,000 to 650,000 when the butter was one day old, from 0 to 198,500 when the butter was two days old, and from 0 to 37,000 when the butter was seven days old. On the same samples, the microscopic counts of the organisms that appeared to be streptococci varied from 5,350,000 to 17,900,000 per ml. immediately after churning, from 6,950,000 to 18,150,000 when the butter was one day old, from 3,200,000 to 14,400,000 when the butter was two days old, and from a very few to 6,950,000 when the butter was seven days old. The microscopic counts were always higher than the plate counts, and there was no definite correlation between the two. The microscopic slides made from the freshly churned butter were characterized by streptococci which were well stained and arranged in pairs and short chains. The slides made from the butter when one day old showed very few chains, and these were largely made up of partly autolyzed cells. The slides made from the butter when seven days old showed no chains, although there were a number of partly autolyzed cells that appeared to be streptococci.

In the eight trials on salted butter, the number of butter culture organisms, as determined by both the plate and the microscopic count, showed a slight increase after one day, a decrease after two days, and

a marked decrease after seven days. In the same trials, the numbers of organisms other than streptococci showed a slight increase after one day, a slight decrease after two days, and an increase after seven days.

With the unsalted butter, the plate counts of the organisms producing colonies suggestive of streptococci varied from 42,000 to 1,445,000 per ml. immediately after churning, from 900,000 to 8,200,000 when the butter was one day old, from 3,200,000 to 15,000,000 when the butter was two days old, and from a very few to 20,000,000 when the butter was seven days old. On these samples, the microscopic counts of the organisms that appeared to be streptococci ranged from 5,350,000 to 26,650,000 per ml. immediately after churning, from 16,000,000 to 53,850,000 when the butter was one day old, from 13,950,000 to 110,400,000 when the butter was two days old, and from 11,200,000 to 128,000,000 when the butter was seven days old. The microscopic counts were regularly much higher than the plate counts, and there was no definite relationship between the two. The microscopic slides made from the freshly churned butter were very similar to the original slides made from commercial unsalted butter and were characterized by streptococci, which were well stained and arranged in pairs and short chains. The slides made from the butter when one day old showed longer chains than those from the fresh butter, and the slides made from the butter when two days old showed a large number of long chains, some of which contained more than 100 cells. The slides made from the butter when seven days old showed

many streptococci in pairs and chains, and the chains usually contained some partly autolyzed cells.

In the eight trials on unsalted butter, the number of butter culture organisms, as determined by both the plate and the microscopic count, showed a large increase after one day, a further increase after two days, and another slight increase after seven days. In the same trials, the numbers of organisms other than streptococci showed an increase after one day, another increase after two days, and a further increase after seven days.

Table 4.

CHANGES IN NUMBERS OF BUTTER CULTURE ORGANISMS IN COMMERCIAL SALTE

Sample	Method of Counting	Types of Microorganisms	B	
			Immediately after churning	Afte
1	Plate	Colonies suggesting streptococci.	50,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	12,300,000	
		Cells not resembling streptococci.	1,600,000	
2	Plate	Colonies suggesting streptococci.	40,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	12,250,000	
		Cells not resembling streptococci.	1,500,000	
3	Plate	Colonies suggesting streptococci.	43,000	
		Colonies not suggesting streptococci.	3,000	
	Microscopic	Cells resembling streptococci.	17,900,000	
		Cells not resembling streptococci.	5,850,000	
4	Plate	Colonies suggesting streptococci.	449,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	10,150,000	
		Cells not resembling streptococci.	Very few	
5	Plate	Colonies suggesting streptococci.	51,000	
		Colonies not suggesting streptococci.	6,000	
	Microscopic	Cells resembling streptococci.	6,400,000	
		Cells not resembling streptococci.	1,050,000	
6	Plate	Colonies suggesting streptococci.	35,000	
		Colonies not suggesting streptococci.	13,000	
	Microscopic	Cells resembling streptococci.	14,950,000	
		Cells not resembling streptococci.	4,800,000	

Table 4.

CULTURE ORGANISMS IN COMMERCIAL SALTED BUTTER HELD AT 21° C.

