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To the Graduate Council:

I am submitting herewith a thesis written by J. V. Britton entitled "A Study of the Microbial Flora of Cottage Cheese Manufactured Under Plant Conditions and Stored at 5° C.". I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Dairying.

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A STUDY OF THE MICROBIAL FLORA OF COTTAGE CHEESE MANUFACTURED UNDER PLANT CONDITIONS AND STORED AT 5° C.

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

J. V. Britton

March, 1960

CRANES CREST

2L.
33

"Gather up the fragments left over,
that nothing may be lost."

John 6:12

453019

CRANES CREST

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

In 1959 enough milk and cream were used in the production of cottage cheese in the United States to fill a stream 2,000 miles long, 10 feet wide and more than 12 inches deep. The vastness of this amount of milk would be hard for one to conceive, but the growing importance of cottage cheese to the dairy industry has been readily apparent in the rapidly increasing per capita consumption--an almost steady increase from 0.6 pounds in 1910 to 5.2 pounds in 1957 (53).

Cottage cheese is a highly nutritive and wholesome food containing all of the essential amino acids in about the proper nutritive balance, plus an abundance of vitamins and minerals. It has been compared favorably to good steak in food value for humans. Cottage cheese falls into the category of a soft unripened variety containing 75 to 80 per cent moisture. High moisture, coupled with the highly nutritive nature of cottage cheese, makes it an excellent environment for the growth of many microorganisms. With increasing consumption and a demand for extended shelf life, the microorganisms which cause physical and organoleptic deterioration have become a

major concern in the production of cottage cheese.

This work includes the manufacturing data, the bacterial flora, organoleptic evaluation and the keeping quality of 64 batches of cottage cheese made over an 11 month period from September 1958 through July 1959. The microorganism counts represent that which can be duplicated or even lowered for cottage cheese made in an average plant with only the aid of reasonable care in sanitation and recommended manufacturing methods.

CHAPTER II

REVIEW OF THE LITERATURE

Cheese made from soured skimmilk probably represents the most ancient form of cheese making. Thom and Fisk (50) refer to passages from Pliny which gives the makers of Roquefort cheese reason to believe that a similar cheese was made by the ancient Romans. It is very probable then that a soft variety of cheese was made and consumed in very ancient times in an unripened state and had at least some semblance of present day cottage cheese.

Much of the commercial expansion of cottage cheese manufacture in the United States dates from 1918, when the United States Department of Agriculture promoted its manufacture and use as a means of more fully conserving skimmilk for human consumption during World War I (42). In the past two decades many articles have been published, with an increasing awareness of the importance of manufacturing high quality cottage cheese. The 1953 Milk Ordinance and Code of the United States Public Health Service included cottage cheese as a milk product, thereby making the applicable requirements of the Ordinance and Code effective. There is a provision in the 1953 Milk Ordinance and Code which allows states and communities to exempt cottage cheese from the

Grade A requirements of the Ordinance and Code, and most of them exercise this right at the present time. However, Indiana has recently recommended the techniques and standards necessary for the production of Grade A cottage cheese (9). With advancement in dairy technology, it is felt that other states and communities will follow the lead of Indiana, and Grade A cottage cheese production will be adopted throughout the United States.

Bacteriological characteristics

Organisms capable of growing at low temperatures present a major problem in cottage cheese production. Many investigators have reported organisms capable of causing deterioration of cottage cheese and other dairy products at ordinary refrigeration temperatures. Most of these organisms belong to the genera Achromobacter, Alcaligenes, Flavobacterium or Pseudomonas (4) while a few spoilage organisms are found in Aerobacter, Escherichia, Lactobacillus, Streptococcus and other genera. Schultze and Olson (47) isolated 620 psychrophilic organisms from milk, cream, chocolate drink and cottage cheese. Bonner et al. (6) isolated 17 organisms capable of growth at low temperatures from spoiled cottage cheese. It was observed that all 17 organisms were destroyed at 61.7° C. for 30 minutes. Of the 17 organisms only one survived at 48.0° C. for 15 minutes in whey at pH 4.55. It has

been observed by numerous other investigators that ordinary pasteurization temperatures destroy the organisms commonly associated with cottage cheese spoilage. In view of the foregoing information, it has been logical to assume that undesirable organisms which are responsible for spoilage in cottage cheese are post pasteurization contaminants. Angevine (2) went a step further by suggesting that most of the problem arises from post cooking contamination since most spoilage organisms do not survive a cooking temperature of 120° F. in the whey for 15 minutes at pH 4.5 to 4.7.

Parker et al. (40) isolated Alcaligenes metalcaligenes and Pseudomonas viscosa from cheese having a typical slimy curd defect. They found that these two organisms and Pseudomonas fragi caused the defect when inoculated on cottage cheese curd. Limited control of these organisms through chlorination and pH control of wash water was suggested by these authors. Davis and Babel (11) isolated 15 organisms from slimy cheese and cheesemaking equipment. These 15 organisms were identified as Proteus, Pseudomonas, Aerobacter, Alcaligenes and Achromobacter genera. Cheese was inoculated with these 15 organisms at pH 4.7°and 21°, 10° and 4.4° C. Some of them did not cause the defect at 10° C. and 4.4° C. for 14 days but all of these organisms caused a slimy defect at 21° C. Bonner et al. (6) isolated and identified organisms

from five genera of bacteria, two of yeast and three of mold from cottage cheese. Most of these organisms produced slime in cottage cheese curd which had been sterilized by cathode rays.

The most commonly cited defect of cottage cheese in the literature has been the gelatinous or slimy curd defect first described by Elliker (19) in 1949. The authors of practically all of the articles on gelatinous or slimy curd defect agree that the responsible organisms are the result of post pasteurization contamination. In the past it has been noted that a strict sanitation program in dairy plants would do much to eliminate the defect.

Temperature and pH have been studied by Collins (9) as factors in the control of gelatinous curd defect. He noted that Pseudomonas fragi, Pseudomonas viscosa, and Alcaligenes metalcaligenes caused surface spoilage at pH values as low as 4.6 and temperatures as low as 3.5° C. However, the defect was greatly retarded at this low temperature and pH.

Collins (10) reported that cultures of Pseudomonas fragi, Pseudomonas viscosa, Alcaligenes metalcaligenes, Escherichia coli and Aerobacter aerogenes were destroyed very rapidly by 3 or 5 parts per million of residual chlorine at pH 6.0, but the bactericidal efficiency of chlorine was less at pH 8.0 and greatly reduced at pH 10.0.

Mather and Babel (28) recently studied the inhibitory effects of Streptococcus citrovorus (Leuconostoc citrovorum) in a special creaming mixture on certain types of spoilage organisms. A creaming mixture containing 1.5 parts of cream of 20 per cent fat and 1.0 part of an acidified culture of Streptococcus citrovorus by weight prevented slime formation on creamed cottage cheese inoculated with Pseudomonas fragi or Pseudomonas putrefaciens.