sms	Bacteria per ml. of Butter			
	Immediately after churning	After one day	After two days	After seven days
cocci.	50,000	39,000	198,500	30,000
eptococci.	0	6,000	7,000	19,000
ci.	12,300,000	7,450,000	8,000,000	4,800,000
ococci.	1,600,000	1,000,000	1,600,000	2,700,000
cocci.	40,000	118,000	2,000	1,500
eptococci.	0	31,000	610,000	670,000
ci.	12,250,000	18,150,000	5,350,000	1,050,000
ococci.	1,500,000	2,650,000	2,150,000	10,150,000
cocci.	43,000	190,000	12,000	Very few
eptococci.	3,000	24,000	2,000	390,000
ci.	17,900,000	9,600,000	3,200,000	2,000,000
tococci.	5,850,000	2,650,000	4,800,000	14,950,000
cocci.	449,000	650,000	30,000	0
reptococci.	0	2,000	10,000	26,000
ci.	10,150,000	8,000,000	5,350,000	Very few
tococci.	Very few	2,150,000	1,050,000	3,750,000
cocci.	31,000	10,000	Very few	0
reptococci.	6,000	0	47,500	3,000,000
ci.	6,400,000	6,950,000	3,750,000	2,150,000
tococci.	1,050,000	1,000,000	3,200,000	8,000,000
cocci.	35,000	7,000	0	0
reptococci.	13,000	17,000	51,000	180,000
ci.	14,950,000	9,500,000	7,450,000	2,650,000
tococci.	4,800,000	3,200,000	4,800,000	6,950,000

Table 4. (continued)

7	Plate	Colonies suggesting streptococci.	8,500	
		Colonies not suggesting streptococci.	2,500	
	Microscopic	Cells resembling streptococci.	16,550,000	18
		Cells not resembling streptococci.	3,750,000	4
8	Plate	Colonies suggesting streptococci.	16,000	
		Colonies not suggesting streptococci.	23,000	
	Microscopic	Cells resembling streptococci.	5,350,000	7
		Cells not resembling streptococci.	4,800,000	2

Table 4. (continued)

cocci.	8,500	48,000	111,000	23,000
ptococci.	2,500	6,000	11,000	3,500
i.	16,550,000	18,150,000	14,400,000	6,950,000
ococci.	3,750,000	4,250,000	2,650,000	3,750,000
cocci.	16,000	93,000	71,000	37,000
ptococci.	23,000	7,000	9,000	11,000
i.	5,350,000	7,450,000	6,950,000	4,800,000
ococci.	4,800,000	2,150,000	2,650,000	3,200,000

Table 5.

CHANGES IN NUMBERS OF BUTTER CULTURE ORGANISMS IN COMMERCIAL UNSAI

Sample	Method of Counting	Types of Microorganisms	Immediately after churning	Aft
1	Plate	Colonies suggesting streptococci.	60,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	17,600,000	3
		Cells not resembling streptococci.	5,350,000	
2	Plate	Colonies suggesting streptococci.	44,000	
		Colonies not suggesting streptococci.	16,000	
	Microscopic	Cells resembling streptococci.	15,450,000	2
		Cells not resembling streptococci.	1,500,000	
3	Plate	Colonies suggesting streptococci.	310,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	26,650,000	5
		Cells not resembling streptococci.	8,550,000	
4	Plate	Colonies suggesting streptococci.	1,445,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	10,650,000	4
		Cells not resembling streptococci.	2,650,000	
5	Plate	Colonies suggesting streptococci.	340,000	
		Colonies not suggesting streptococci.	30,000	
	Microscopic	Cells resembling streptococci.	5,350,000	2
		Cells not resembling streptococci.	1,050,000	
6	Plate	Colonies suggesting streptococci.	61,500	
		Colonies not suggesting streptococci.	11,000	
	Microscopic	Cells resembling streptococci.	9,600,000	3
		Cells not resembling streptococci.	1,150,000	

Table 5.

JULTURE ORGANISMS IN COMMERCIAL UNSALTED BUTTER HELD AT 21° C.

sms	Bacteria per ml. of Butter			
	Immediately after churning	After one day	After two days	After seven days
ococci.	60,000	3,495,000	8,800,000	15,600,000
eptococci.	0	130,000	161,000	10,000,000
ci.	17,600,000	32,550,000	49,450,000	32,550,000
ococci.	5,350,000	4,800,000	7,450,000	25,050,000
ococci.	44,000	4,900,000	11,800,000	20,000,000
eptococci.	16,000	2,000,000	3,000,000	20,000,000
ci.	15,450,000	29,850,000	110,400,000	128,000,000
ococci.	1,500,000	4,250,000	19,200,000	54,950,000
ococci.	310,000	8,200,000	9,020,000	1,800,000
eptococci.	0	2,000,000	800,000	1,500,000
ci.	26,650,000	53,850,000	64,550,000	26,650,000
ococci.	8,550,000	3,750,000	4,800,000	218,650,000
ococci.	1,445,000	6,000,000	15,000,000	4,000,000
eptococci.	0	200,000	720,000	3,600,000
ci.	10,650,000	42,150,000	48,200,000	29,850,000
ococci.	2,650,000	3,100,000	11,200,000	55,450,000
ococci.	340,000	900,000	5,250,000	Very few
eptococci.	30,000	100,000	1,500,000	23,800,000
ci.	5,350,000	25,650,000	34,650,000	42,200,000
ococci.	1,050,000	3,200,000	3,300,000	17,050,000
ococci.	61,500	1,700,000	6,850,000	Very few
eptococci.	11,000	200,000	3,700,000	57,000,000
ci.	9,600,000	32,550,000	42,650,000	37,850,000
ococci.	1,150,000	6,950,000	9, 050,000	108,250,000

Table 5. (continued)

7	Plate	Colonies suggesting streptococci.	42,000	1
		Colonies not suggesting streptococci.	3,000	
	Microscopic	Cells resembling streptococci.	16,000,000	27
		Cells not resembling streptococci.	2,650,000	8
8	Plate	Colonies suggesting streptococci.	51,500	4
		Colonies not suggesting streptococci.	7,000	1
	Microscopic	Cells resembling streptococci.	10,650,000	16
		Cells not resembling streptococci.	5,200,000	7

Table 5. (continued)

ococci.	42,000	1,700,000	3,200,000	4,500,000
reptococci.	3,000	240,000	10,000,000	20,500,000
cci.	16,000,000	27,200,000	13,950,000	11,200,000
tococci.	2,650,000	8,550,000	37,850,000	137,600,000
ococci.	51,500	4,250,000	3,800,000	4,180,000
reptococci.	7,000	1,000,000	13,000,000	19,310,000
cci.	10,650,000	16,000,000	37,850,000	28,250,000
tococci.	5,200,000	7,450,000	43,200,000	109,550,000

THE CHANGES IN NUMBERS OF STREPTOCOCCUS LACTIS AND CITRIC ACID FERMENTING STREPTOCOCCI IN BUTTER HELD AT 21° C.

The changes in the numbers of Streptococcus lactis and the citric fermenting streptococci in butter were studied in 20 samples. Ten samples were salted and the other ten unsalted, but were from the same churnings.

The organisms used in the study were pure cultures of S. lactis and citric acid fermenting streptococci that had been employed in developing butter cultures. S. lactis 16 and S. lactis 65 were isolated from sour cream, and were selected because of their usefulness in developing good butter cultures when mixed with a suitable citric acid fermenter. Organism B31 was isolated from sour cream and was classified as S. paracitrovorus. It produced high volatile acidities in milk. Organisms 27 and 1 were of unknown origin, and were classified as S. citrovorus; both produced volatile acidities in milk that were fairly high.

The samples of butter were churned in a small experimental churn in the Department of Dairy Bacteriology, Iowa State College. Fresh, sweet cream was pasteurized to 65° C. for 30 minutes, cooled to 4° C., and held for two hours. The cream was then inoculated with 20 per cent of a skimmilk culture of the organism to be studied and churned immediately. After churning, the butter was washed with sterile dis-

tilled water and part of it left unsalted, while to the remainder sufficient salt was added so that the resulting butter contained about 2 per cent of salt. Both the plate and the microscopic counts were made immediately after churning, after one day, after two days, and after seven days. In counting, the colonies were divided into two groups, namely, colonies that were apparently streptococci, and colonies that were apparently not streptococci; and in the microscopic counts the cells were likewise divided into two groups, namely, cells that appeared to be streptococci, and cells that did not appear to be streptococci. The results obtained on the salted butter are given in table 6, and those on the unsalted butter in table 7.

With the salted butter, the plate counts of the organisms producing colonies that appeared to be streptococci varied from 1,260,000 to 16,240,000 per ml. immediately after churning, from 1,550,000 to 9,850,000 when the butter was one day old, from 630,000 to 12,350,000 when the butter was two days old and from a very few to 16,800,000 when the butter was seven days old. On these samples, the microscopic counts of the organisms that appeared to be streptococci varied from 4,500,000 to 46,850,000 per ml. immediately after churning, from 6,000,000 to 44,650,000 when the butter was one day old, from 4,450,000 to 41,600,000 when the butter was two days old, and from 2,650,000 to 47,450,000 when the butter was seven days old. The microscopic counts were consistently higher than the plate counts, and there was no definite relationship between the two. The slides made from the freshly churned butter showed streptococci which were well

stained and arranged in pairs and short chains; the slides made from the butter when one day old showed a few chains containing some partly autolyzed cells, and the slides made from the butter when two days old showed very few chains which were made up principally of partly autolyzed cells. Slides made from the butter when seven days old showed no chains, and a large number of partly autolyzed cells.

In the salted water, the numbers of S. lactis and citric acid fermenting streptococci, as determined by both the plate and the microscopic count, sometimes showed a slight increase when one day old, a decrease when two days old, and further decrease when seven days old. In the same trials, the organisms not suggesting streptococci showed, according to the plate count, very little development after one day, a slight development after two days, and a small additional development after seven days. While, according to the microscopic counts, they showed a slight increase after one day, another increase after two days, and a further increase after seven days.