Other investigators (40, 44, 36, 15, 4, 10, 46, 31, 23, 48, 19) have noted that undesirable organisms can enter cheese in many ways, such as wash water, improperly pasteurized milk and cream, coagulator, air, contaminated equipment and the personnel who work with the cheese and starter cultures. Many of these investigators recognized water supplies as the greatest potential for contamination of the curd. All are in accord that wash water should be chlorinated and most of them recommended a concentration of five to ten parts per million residual chlorine.

Yeasts and molds present another major problem in cottage cheese keeping quality because they are capable of growing at storage temperatures and pH ranges found in finished cottage cheese. Bonner and Harmon (4) found that Geotrichum candidum was the only one of 17 organisms studied that survived 120° F. for 15 minutes in whey at pH 4.55. Lindgren

(24) studied lethal temperatures for several strains of Mucor, Aspergillus, Penicillum, Phoma and Cladosporium isolated from cheese and butter and found that none of the strains survived 66° C. for 16 seconds. He therefore concluded that the presence of fungi in dairy products could only be due to recontamination. Marcue (26) and Harmon and Smith (20) have observed the importance of air as a source of contamination by yeasts and molds. Kester (23) recommended filtering air coming into the cheese room or using a chemical spray. Angevine (2) recommended filtered air under pressure for processing rooms and filtered and refrigerated air for packaging rooms. Olson and Ball (34) and Bonner and Harmon (5) indicated that sorbic acid was effective in controlling surface growth, including yeasts and molds on cottage cheese. Brunner and Mallman (8) found that using a one per cent solution of dihydroacetic acid and its sodium salt as a dip for cartons practically eliminated surface growth during storage. Stull (40) reported that inclusion of nordihydroguaiaretic acid and sorbic acid in the dressing will extend shelf life. The use of sorbic acid has been declared illegal by the United States Food and Drug Administration. However, some feel that in the future it should be considered as a means of extending shelf life, but not to mask poor quality.

In studies of the microbial flora of cottage cheese,

wide ranges in counts per gram have been reported. Harmon and Smith (20) observed that in 35 fresh samples secured from manufacturers coliform counts per gram of cheese ranged from 0 to 1,300, yeast and mold counts 0 to 17,000, lipolytic counts 20 to 1,800,000, proteolytic counts 0 to 1,500,000, and psychrophilic counts ranged from 20 to 2,600,000. Tuckey (52) studied 21 samples of cheese obtained from retail outlets and observed counts per gram ranging from 0 to 300,000 for coliforms, yeast and mold from 1 to 1,000,000 and psychrophilic from 18,000 to 70,000,000. Four of the 21 samples studied by Tuckey (52) had no coliforms in one gram samples and only three samples had psychrophilic counts of 30,000 or less per gram.

Morgan et al. (30 in a 1950 study of 84 samples purchased from retail outlets found coliform counts per gram of cheese ranging from less than 2 to more than 100,000, yeast counts of less than 100 to greater than 10 million, mold counts of less than 100 to more than 10 million, and 95.5 per cent of the samples caused reduction of litmus milk at 7° C. It was assumed that the litmus reduction was caused by psychrophiles.

Harmon and Smith (19) studied 17 vats of cheese and reported coliform counts of less than 1 to 210, lipolytic counts of 20 to 36,000, proteolytic counts of less than 1

to 1,500,000 and yeast and mold counts of less than 1 to 2,000 per gram of packaged cheese.

Overcast and Skean (37) in studying 27 samples of creamed cottage cheese purchased at retail outlets in Tennessee found total bacteria counts ranging from 10,600 to 600,000,000 per gram, psychrophilic counts ranging from 200 to 546,000,000 per gram, proteolytic counts ranging from 2,000 to 260,000,000 per gram, lipolytic counts ranging from less than 1 to 2,400,000 per gram, coliform counts ranging from less than 1 to 715,000 per gram and yeast and mold counts of less than 1 to 960,000 per gram on the day cheese samples were purchased. Only 5 of the 27 samples had coliform counts of less than 10 per gram.

Deane (13) in studying the microbial flora and keeping quality of packaged cottage cheese observed that poor flavor was associated with initial mold counts in excess of 100 per gram, while proteolytic and lipolytic counts in excess of 100 per gram were more closely associated with keeping quality.

Boyd (7) reported that the Spokane Health Department made a study which included one company that had coliform counts of less than one per gram of cheese on all samples except one which had only one coliform per gram. However, in the same study 22 per cent of the samples analyzed had

over 1,000 coliform organisms per gram.

Lyons and Mallmann (25) found that 78 per cent of samples studied had coliforms in excess of 220 per 100 grams of cheese and 95 per cent of all samples analyzed contained coliform organisms.

Chemical characteristics.

The composition of cottage cheese has both legal as well as economic significance to the manufacturer. The Food and Drug Administration (17) has set the legal standard at a minimum of 80 per cent moisture and 4 per cent butterfat for creamed cottage cheese.

Morgan et al. (30) in a study conducted in 1950 found that moisture content of 86.36 per cent of samples studied ranged from 75.0 to 79.9 per cent moisture. Fat content varied between 3.0 and 6.0 per cent for 88.6 per cent of the samples studied. Seventy-five per cent of the samples studied ranged from 0.60 to 0.99 per cent in total chloride content. The pH values of all samples studied ranged from 4.70 to 5.66. Tuckey (52) studied 21 retail samples and reported ranges as follows: pH 4.58 to 5.15, fat 3.3 to 12.0 per cent, total solids 17.65 to 24.98 per cent and moisture 75.02 to 82.35 per cent. Harmon et al. (22) in analyzing 82 samples of commercial creamed cottage cheese found fat content to vary from 1.69 to 7.89 per cent and total solids

varied from 14.49 to 27.06 per cent.

Overcast and Skean (37) in studying 27 retail samples of creamed cottage cheese found variation of 0.6 to 6.8 per cent butterfat, 15.4 to 23.6 per cent total solids and 0.70 to 2.21 per cent salt.

Dean and Nelson (12) studied 70 samples from 25 plants and found that butterfat, moisture and total chlorides ranged from 2.20 to 2.83, 71.60 to 81.80, and 0.32 to 1.70 per cent respectively. Olson et al. (35) concluded a need for better manufacturing methods after a study of 69 samples of cheese purchased at retail outlets showed a range of 1.27 to 8.32 per cent fat and 76.0 to 81.0 per cent moisture. Wide variations in composition reported by these and other writers indicate a need for closer composition control during manufacture.

The manufacturing process determines the composition of the cheese. It was interesting to note that factors considered important in the manufacture of cottage cheese 20 years ago were still factors which control the quality of finished cheese. Glower (18) in 1940 reported the following points as factors controlling manufacture of cottage cheese:

1. The quality of the raw milk.
2. Pasteurizing temperature.

3. The quality and amount of starter.
4. Amount of rennet enzyme used.
5. The acidity of the whey at the time the curd is cut.
6. The use of water to aid in cooking.
7. The rapidity of heating the curd.
8. Time and temperature used in cooking.
9. Temperature of wash water and number of washings.
10. Proper chilling of the curd before creaming.

All of the factors mentioned above were still basically recognized, but a few modifications had been made in the way some of them were applied when this study was made. In addition, acidification (9) and chlorination (10) of wash water have in recent years become important factors controlling quality.

Olson (33) pointed out the following factors in the manufacturing process which control quality.

1. High acid results in low quality cheese with off flavors and tough body.
2. Low solids milk results in low yields and poor quality.
3. Pasteurization above 145° F. for 30 minutes results in weak curd that shatters easily.
4. Addition of two per cent non fat dry milk solids will eliminate effects of overheated skim.

5. Fresh thoroughly ripened starters perform best.

6. Using ten per cent starter instead of five per cent gives more rapid acid development but poorer body and texture.

7. Delaying addition of rennet for one to two hours results in better body if more is used.

8. Setting temperatures below 87° F. and above 93° F. result in poor body.

9. Ordinary skim should be cut at whey acidity of 0.50 to 0.52 per cent.

   a. Low acidity--weak curd.

   b. High acidity--pasty body.

10. Fast cooking period gives better body providing acid is high at cutting.

11. Water jacketed vat is superior to addition of water for cooking.

12. Cooking should be 120° to 130° F.

Rosenberger (43) reported wide variations in practices used in cottage cheese making. He found setting temperatures varied from 70° to 90° F., the starter percentage from 0.50 to 8.0 per cent and the incubation time from 4 to 16 hours. Tretsven (51) in discussing manufacturing procedures pointed out the possibility of forming volatile materials to eliminate agitation and breaking of the curd while cooking. His suggestion was to form enough volatile material as by-products of the fermentation to lower the specific gravity just enough to hold the curd particles suspended in the whey. Convection currents would then move the curd particles around, thereby eliminating agitation. Reid (41) reported that a

large number of manufacturers preferred a cutting acidity of 0.45 to 0.50 per cent. He also found that consumers prefer curd size be kept the same from day to day and each particle should be coated smoothly with no excess cream. Emmons et al. (16) developed a simple test for determining the optimum time to cut the curd. The test was known as the A-C (Acid Coagulation Endpoint) test. By observing the point where acid coagulation takes place, the curd can be cut at the optimum time. Webb (56) recognized that one of the most important factors in securing uniformity from day to day was to have a responsible person in charge from pasteurizing the milk to packaging the cheese.

Organoleptic characteristics.

In recent years an increasing demand for a bland, milk acid, and clean flavored cottage cheese has been noted (2). High cooking temperatures have eliminated many of the starter organisms responsible for a high acid flavor, but at the same time contaminating organisms causing undesirable off flavors grow because they are not suppressed by acid produced by the starter organisms.

Wales and Harmon (55) stated that biacetyl produced during the fermentation of citric acid by Leuconostoc citrovorum and/or Leuconostoc dextranicum was primarily responsible for some of the desirable flavor and aroma in dairy products,

including cottage cheese. Acetylmethylcarbinol produced by the same fermentation scheme was readily oxidized to biacetyl. Twelve organisms capable of causing spoilage were inoculated into cheese containing 0.7 to 10.4 parts per million biacetyl and 15 to 50 parts per million acetylmethylcarbinol and stored at 40° F. for 12 days and 50° F. for 6 days. Biacetyl content of cheese inoculated with Achromobacter butyri increased during storage. The Pseudomonas organisms caused greatest decreases in biacetyl. There was no appreciable change in acetylmethylcarbinol at 40° F., but six of the organisms caused continuous decreases at 50° F.

Parker and Elliker (39) noted that cheese with a high biacetyl content tended to receive a higher flavor score than those with a low biacetyl content. Cultures of Pseudomonas viscosa and Pseudomonas fragi when added to cottage cheese destroyed the biacetyl present in 48 to 96 hours. Cultures of Alcaligenes metalcaligenes had relatively little effect on biacetyl content. Parker and Elliker (38) reported that a loss of biacetyl was accompanied by an increase in acetylmethylcarbinol. Pseudomonas fragi reduced almost all of the biacetyl to acetylmethylcarbinol while other organisms produced other substances, probably 2,3-butylene glycol. Mather and Babel (28) reported that Pseudomonas fragi and Pseudomonas

putrefaciens decreased the biacetyl content of regularly creamed cottage cheese, but did not decrease the biacetyl content of cheese creamed with a special mixture prepared with Streptococcus citrovorus (Leuconostoc citrovorum).

Sandine et al. (45) in studying excessive gas production reported that Streptococcus lactis, Streptococcus cremoris and the Leucouostoc species could be used together to achieve a combination of sufficient aroma and active acid production. Nelson and Brence (32) reported that the addition of 0.008 to 0.05 per cent citric acid to the cheese milk before inoculation tended to increase the volatile acid number sufficiently to improve the flavor of the cheese.

Young (57) found the following flavor defects in cottage cheese.

1. Those associated with the milk supply.
2. High acid.
3. Bitter flavor caused by proteolytic bacteria contamination.
4. Oxidized or metallic flavors.
5. Developed flavors which were a reflection of improper sanitation.
6. Flat or chalky flavor which was associated with the use of a poor culture.

Harmon et al. (21) in a shelf life study reported that the type of organoleptic deterioration which occurred at 42° F. was influenced by pH which varied from 4.50 to 5.28.

Surface slime was the most common defect and occurred over the entire pH range. Unclean flavors were more common in the upper pH range. Musty, yeasty and sour flavors occurred over the entire pH range. No correlation could be made between organoleptic quality and shelf life. McDaniel and Stein (29) state that acidification of wash water to pH 5.0 would be a reasonable precautionary measure. They stated that high alkaline wash water may raise the pH 0.10 to 0.15 pH units and this rise may adversely affect the keeping quality of the finished product. Marquardt (27) found that there was no relationship between the score of cheese when fresh and the rate of spoilage. Deane et al. (13) noted that microorganism counts could not be directly related to flavor, but poor flavor was more closely associated with mold counts in excess of 100 per gram of cheese as it was received. Collins (9) reported that fruitiness caused by Pseudomonas fragi was the most common defect in a shelf life study in California. Morgan et al. (30) in surveys in 1941 and 1950 reported bitter, acidy, yeasty, musty or moldy, cooked bologna (meaty), malty, fruity, sour, metallic, unnatural, and unclean flavors of varying intensities in retail cottage cheese in Connecticut.