With the unsalted butter, the plate counts of the organisms producing colonies suggestive of streptococci varied from 2,170,000 to 52,800,000 per ml. immediately after churning, from 15,500,000 to 281,111,000 when the butter was one day old, from 10,200,000 to 238,000,000 when the butter was two days old, and from 9,000,000 to 78,000,000 when the butter was seven days old. On the same samples, the microscopic counts of the organisms that appeared to be streptococci varied from 5,250,000 to 56,450,000 per ml. immediately after

churning, from 26,150,000 to 281,100,000 when the butter was one day old, from 50,650,000 to 1,666,650,000 when the butter was two days old, and from 16,350,000 to 746,650,000 when the butter was seven days old. The microscopic counts were always higher than the plate counts, and there was no regular relationship between the two. The microscopic slides made from the freshly churned butter were very similar to the original slides made from commercial unsalted butter, and contained principally streptococci, which were well stained and arranged in pairs and short chains. The slides made from the butter when one day old showed longer chains than those made from the fresh butter, while the slides made from the butter when two days old showed a great number of long chains. The slides made from the butter after seven days showed many streptococci in pairs and a few chains, some of which contained largely autolyzed cells.

In the unsalted butter, the numbers of S. lactis and citric acid fermenting streptococci as determined by both the plate and by the microscopic count, showed a large increase when one day old, a further increase when two days old, and a slight increase when seven days old. In the same trials, the organisms not suggesting streptococci, according to the plate counts showed very little development after one day, a slight development after two days, and further development after seven days, while, according to the microscopic counts, they showed a slight increase after one day, another increase after two days, and a further increase after seven days.

Table 6.

CHANGES IN NUMBERS OF STREPTOCOCCUS LACTIS AND CITRIC ACID FERMENTING STREPTOC

Sample	Method of Counting	Types of Microorganisms	Immediately after churning	Af
Not Inoculated	Plate	Colonies suggesting streptococci.	0	
		Colonies not suggesting streptococci.	500	
	Microscopic	Cells resembling streptococci.	8,000,000	
		Cells not resembling streptococci.	2,150,000	
S. lactis 16	Plate	Colonies suggesting streptococci.	1,260,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	29,850,000	
		Cells not resembling streptococci.	1,050,000	
S. lactis 65	Plate	Colonies suggesting streptococci.	6,150,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	35,750,000	
		Cells not resembling streptococci.	4,250,000	
B 31	Plate	Colonies suggesting streptococci.	1,890,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	11,750,000	
		Cells not resembling streptococci.	2,150,000	
27	Plate	Colonies suggesting streptococci.	1,750,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	18,650,000	
		Cells not resembling streptococci.	1,050,000	
1	Plate	Colonies suggesting streptococci.	4,450,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	8,000,000	
		Cells not resembling streptococci.	550,000	

Table 6.

S AND CITRIC ACID FERMENTING STREPTOCOCCI IN SALTED BUTTER HELD AT 21° C.

anisms	Bacteria per ml. of Butter			
	Immediately after churning	After one day	After two days	After seven days
ptococci.	0	0	0	0
streptococci.	500	1,000	5,000	12,000
ococci.	8,000,000	9,600,000	8,000,000	4,250,000
reptococci.	2,150,000	3,200,000	5,350,000	4,800,000
ptococci.	1,260,000	1,550,000	1,450,000	3,650,000
streptococci.	0	0	0	0
ococci.	29,850,000	14,400,000	15,450,000	17,050,000
reptococci.	1,050,000	1,600,000	2,150,000	550,000
ptococci.	6,150,000	4,950,000	8,950,000	7,700,000
streptococci.	0	0	0	0
ococci.	35,750,000	44,250,000	34,150,000	30,400,000
reptococci.	4,250,000	4,800,000	1,050,000	2,650,000
ptococci.	1,890,000	1,960,000	2,250,000	1,300,000
streptococci.	0	2,000	17,000	13,000
ococci.	11,750,000	10,150,000	9,600,000	11,200,000
reptococci.	2,150,000	3,200,000	4,800,000	5,350,000
ptococci.	1,750,000	9,350,000	12,350,000	16,800,000
streptococci.	0	0	0	0
ococci.	18,650,000	32,550,000	41,600,000	47,450,000
reptococci.	1,050,000	1,000,000	550,000	2,650,000
reptococci.	4,450,000	3,850,000	2,130,000	1,355,000
streptococci.	0	0	41,000	3,500
tococci.	8,000,000	6,950,000	4,800,000	8,250,000
treptococci.	550,000	1,300,000	1,050,000	1,600,000

Table 6. (continued)

Not Inoculated	Plate	Colonies suggesting streptococci.	0	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	Very few	
		Cells not resembling streptococci.	Very few	
S. lactis 16	Plate	Colonies suggesting streptococci.	6,160,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	21,850,000	
		Cells not resembling streptococci.	0	
S. lactis 65	Plate	Colonies suggesting streptococci.	16,240,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	46,850,000	
		Cells not resembling streptococci.	0	
B 31	Plate	Colonies suggesting streptococci.	2,100,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	4,500,000	
		Cells not resembling streptococci.	0	
27	Plate	Colonies suggesting streptococci.	3,640,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	11,650,000	
		Cells not resembling streptococci.	0	
1	Plate	Colonies suggesting streptococci.	12,450,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	45,250,000	
		Cells not resembling streptococci.	0	

Table 6. (continued)

treptococci.	0	0	0	0
ng streptococci.	0	0	0	6,000
ptococci.	Very few	Very few	Very few	Very few
streptococci.	Very few	Very few	Very few	50,000
treptococci.	6,160,000	2,380,000	630,000	Very few
ng streptococci.	0	0	125,000	18,300,000
ptococci.	21,850,000	8,550,000	5,700,000	2,650,000
streptococci.	0	Very few	4,250,000	1,050,000
treptococci.	16,240,000	6,090,000	1,520,000	Very few
ng streptococci.	0	0	480,000	1,887,000
ptococci.	46,850,000	24,000,000	9,050,000	4,650,000
streptococci.	0	0	5,850,000	7,000,000
treptococci.	2,100,000	4,281,000	1,535,000	81,000
ng streptococci.	0	29,000	150,000	1,599,000
ptococci.	4,500,000	6,000,000	4,450,000	3,450,000
streptococci.	0	Very few	2,400,000	3,450,000
treptococci.	3,640,000	4,592,000	3,290,000	290,000
ng streptococci.	0	0	310,000	2,005,000
ptococci.	11,650,000	12,150,000	11,500,000	10,350,000
streptococci.	0	0	1,500,000	23,100,000
treptococci.	12,450,000	3,990,000	3,700,000	950,000
ng streptococci.	0	21,000	300,000	4,850,000
ptococci.	45,250,000	44,650,000	35,250,000	31,500,000
streptococci.	0	800,000	1,250,000	27,900,000

Table 7.

CHANGES IN NUMBERS OF STREPTOCOCCUS LACTIS AND CITRIC ACID FERMENTING STREPTOCOCC

Sample	Method of Counting	Types of Microorganisms	Immediately after churning	Al
Not Inoculated	Plate	Colonies suggesting streptococci.	0	
		Colonies not suggesting streptococci.	500	
	Microscopic	Cells resembling streptococci.	15,450,000	
		Cells not resembling streptococci.	1,050,000	
S. lactis 16	Plate	Colonies suggesting streptococci.	6,510,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	33,900,000	
		Cells not resembling streptococci.	5,350,000	
S. lactis 65	Plate	Colonies suggesting streptococci.	14,350,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	52,800,000	
		Cells not resembling streptococci.	3,750,000	
B 31	Plate	Colonies suggesting streptococci.	2,170,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	12,000,000	
		Cells not resembling streptococci.	1,500,000	
27	Plate	Colonies suggesting streptococci.	3,080,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	20,250,000	
		Cells not resembling streptococci.	2,150,000	
1	Plate	Colonies suggesting streptococci.	3,780,000	
		Colonies not suggesting streptococci.	0	
	Microscopic	Cells resembling streptococci.	8,800,000	
		Cells not resembling streptococci.	1,850,000	

Table 7.

AND CITRIC ACID FERMENTING STREPTOCOCCI IN UNSALTED BUTTER HELD AT 21° C.

Organisms	Bacteria per ml. of Butter			
	Immediately after churning	After one day	After two days	After seven days
streptococci.	0	0	0	0
ting streptococci.	500	1,500	31,000	14,950,000
reptococci.	15,450,000	11,400,000	16,000,000	82,950,000
streptococci.	1,050,000	8,000,000	54,950,000	460,250,000
streptococci.	6,510,000	23,100,000	70,000,000	78,000,000
ting streptococci.	0	0	0	0
reptococci.	38,950,000	82,650,000	1,666,650,000	746,650,000
streptococci.	5,850,000	3,750,000	4,800,000	16,550,000
streptococci.	14,350,000	73,500,000	238,000,000	75,000,000
ting streptococci.	0	0	0	0
reptococci.	52,800,000	201,600,000	805,350,000	211,550,000
streptococci.	3,750,000	6,950,000	4,800,000	19,750,000
streptococci.	2,170,000	16,800,000	21,600,000	9,750,000
ting streptococci.	0	110,000	1,320,000	2,000,000
reptococci.	12,000,000	39,450,000	54,400,000	92,800,000
streptococci.	1,600,000	7,450,000	12,250,000	16,050,000
streptococci.	3,080,000	20,500,000	49,000,000	21,000,000
ating streptococci.	0	80,000	151,000	720,000
reptococci.	20,250,000	46,350,000	139,200,000	576,550,000
streptococci.	2,150,000	9,050,000	18,800,000	22,950,000
streptococci.	3,780,000	15,500,000	10,200,000	2,350,000
ting streptococci.	0	0	300,000	2,110,000
reptococci.	8,800,000	26,150,000	50,650,000	54,950,000
streptococci.	1,850,000	2,600,000	14,400,000	32,000,000