Harmon and Smith (20) stated that yeast and mold, coliform, lipolytic, proteolytic and psychrophilic organisms

all contribute to off flavors in cottage cheese. In spoiled samples, some relationship was apparent between the predominant off flavor and type of organisms predominating in the fermentation. Unclean flavor was associated with coliform counts in excess of 1,000,000 per gram. Musty, moldy and yeasty flavors were associated with yeast and mold counts in excess of 1,000,000 per gram. Slimy surface discoloration was associated with lipolylic or proteolytic populations in excess of 10,000,000 per gram. Samples with fruity and/or fermented flavor contained yeast and mold or lipolytic bacteria in excess of 1,000,000 per gram or 10,000,000 proteolytic organisms per gram.

Marcus (26) has suggested that a standard of quality for the distribution level be made on the basis of flavor and aroma plus direct microscopic examination after incubation at 70° F. for 24, 48 and 72 hours. Overcast and Skean (37) found that high bacteria counts were associated with poor keeping quality and recommended that bacterial standards be set for cottage cheese. They stated that a total plate count of 50,000 per gram and a coliform count of less than 10 per gram would be reasonable and readily attainable under plant conditions. Studies have been made on the feasibility of using free tryptophen and/or free tyrosine values as an index to keeping quality. Harmon and Smith (20) reported

that free tryptophen values were not an accurate index to keeping quality. They also reported that studies made by Rhodes indicated free tyrosine values were not an accurate index to keeping quality. Angevine (2) suggests a second standard plate count (48 hours at 32° C.) as an index to keeping quality.

CHAPTER III

EXPERIMENTAL METHODS

Sixty-four lots of cottage cheese manufactured in the University of Tennessee Creamery over an eleven month period were analyzed bacteriologically, chemically and organoleptically.

Manufacturing procedure.

The cheese making procedure was much like that used by any dairy plant employing the short-set method. All equipment, cheese vats and packaging machinery were sanitized with a 100 to 200 parts per million chlorine solution. The raw materials used varied depending on what was available. Skimmilk was used where possible. When there was a shortage of skimmilk a dependable low heat nonfat dry milk powder was used to fortify to nine to ten per cent total solids.

Skimmilk was poured into the cheese vat from ten gallon cans. Whenever powder was used, it was dissolved by pouring the powder into a funnel on the suction side of a pump circulating milk from the vat.

Approximately five per cent starter was used in all lots of cheese. Generally the starter ranged between 0.80 and 0.90 per cent titratable acidity when added to the cheese milk. A setting temperature of 90° F. was used on all lots of cheese.

A commercial coagulator was used according to the recommendation of the manufacturer. Generally, however, 15 milliliters per 100 gallons of milk were used for small curd and 30 milliliters per 100 gallons of milk for large curd. Usually the coagulator was added after the acidity had developed at least 0.02 per cent and the time ranged from 30 to 90 minutes after the addition of the starter.

The setting period ranged between four and one-half and five hours. Cutting time was determined by titrating to a faint pink a nine milliliter sample of clear whey with one-tenth normal sodium hydroxide using phenolphthalein as an indicator. A base of 0.52 per cent titratable acidity (3) was used for milk with a total solids content of 9.0 per cent and 0.02 per cent change in titratable acidity for each one-half per cent solids above or below 9.0 per cent. However, close examination of Table II indicated that this schedule was not adhered to in all cases. Approximately the first two-thirds of the lots were cut with five-eighths inch curd knives while the remainder were cut with three-eighths inch knives. The curd was allowed to stand 20 minutes after cutting before the beginning of the cooking period.

The cooking procedure followed the fairly rigid schedule outlined below.

1. Turn on steam and raise water jacket temperature to 100° F. (no stirring) and hold 15 minutes.

2. Raise water jacket temperature to 120° F. and hold for 15 minutes. Stir occasionally during this period.

3. Raise water jacket temperature to 130° F. and hold for 15 minutes. Stir gently until temperature in the vat reaches 100° F., then stir more vigorously to prevent matting of curd.

4. Raise water jacket temperature to 140° F. and hold for 15 minutes or as long as it takes to reach the final cooking temperature, usually 125 to 128° F. Stir during this period.

The cooking temperature was reached in 60 to 75 minutes and was held 25 minutes before draining. However, a few lots required a somewhat higher temperature in order to cook curd to the desired firmness. Curd was checked for proper cooking by breaking open representative particles and by putting some of the curd in 60° to 65° F. water for one minute and then checking it for firmness.

The curd was washed with three waters. Only part of the whey was drained in order to adjust the temperature of the first wash water at time of draining to around 85° F. Similarly, only part of the first wash water was drained. The second and third wash waters were drained completely. The last two wash waters were cooled to 35° to 38° F. All wash water was acidified to pH 5.0 and 6.0 and chlorinated at the rate of 6 to 8 parts per million residual chlorine. The pH of several of the earlier samples was allowed to drop slightly below pH 5.0 while only three cases were recorded where pH rose above 6.0. Temperature of the curd was lowered

to around 85° F. with the first wash water, as close to 60° F. as possible with the second wash water and between 40° and 45° F. with the last wash water. The curd was allowed to drain 15 to 25 minutes in some of the earlier samples, but the time was extended to 40 to 50 minutes later in the study.

The curd was weighed into a creaming vat where it was creamed and salted at the rate of 24 pounds of cream and 1 pound of salt per 100 pounds of curd.

Bulk cheese utilized by University facilities was stored in cans holding 20 pounds each. A cylinder type packaging machine was used in filling 12 ounce cartons for retail and wholesale outlets.

Cheese was stored in a refrigerated room maintained at 40° F. or lower until time of distribution.

All manufacturing and bacteriological data were recorded on a cottage cheese manufacturing report designed for this study. A reproduction of the manufacturing report with all data recorded on it is included in Appendix A.

Preparation of sample for analysis.

A Virtis "45" Homogenizer manufactured by The Virtis Company, Inc., Gardiner, New York was used in preparing samples for analysis. The machine consists of a sharp cutting blade on the end of a shaft which rotates at a high

speed. Samples prepared with the equipment described had a creamy consistency with no large unbroken curd particles. The following procedure was used.

1. Weigh out 20 grams of cheese in a sterile glass 100 milliliter Virtis homogenizer flask.
2. Add 20 milliliters of sterile buffered water (1.25 milliliters stock phosphate buffer per liter as recommended by "Standard Methods for the Examination of Dairy Products") (1).
3. Stir on Virtis homogenizer at setting of 80 for one minute (maximum revolutions per minute 45,000 at setting of 100).
4. Let set for one minute and then stir again for 30 seconds.
5. Remove the flask from homogenizer and the samples was ready for plating or analysis.

All parts of the homogenizer coming in contact with cheese were sanitized by boiling. The flask cover which could not be boiled was chlorinated with 200 to 300 parts per million chlorine solution. The flask cover did not come in contact with the sample.

Microbiological examination.

Total bacteria, psychrophilic, coliform and yeast and mold plate counts were determined for 0, 7 and 11 days of storage at 5° C. Table I outlines the incubation temperature and time and media used in the bacteriological determinations.