Table 7. (continued)

Not Inoculated	Plate	Colonies suggesting streptococci.	0
		Colonies not suggesting streptococci.	0
	Microscopic	Cells resembling streptococci.	50,000
		Cells not resembling streptococci.	950,000
S. lactis 16	Plate	Colonies suggesting streptococci.	14,700,000
		Colonies not suggesting streptococci.	0
	Microscopic	Cells resembling streptococci.	40,000,000
		Cells not resembling streptococci.	0
S. lactis 65	Plate	Colonies suggesting streptococci.	16,800,000
		Colonies not suggesting streptococci.	0
	Microscopic	Cells resembling streptococci.	50,500,000
		Cells not resembling streptococci.	0
B 31	Plate	Colonies suggesting streptococci.	2,520,000
		Colonies not suggesting streptococci.	0
	Microscopic	Cells resembling streptococci.	5,250,000
		Cells not resembling streptococci.	0
27	Plate	Colonies suggesting streptococci.	18,970,000
		Colonies not suggesting streptococci.	0
	Microscopic	Cells resembling streptococci.	50,000,000
		Cells not resembling streptococci.	0
1	Plate	Colonies suggesting streptococci.	21,000,000
		Colonies not suggesting streptococci.	0
	Microscopic	Cells resembling streptococci.	56,450,000
		Cells not resembling streptococci.	0

Table 7. (continued)

treptococci.	0	0	0	0
ng streptococci.	0	5,000	5,500	920,000
ptococci.	50,000	600,000	650,000	150,000
streptococci.	950,000	3,900,000	3,650,000	3,750,000
treptococci.	14,700,000	40,000,000	21,000,000	19,600,000
ng streptococci.	0	0	0	0
ptococci.	40,000,000	200,000,000	224,000,000	128,000,000
streptococci.	0	0	0	Very few
treptococci.	16,800,000	210,000,000	231,000,000	9,000,000
ng streptococci.	0	0	0	14,000,000
ptococci.	50,500,000	60,200,000	154,150,000	27,200,000
streptococci.	0	0	0	33,600,000
treptococci.	2,520,000	38,400,000	13,400,000	9,000,000
ng streptococci.	0	0	0	0
ptococci.	5,250,000	281,100,000	81,250,000	16,350,000
streptococci.	0	0	0	0
treptococci.	18,970,000	36,000,000	39,100,000	12,300,000
ing streptococci.	0	0	4,000,000	4,500,000
ptococci.	50,000,000	146,550,000	157,000,000	53,500,000
streptococci.	0	0	4,600,000	11,450,000
treptococci.	21,200,000	50,400,000	34,200,000	10,100,000
ing streptococci.	0	0	9,200,000	9,050,000
ptococci.	56,450,000	144,450,000	144,900,000	89,450,000
streptococci.	0	0	34,250,000	44,800,000

THE CHANGES IN NUMBERS OF MICROORGANISMS IN BUTTER HELD AT ABOUT -20° C.

The changes in the numbers of microorganisms in butter held in storage at about -20° C. were studied with 29 samples; 18 of the samples were salted, and 11 were unsalted. The samples were from various sources, and were held in storage for periods ranging from 150 to 171 days, after being held for seven days at 21° C. in the keeping quality tests. The results obtained on the salted butter are presented in table 8, and those on the unsalted butter in table 9.

When stored, the microscopic counts on the salted butter varied from 9,600,000 to 763,000,000, and at the end of the storage period from 4,250,000 to 58,650,000 microorganisms per ml. There was always a decrease in numbers of microorganisms during the storage period. The microscopic slides made at the end of the storage period were characterized by the same types of microorganisms as the slides made at the beginning, but many of the cells were partly autolyzed.

When stored, the microscopic counts on the unsalted butter ranged from 30,400,000 to 1,750,000,000, and at the end of the storage period from 16,050,000 to 219,200,000 microorganisms per ml. The same types of microorganisms were found on the microscopic slides at the end of the storage period as at the beginning, but there was a decrease in numbers, and many partly autolyzed cells were seen.

Table 8.

CHANGES IN NUMBERS OF MICROORGANISMS IN SALTED BUTTER HELD AT ABOUT -20° C.

Sample	When Stored	After Storage Period		
	Microorganisms per ml. of butter Microscopic count	Days in Storage	Microorganisms per ml. of butter Microscopic count	Microflora
101	9,600,000	154	4,250,000	Streptococci, rods.
102	182,400,000	154	19,200,000	Streptococci, rods.
103	187,200,000	154	25,050,000	Streptococci, rods.
104	763,000,000	154	24,550,000	Streptococci, micrococci, rods.
105	657,000,000	154	34,650,000	Streptococci, micrococci, rods.
106	337,000,000	154	26,150,000	Streptococci, micrococci.
107	14,400,000	170	7,450,000	Streptococci, micrococci, rods.
108	51,200,000	170	31,450,000	Streptococci, micrococci, rods.
109	20,250,000	161	6,950,000	Streptococci, micrococci, rods.
110	9,600,000	161	5,350,000	Streptococci, micrococci, rods.
111	16,000,000	161	4,250,000	Streptococci, rods.
112	47,450,000	161	46,400,000	Micrococci, streptococci, rods.

Table 8. (continued)

113	17,600,000	155	6,400,000	Streptococci, micrococci, rods.
114	137,600,000	155	58,650,000	Micrococci, streptococci, rods.
115	50,950,000	155	13,500,000	Yeasts, micrococci, rods.
116	11,200,000	150	4,250,000	Micrococci, streptococci.
117	12,800,000	150	6,950,000	Streptococci, micrococci, rods, yeasts.
118	19,200,000	150	4,550,000	Streptococci, micrococci, rods.

Table 9.

CHANGES IN NUMBERS OF MICROORGANISMS IN UNSALTED BUTTER HELD AT ABOUT -20° C.

Sample	When Stored	After Storage Period		
	Microorganisms per ml. of butter Microscopic count	Days in Storage	Microorganisms per ml. of butter Microscopic count	Microflora
201	1,440,000,000	154	27,200,000	Yeasts, mold segments, pairs suggesting streptococci
202	307,200,000	154	32,000,000	Streptococci, rods, micrococci.
203	205,000,000	154	16,050,000	Pairs suggesting streptococci, rods, micrococci.
204	1,750,000,000	154	219,200,000	Pairs suggesting streptococci, rods, yeasts.
205	930,000,000	154	54,950,000	Pairs suggesting streptococci, rods, micrococci.
206	531,000,000	154	49,050,000	Streptococci, micrococci.
207	30,400,000	170	28,250,000	Micrococci, streptococci, few rods.
208	124,800,000	170	70,400,000	Pairs suggesting streptococci, rods, micrococci, yeasts.
209	310,950,000	161	155,850,000	Rods, micrococci, streptococci.
210	153,350,000	155	29,350,000	Streptococci, micrococci, rods.
211	164,450,000	150	40,550,000	Streptococci, micrococci, rods, yeasts.

DISCUSSION OF RESULTS

The keeping quality was correctly predicted from the original microscopic slides with 292 (96.4 per cent) of 303 samples of commercial salted butter, with 74 (79.6 per cent) of 93 samples of commercial unsalted butter, and with 45 (84.9 per cent) of 53 samples of exhibition butter. Since unsalted butter deteriorates more readily than salted butter, it would be reasonable to expect that the keeping quality of unsalted butter would be more difficult to predict correctly than the keeping quality of salted butter. Due to the presence of a small amount of salt, exhibition butter should not deteriorate as readily as unsalted butter, and accordingly, it would also be reasonable to expect that the keeping quality of exhibition butter would not be as difficult to predict correctly as the keeping quality of unsalted butter.

From the results obtained, it appears that much can be learned about the keeping quality of butter by holding samples at 21° C. for seven days, and comparing, microscopically, the microflora when received with the microflora after the holding period. By observing the morphologic types of organisms present on the microscopic slide made from a sample of butter before the holding period, the keeping quality can be fairly accurately predicted. From this slide, the number of microorganisms in the butter can be estimated; a general

idea as to the quality of cream used; and whether or not butter culture was employed in the manufacture of the butter can also be obtained from it. By comparing the numbers and types of organisms found on the microscopic slide made after the holding period with the organisms found on the original slide, the increase or decrease in the numbers of organisms of the various morphologic types during the holding period can be estimated. The numbers and types of organisms on the slide will also indicate whether or not the butter was carefully made under sanitary conditions, and in case deterioration did take place, whether this deterioration was due to microorganisms, or to some other cause.

The most prevalent defects encountered after the holding period in the samples studied were protein decomposition, cheesiness, and putrid. These defects developed in 10 per cent of the commercial salted samples, 25.8 per cent of the commercial unsalted samples, and 30.2 per cent of the samples of exhibition butter. The original microscopic slides made from these samples showed the presence of small thin rods, and the microscopic slides made from the deteriorated samples revealed enormous numbers of such rods, so that there was apparently extensive growth during the holding period. The plate counts did not indicate in any way that these samples would deteriorate.