Samples were prepared for plating as explained in the previous section. Counts had to be doubled because the sample

contained 50 per cent water. Samples were plated at dilutions 1 to 10, 1 to 100 and 1 to 1,000 for total plate and psychrophilic counts, 1 milliliter of sample and 1 to 10 dilution for coliform counts and 1 milliliter of sample, 1 to 10 and 1 to 100 dilutions for yeast and mold counts.

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TABLE I

INCUBATION TEMPERATURE, TIME AND MEDIA USED IN BACTERIOLOGICAL DETERMINATIONS

Type Count	Media	Incubation Temperature °C	Incubation Time
Total plate count	Milk Protein Hydrolysate agar	32	48 hr ± 3
Psychrophilic count	Milk Protein Hydrolysate agar	5	7 days
Coliform count	Violet Red Bile agar	35	20-24 hrs.
Yeast and Mold count	Potato Dextrose agar	21	5 days

Samples having excessively high counts at zero and/or seven days of storage were plated at higher dilutions on the next plating series. A Quebec Colony Counter, Darkfield Model, was used in making all counts except yeast and mold. Yeast and mold counts were made without the aid of a colony counter.

Chemical analysis.

Composition analysis included butterfat, total chlorides, pH and moisture.

Butterfat determinations were made by a modified Babcock method. Clear fat columns were obtained by using an 18 gram sample and approximately 18 milliliters of commercial sulphuric acid in an 18 gram milk test bottle. The sample was shaken periodically as the acid was added. It was then placed in a heated centrifuge for five minutes. Hot water of 140° F, or above was added to the base of the neck and the sample was centrifuged for two minutes. The fat column was brought into the graduated neck of the bottle by the addition of water and the sample was centrifuged for one minute. The per cent butterfat was read by use of dividers and recorded on the cottage cheese manufacturing report (see Appendix A). Fat tests obtained by this method were doubled because one-half of the sample was distilled water as explained previously in the section on preparation of sample for analysis.

Total chlorides were determined by the silver nitrate method used by Harmon et al. (22). Twenty grams of a sample

prepared as explained previously, were made up to 250 milliliters, using water at 180° F. Curd was removed by filtering. Twenty-five milliliter portions were then titrated with a 0.1711 normal solution of silver nitrate using one milliliter of 2 per cent potassium chromate solution as an indicator. Results were recorded as per cent total chlorides.

A Beckman Model M glass electrode pH meter was used to make all pH determinations on the cheese. The sample was placed in a clean, dry 50 milliliter beaker and crushed with a glass stirring rod until a smooth mixture was obtained. The pH meter was standardized and checked against a buffer solution of pH 7.0 at room temperature for each series of determinations. The pH was determined for 0, 7, and 11 days of storage on all samples.

A Cenco moisture tester, manufactured by Central Scientific Company, Chicago, Illinois, was used to determine the moisture content. This piece of equipment employs a sensitive torsion balance for weighing the sample and an infrared lamp for drying it. The machine was a large drum with a scale graduated from 1 to 100 per cent with divisions of 0.02 per cent inscribed on it. Readings can be estimated to 0.01 per cent. The machine was checked periodically for accuracy using a sample of distilled water. In all cases distilled water checked 100 per cent moisture. The samples, prepared as previously explained, contained 50 per cent buf-

fered (1.25 milliliters of stock phosphate buffer per liter) distilled water. Therefore, in order to obtain the correct moisture content the solids content for the sample had to be doubled and then subtracted from 100 per cent.

Organoleptic examination.

One 12 ounce package from each lot was examined organoleptically after 1, 8, 11 and 15 days of storage at 5° C. A portion of the cheese was removed aseptically from the package with a flamed spatula on each of the four days for judging. Scoring was done by two experienced judges.

The score card recommended by the Cottage Cheese Score Card Committee of the American Dairy Science Association, June, 1957, was used as a guide in scoring and for recording scores. Appendix B includes a reproduction of the score card with the data from an actual sample recorded on it. Also included in Appendix B is a glossary of terms which was used in scoring.

CHAPTER IV

RESULTS AND DISCUSSION

The objective of this study was to gather data from which bacterial standards for cottage cheese could be suggested. It was possible to make some very positive statements regarding coliform organisms in cottage cheese. Total bacteria counts for the 64 samples of cottage cheese examined in this study indicated that it was possible to control total bacteria counts within certain limits for fresh creamed cottage cheese. A variety of information gathered over an 11 month period has been discussed herein under the headings of manufacturing, bacteriological, chemical and organoleptic data. A plant striving to attain and/or maintain low bacteria counts for cottage cheese must pay close attention to all facets of its operations.

Manufacturing data.

The data presented in Table II from manufacturing reports outline the detailed procedure used during the manufacturing process for the 64 lots studied. Basically, the procedure which was used in the University Creamery at the time this study began was adopted. However, a few procedures were changed as the study progressed.

All lots of cheese were made from fresh skim milk, a

TABLE II

MANUFACTURING DATA FOR 64 LOTS OF COTTAGE CHEESE

Sample number	Per cent solids	Minerals (ml.)	Acidity skim	Acidity starter	Acidity skim & starter	Acidity at coagulator addition	Acidity cut	Cooking time * (minutes)	Cooking T.** (°F.)	pH 1st wash water	pH 2nd & 3rd wash waters	Drain time***	Curd T. at packaging (°F.)	Per cent yield
1	9.98	-	0.15	0.88	0.21	0.26	0.54	85	121	-	-	15	50	20.1
2	9.46	-	.15	.90	.21	.24	.53	94	128	-	-	15	48	17.3
3	9.69	-	.15	.89	.22	.24	.53	88	127	6.85	5.85	20	48	17.5
4	9.13	-	.16	.85	.21	.23	.52	90	125	5.15	5.10	20	45	18.6
5	9.54	-	.16	.90	.21	.24	.53	105	134	5.00	5.00	15	45	18.5
6	9.0	-	.15	.85	.19	.21	.51	118	135	5.15	5.10	25	48	17.1
7	9.69	-	.15	.87	.21	.23	.55	85	123	4.93	4.90	20	48	17.1
8	9.0	-	.16	.91	.21	.23	.51	85	123	5.10	5.08	15	50	18.1
9	9.48	-	.16	.84	.22	.24	.53	85	122	5.00	5.10	15	48	19.7
10	9.0	-	.16	.90	.20	.22	.52	90	124	4.80	5.04	15	49	17.8
11	10.2	-	.16	.90	.21	.23	.57	97	132	4.91	4.75	20	47	20.6
12	9.0	20	0.15	0.86	0.19	0.21	0.52	85	124	5.08	5.10	20	44	17.6

TABLE II (continued)

Sample number	Per cent solids	Minerals (ml.)	Acidity skim	Acidity starter	Acidity skim & starter	Acidity at coagulator addition	Acidity cut	Cooking time* (minutes)	Cooking T.** (°F.)	pH 1st wash water	pH 2nd & 3rd wash waters	Drain time***	Curd T. at packaging (°F.)	Per cent yield
13	9.0	-	0.15	0.88	0.20	0.22	0.52	91	126	5.05	5.20	15	48	18.9
14	9.0	-	.16	.90	.20	.22	.52	87	126	5.00	4.93	35	48	16.6
15	9.0	-	.17	.92	.21	.23	.52	90	126	5.20	5.35	25	45	18.2
16	9.39	-	.16	.92	.22	.23	.52	93	126	5.00	4.98	25	50	18.6
17	9.70	-	.15	.91	.21	.23	.53	100	128	4.89	4.89	25	50	18.9
18	9.71	-	.15	.90	.20	.22	.53	115	130	4.75	4.67	25	50	19.5
19	9.35	-	.15	.88	.20	.21	.52	105	127	4.80	4.70	20	50	18.6
20	9.0	-	.15	.92	.18	.20	.52	100	127	4.83	4.80	20	50	18.5
21	9.0	-	.16	.90	.18	.20	.51	105	129	4.78	4.68	25	48	17.1
22	10.2	-	.15	.91	.21	.22	.54	98	128	5.35	5.32	25	51	19.6
23	9.0	-	.16	.91	.19	.21	.54	105	130	4.50	4.46	25	48	18.7
24	9.0	-	.15	.89	.18	.19	.51	107	127	4.60	4.60	15	47	17.7
25	9.0	-	.15	.87	.18	.20	.52	102	128	5.00	5.02	20	50	19.2
26	9.0	-	.15	.91	.18	.20	.51	105	126	4.59	4.51	25	50	17.3
27	10.4	-	.15	.88	.18	.20	.54	105	128	5.25	4.95	20	46	20.5
28	9.0	-	.15	.91	.19	.20	.52	103	126	5.23	4.91	20	48	18.0
29	9.0	-	.15	.91	.19	.20	.51	106	128	4.85	4.81	20	51	18.1
30	9.0	-	.15	.93	.18	.20	.52	107	128	4.89	4.82	15	50	18.8
31	10.2	60	.16	.90	.21	.23	.56	105	126	5.00	4.94	25	51	19.2
32	9.0	30	.15	.91	.18	.20	.51	106	126	5.42	5.55	15	47	17.6
33	9.0	30	.15	.91	.19	.20	.52	123	134	4.95	4.90	25	50	16.0
34	9.0	60	.15	.90	.19	.20	.50	93	126	5.52	5.92	25	48	17.5
35	10.2	60	.15	.89	.18	.21	.55	110	126	5.42	5.30	15	45	19.9
36	9.0	60	.15	.93	.18	.20	.52	135	136	5.08	4.95	35	49	17.3
37	6.9	98	.16	.85	.19	.25	.52	85	124	7.35	6.00	55	42	-
38	12.3	98	.18	.85	.22	.25	.59	100	132	7.35	6.00	20	45	-
39	9.0	45	.15	.84	.19	.26	.52	110	138	5.95	6.00	35	45	20.7
40	10.3	63	.15	.90	.21	.23	.53	100	125	5.68	5.59	25	47	17.7
41	10.4	51	.15	.90	.21	.28	.56	100	126	5.00	4.88	30	49	18.1
42	10.0	120	.17	.95	.21	.28	.55	102	128	5.00	5.00	50	50	17.8
43	9.35	-	.15	.89	.19	.21	.51	105	128	5.50	5.50	40	49	16.9
44	10.2	63	0.15	0.91	0.21	0.28	0.54	105	130	5.00	5.00	45	46	18.0

TABLE II (continued)

Sample number	Per cent solids	Minerals (ml.)	Acidity skim	Acidity starter	Acidity skim & starter	Acidity at coagulator addition	Acidity cut	Cooking time* (minutes)	Cooking T.** (°F.)	pH 1st wash water	pH 2nd & 3rd wash waters	Drain time***	Curd T. at packaging (°F.)	Per cent yield
45	10.0	60	0.15	0.90	0.20	0.28	0.55	97	128	5.50	5.50	45	49	17.7
46	9.0	70	.15	.54	.18	.24	.51	110	134	5.00	5.50	40	47	15.7
47	9.72	36	.15	.96	.23	.30	.55	105	130	5.00	5.00	50	47	18.1
48	10.4	60	.15	.86	.21	.28	.56	105	130	5.00	5.00	45	44	19.7
49	9.0	-	.15	.89	.18	-	.55	90	134	5.00	5.00	25	47	17.2
50	9.83	-	.15	.93	.20	.27	.53	100	128	5.00	5.00	40	49	18.4
51	9.0	-	.15	.90	.18	.24	.53	95	130	5.00	5.00	25	50	17.3
52	9.0	-	.15	.93	.18	.18	.50	90	128	5.00	5.00	45	50	15.2
53	9.0	-	.16	.93	.19	.27	.51	85	128	5.00	5.50	40	48	15.8
54	9.0	-	.16	.85	.18	.22	.53	95	130	4.50	5.00	35	50	15.7
55	9.0	180	.16	.89	.19	.29	.50	95	128	5.00	5.00	60	48	16.1
56	10.6	150	.16	.90	.20	.26	.52	85	127	5.00	5.00	30	50	16.5
57	9.0	180	.15	.95	.18	.20	.50	85	127	5.00	5.00	40	49	15.6
58	9.0	120	.15	.90	.18	.19	.51	85	129	5.00	5.00	35	49	15.0
59	9.0	180	.15	.94	.18	.20	.51	85	128	5.00	5.50	35	50	15.7
60	9.08	180	.15	.90	.18	.18	.50	105	133	5.00	5.00	40	46	16.3
61	9.34	180	.15	.90	.18	.19	.50	95	127	5.50	5.00	45	48	16.6
62	9.69	180	.15	.85	.20	.20	.52	100	130	5.50	5.00	50	47	16.8
63	9.69	180	.17	.92	.20	.26	.53	95	128	5.00	5.00	50	50	16.7
64	9.11	-	0.15	0.89	0.21	0.25	0.52	100	130	5.00	5.00	40	49	16.8

* Total time from turning steam on until whey was drained.

** Final temperature reached.

*** The period of time between starting to drain the last wash water and weighing cheese into creaming vat.

reliable nonfat dry milk powder, or a combination of the two. Skimmilk was pasteurized by the holding methods at 144° F. for 30 minutes. All samples of skimmilk were assumed to contain 9.0 per cent total solids before any solids were added. Although no total solids determinations were made on the skimmilk which went into cheese, other skimmilk from the same source was tested periodically by the Mojoinner method and contained close to 9.0 per cent total solids. Occasional checks on the skimmilk with a lactometer also indicated that total solids content was close to 9.0 per cent. The variation in per cent solids was caused by fortifying to 11 to 12 per cent total solids and then removing a certain amount to be used for other purposes in the plant. After this was removed, various amounts of skimmilk were added thereby giving a variation in total solids for different vats of milk.