The growth of microorganisms during the holding period did not always result in deterioration. Higher microscopic counts were found after the holding period than before in 59.7 per cent of the commercial salted samples, 89.2 per cent of the commercial unsalted samples, and 92.5 per cent of the samples of exhibition butter. The type of organ-

isms which developed and predominated after the holding period seemed to be the deciding factor in whether or not deterioration took place. In no case did a sample show good keeping quality when small thin rods predominated in the microflora of the butter after the seven-day holding period. Micrococci developed readily, especially in unsalted and exhibition butter held at 21° C., but they apparently did not have any influence on the keeping quality. This would be reasonable to expect when, in general, micrococci cause changes in milk only slowly. In nearly all cases where deterioration did take place, a large increase in the numbers of microorganisms was found. This would indicate that bacteriological deterioration is more prevalent than chemical deterioration of butter under the holding conditions used in the tests.

No correlation existed between the plate counts and the keeping qualities of the butter. Some samples with low plate counts kept poorly, and some samples with high plate counts kept well. Keeping quality did not seem to be so directly related to the numbers as to the types of microorganisms present in the original butter. The colonies found on the plates did not indicate the general types of organisms responsible for deterioration of the butter.

The flavor scores of the butter when received were not correlated with the keeping quality. There were samples in the lower range of flavor scores that kept well, and others that kept poorly, and the same was true of the samples in the higher range of flavor scores. This indicated that the quality of the cream was probably not as important a factor in making butter of good keeping quality as the care exercised

and the sanitary conditions under which the butter was made.

Butter culture organisms did not develop to any extent in salted butter held at 21° C., but did develop very well in unsalted butter held at 21° C. This was indicated both by the plate and by the microscopic counts. Strains of S. lactis and citric acid fermenting streptococci used in butter culture mixtures also developed slowly, if at all, in salted butter held at 21° C., but developed very well in unsalted butter held at this temperature. It was also noted in comparing the appearance of the cells of the butter culture organisms in the salted butter with the appearance of the cells of the same culture in unsalted butter that the cells in the salted butter seemed to be shriveled, and were stained a little deeper in color. This difference was probably due to the presence of salt.

The samples of salted and unsalted butter held in storage at about — 20° C. showed a decrease in the numbers of microorganisms during the storage period. The microflora of the stored butter, as shown by the microscopic slides, appeared about the same as that of the butter before storage, but many of the cells were partly autolyzed. Growth of microorganisms would not be expected at this temperature.

SUMMARY

The keeping quality of butter was studied with 303 samples of commercial salted butter, 93 of commercial unsalted butter, and 53

of exhibition butter. The samples were received in two-ounce, sterile, glass-stoppered bottles, and scored for flavor and aroma by experienced judges on the basis of 45 points for perfect. Microscopic slides were made from the samples, and the samples were also plated on beef infusion agar, after which they were placed in an incubator and held at 21° C. for seven days. The keeping qualities of the samples were predicted by a study of the microorganisms on the slides, and the predictions made before the samples were rescored after the holding period. The types and numbers of rods present seemed to be an index to the keeping qualities. Clumps of well-stained, thin rods were almost always a sure sign of deterioration, especially in unsalted butter. It was found possible to correctly predict the keeping qualities from the types, appearance, and numbers of organisms with 96.4 per cent of the commercial salted samples, 79.6 per cent of the unsalted, and 84.9 per cent of the exhibition samples.

Protein decomposition, cheesiness, and putrid were the most common defects encountered in the samples studied; whenever these defects developed, a large number of small thin rods were present on the microscopic slides made from the butter after the holding period. Apparently, the small thin rods decomposed the protein during the time the butter was being held at 21° C.

The growth of microorganisms in butter held at 21° C. did not always result in deterioration, but when thin rods developed in the butter, deterioration almost always occurred.

The microscopic counts on the butter were always higher than the

plate counts, and there was no definite correlation between the two.

There was no apparent correlation between the plate counts of the butter and the keeping quality. Some of the samples with high plate counts kept well, and some with low plate counts deteriorated a great deal.

The original flavor score did not seem to be correlated with the keeping quality since some of the samples in all ranges of flavor scores exhibited good keeping quality.

The changes in the numbers of butter culture organisms in butter were studied, both by the plate and by the microscopic method, in eight samples of salted butter, and eight samples of unsalted butter held at 21° C. The organisms showed very little growth in the salted butter, but grew very well in the unsalted butter.

The changes in the numbers of S. lactis and citric acid fermenting streptococci were studied, both by the plate and by the microscopic method, in ten samples of salted butter, and ten samples of unsalted butter held at 21° C. The organisms showed very little growth in the salted butter, but grew very well in the unsalted butter.

Salt had a very definite inhibiting effect on the development of microorganisms in butter held at 21° C.

The changes in the numbers of microorganisms were studied microscopically in 18 samples of salted butter, and 11 samples of unsalted butter held at about — 20° C. for storage periods ranging from 150 to

171 days, after being held for seven days at 21° C. There was always a decrease in numbers of microorganisms, both in the salted and unsalted butter, during the storage period. The slides made after the storage period contained the same general types of organisms as the slides made at the beginning. Many partly autolyzed cells were seen on the slides made at the end of the storage period.

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