Titratable acidity of skimmilk varied from 0.15 to 0.17 per cent before the addition of powder or starter. The starter showed a variation in acidity from 0.84 to 0.93 per cent. The first 36 samples were made with a culture which had been carried in the creamery for several years and was a very rapid acid producer. However, from every day organoleptic examination of the culture it seemed apparent that the flavor organisms were no longer present. Most of the remaining 28 samples were made with a culture selected at a Cottage Cheese Clinic held at the University of Tennessee

Creamery in March, 1959. This culture was selected from four commercial cultures. It maintained fast acid production plus good flavor and aroma throughout the remainder of the study. Cutting acidities varied some, but generally the curd was cut using a titratable acidity of 0.52 per cent as a base and adding or subtracting 0.02 per cent titratable acidity for each one-half per cent solids above or below 9.0 per cent total solids. This schedule of cutting acidities was not adhered to strictly, but curd was not cut in any case at a clear whey acidity of less than 0.5 per cent.

The cooking time averaged 77.2 minutes from the time steam was turned on until it was turned off. The holding period after steam was turned off averaged 21.2 minutes or an average total cooking time of 98.4 minutes. The cooking temperature ranged from 121° to 138° F. and averaged 128.2° F. It was felt that it would be desirable to use a total cooking period of at least 90 minutes and a temperature of at least 125° F. for making cottage cheese. With high quality skim milk and proper cutting acidity, a time-temperature combination similar to this should yield cottage cheese with excellent body and texture, plus very low microorganism counts if other recommended manufacturing methods have been followed.

Curd was washed with three waters, all of which were acidified (Table II), and chlorinated at the rate of 6 to 8 parts per million residual chlorine. The pH of the first

wash water ranged from 4.50 to 7.35 while the second and third wash waters ranged from pH 4.46 to 7.35. Most of the wash waters had a pH of close to 5.0. It was felt that a pH of near 5.0 for wash water was necessary to maintain a satisfactory pH in finished cheese. The first wash water was not refrigerated. Different amounts of the whey had to be drained off before the first wash water was pumped into the vat as the temperature of the water supply varied at different times of the year. The temperature of the curd was lowered to 85° to 90° F. with the first wash water. Curd temperature was lowered to 60° to 65° F. with the second wash water. Curd temperature was lowered as low as possible with the third wash water, usually 42° to 45° F. The temperature of the curd at time of packaging rose three to six degrees above the temperature of the last wash water. The draining time recorded in Table II represents the time from starting to drain the third wash water until cheese was weighed. After being weighed, the cheese was put into a creaming vat and allowed to drain an additional 10 to 15 minutes. This additional draining time has not been recorded in Table II. The cheese was then creamed, salted, and immediately packaged.

Curd yield was calculated for each batch of cheese. Yields ranged from 14.98 to 20.74 per cent. The first 38 lots were cut with five-eighths inch curd knives and in

general had slightly higher yields than lots 39 through 64 which were cut with three-eighths curd knives. Curd yields calculated as per cent of the total weight of skim milk in the lot. Total solids of the skimmilk ranged from 8.7 to 12.3 per cent. Therefore, it was reasonable to expect quite a wide variation in per cent curd yield.

Bacteriological data.

Total bacteria (Table III) and coliform (Table IV) counts obtained for 64 samples of creamed cottage cheese indicated that it would be feasible to establish bacterial standards for cottage cheese up to a week of storage or possibly longer based on these two types of counts. Psychrophilic counts (Table V) showed generally the same picture as total counts for fresh cheese and cheese which was a week old. Yeast and mold (Table VI) counts varied widely and information obtained in this study would not suggest the use of this type of count in setting standards for cottage cheese. The manufacturing conditions in the room where the cheese was made was such that aerial contamination of the cheese caused yeast and mold counts to be higher than they should be if conditions were right for cheese making.

It was felt that a total bacteria plate count of less than 50,000 per gram would be a reasonable standard for fresh creamed cottage cheese for the first week after it was made.

TABLE III

TOTAL BACTERIA COUNTS FOR 64 SAMPLES OF COTTAGE CHEESE STORED AT 5° C. FOR 0, 7, AND 11 DAYS

Sample number	Days of storage			Sample number	Days of Storage		
	0	7	11		0	7	11
	thousands				thousands		
1	67.0	58.0	150.0	33	1.0	1.5	1.6
2	12.0	19.0	19.0	34	1.8	0.6	0.4
3	96.0	72.0	164.0	35	0.5	0.4	0.3
4	9.4	9.0	9.4	36	15.0	12.0	8.2
5	28.0	18.0	29.0	37	0.4	0.6	0.4
6	35.0	286.0	477.0	38	0.7	1.2	9.4
7	18.0	10.0	14.4	39	1.0	0.6	0.9
8	9.0	12.0	8.4	40	7.7	0.4	0.6
9	90.0	43.0	132.0	41	2.8	1.4	2.3
10	80.0	64.0	47.8	42	1.2	12.0	108.0
11	3.0	3.4	206.0	43	1.9	1.3	6.5
12	1.6	0.6	3.0	44	6.6	5.0	2.0
13	19.6	8.6	1.6	45	20.0	21.0	45.0
14	5.0	16.4	3.8	46	0.7	18.6	4.0
15	6.0	6.0	7.0	47	7.8	49.0	400.0
16	12.4	10.4	16.0	48	0.1	0.4	1.4
17	20.8	41.6	25.4	49	1.6	0.2	8.8
18	1.5	1.2	206.0	50	0.2	0.2	22.0
19	1.0	2.8	632.0	51	0.3	2.2	0.8
20	3.0	1.6	6.0	52	0.5	8.0	4.9
21	1.6	3.2	3.5	53	1.8	0.3	300.0
22	0.5	0.5	0.9	54	0.8	1.8	310.0
23	122.0	116.0	98.0	55	3.2	6.8	150.0
24	0.7	0.4	0.9	56	11.0	15.0	86.0
25	1.1	0.4	0.5	57	12.0	14.0	29.0
26	0.4	0.8	0.6	58	1.8	1.0	12.0
27	3.9	2.2	0.6	59	20.0	5.8	9.0
28	0.8	0.5	1.9	60	13.0	3.6	19.0
29	1.1	0.7	1.6	61	25.0	27.0	11.0
30	0.4	0.5	0.9	62	0.7	8.0	15.0
31	4.4	2.6	2.6	63	15.0	0.7	1.0
32	2.0	1.1	0.8	64	0.4	1.4	1.0

Overcast and Skean (37) state that "A total plate count of less than 50,000 per gram should be reasonable and readily attainable under plant conditions." With a standard of less than 50,000 bacteria per gram and using the logarithmic average of the last four samples taken as suggested for milk by the American Public Health Association (1), the 64 samples (Table II) of cottage cheese did not exceed this suggested standard at any time for counts made at 0 and 7 days of storage. After 11 days of storage several cases were noted where the logarithmic averages of the last four consecutive samples rose above 50,000 per gram. The highest logarithmic average for any four consecutive samples at 0 and 7 days of storage was 43,000 per gram. After 11 days of storage one series of 4 consecutive samples had a logarithmic average of 180,000 per gram. Arithmetic counts ranged from 120 per gram to 122,000 per gram, with an average of 13,000 per gram, on the day cheese was made. The highest count recorded was 632,000 per gram after 11 days of storage. The logarithmic averages of the 64 samples for 0, 7 and 11 days of storage were 3,400, 3,700, and 8,300 per gram respectively. Counts reported in Table III are extremely low when compared with many previous bacterial studies, but if one considers the fact that the majority of the bacteria found in cottage cheese enter after the cooking period it should be obvious that there was plenty of room for improvement even for counts

such as those reported here.

Coliform organisms are a recognized sign of recontamination in cottage cheese as well as other pasteurized dairy products. All constituents going into cottage cheese should be pasteurized, thereby eliminating coliform organisms. A standard of less than ten coliform organisms per gram would be reasonable for creamed cottage cheese. Since coliform organisms do not normally grow at ordinary refrigeration temperatures for cottage cheese (40° F. or below), this standard should be maintained throughout the holding period including storage in retail cabinets. The United States Public Health Service (1) recommended for milk that three out of the last four samples taken should have less than ten coliform organisms per milliliter. Using this standard and the interpretation of the 1953 Milk Ordinance and Code (54) of the United States Public Health Service, all 64 samples (Table IV) in this study would conform to the grade A standard recommended for milk.

Organisms capable of growing at ordinary refrigeration temperature (40° F. or below) for cottage cheese present a major problem in maintaining long shelf life. Most, if not all, psychrophilic organisms found in cottage cheese enter after it has been made. A great majority of the psychrophilic organisms in cottage cheese could be eliminated by following strict recommended sanitary practices during

TABLE IV

COLIFORM BACTERIA COUNTS PER GRAM FOR 64 SAMPLES OF COTTAGE CHEESE HELD AT 5° C. FOR 0, 7, AND 11 DAYS

Sample number	Days of storage			Sample number	Days of storage		
	0	7	11		0	7	11
1	58	<6000	14	33	*	*	*
2	*	*	3	34	*	*	*
3	*	*	*	35	*	*	*
4	*	*	*	36	*	*	*
5	*	*	*	37	*	*	*
6	*	*	*	38	*	*	*
7	*	*	*	39	*	*	*
8	*	*	*	40	*	*	*
9	*	*	*	41	*	*	*
10	*	*	*	42	*	*	*
11	*	*	*	43	*	*	*
12	*	*	*	44	*	*	*
13	*	*	*	45	6	2	4
14	*	*	*	46	*	*	*
15	*	*	*	47	*	*	*
16	*	*	*	48	*	*	*
17	18	14	*	49	*	*	*
18	*	*	*	50	*	*	*
19	*	*	*	51	*	*	*
20	14	4	4	52	*	*	*
21	*	*	*	53	*	4	10
22	*	*	*	54	*	*	*
23	*	*	*	55	*	*	*
24	*	*	*	56	*	*	*
25	*	*	*	57	*	*	*
26	*	*	*	58	*	*	*
27	*	*	*	59	2	*	*
28	*	*	*	60	*	*	*
29	*	*	*	61	8	60	46
30	2	*	2	62	*	*	*
31	*	*	*	63	*	*	*
32	*	*	*	64	*	*	*

* Less than one per gram

TABLE V

PSYCHROPHILIC BACTERIA COUNTS PER GRAM FOR 64 SAMPLES OF COTTAGE CHEESE HELD AT 5° C. FOR 0, 7, AND 11 DAYS

Sample number	Days of storage			Sample number	Days of storage		
	0	7	11		0	7	11
	thousands				thousands		
1	6.0	6.0	5.2	33	1.0	0.8	0.8
2	55.0	19.0	1.4	34	0.4	0.2	0.4
3	5.0	0.9	8.6	35	1.4	1.6	1.8
4	24.0	6.8	6.6	36	0.8	3.4	0.6
5	0.3	12.0	60.0	37	0.4	0.8	1.0
6	5.8	0.1	70.0	38	0.4	0.2	8.4
7	27.0	0.6	2.8	39	1.6	0.8	0.8
8	0.2	0.8	0.4	40	0.6	1.2	0.4
9	0.6	0.6	1.4	41	0.4	0.4	1.6
10	0.4	0.4	0.5	42	1.2	8.0	70.0
11	0.6	1.1	38.0	43	0.6	0.4	0.8
12	0.4	0.4	20.0	44	0.2	1.0	0.2
13	0.2	0.2	0.8	45	0.2	0.8	1.8
14	0.2	0.4	80.0	46	0.6	0.4	0.4
15	0.7	1.0	1.2	47	0.2	12.0	360.0
16	1.0	11.0	240.0	48	0.8	0.4	0.4
17	0.8	1.4	52.0	49	0.2	0.4	0.8
18	0.4	0.6	142.0	50	0.2	0.8	19.0
19	0.2	0.2	600.0	51	0.4	0.8	0.5
20	0.6	0.8	11.0	52	0.8	0.2	0.2
21	1.0	0.4	2.4	53	0.8	0.6	1200.0
22	0.2	0.4	0.2	54	0.4	3.4	220.0
23	4.4	0.2	2.8	55	0.4	0.6	160.0
24	0.1	0.3	0.4	56	0.2	2.4	2.4
25	0.8	0.8	0.8	57	0.6	0.4	1.8
26	0.2	1.0	0.4	58	0.6	0.4	0.8
27	3.4	0.6	0.6	59	0.6	1.4	0.2
28	0.8	0.2	0.6	60	0.4	0.6	0.4
29	0.4	0.2	0.2	61	0.8	0.8	0.4
30	0.2	0.2	0.8	62	0.2	19.0	260.0
31	2.4	28.0	146.0	63	1.4	1.0	0.4
32	1.0	0.8	0.4	64	0.4	0.2	0.8

manufacturing. Psychrophilic organisms were not a problem in this study. The data presented in Table V indicate that if the logarithmic average of the last four samples was applied on the psychrophilic counts for successive samples there would be no case where the logarithmic average would exceed or even come close to 30,000 per gram for 0 and 7 days of storage. Very low psychrophilic counts ranging from 80 to 55,000 per gram were recorded on the day cheese was made. Of the 64 samples studied, 51 samples had psychrophilic counts of 1,000 per gram or less on the day cheese was made. Samples which showed increases at seven days of storage generally rose considerably in count after eleven days of storage. This indicates that psychrophilic counts could possibly be used as an index to keeping quality. It was felt that the low psychrophilic counts encountered in this study as contrasted to generally higher counts reported in other studies (37, 20, 12) indicated need for more study in this area before a standard for psychrophilic bacteria can be suggested.

The environment in the cheese making room has a definite effect on the types of spoilage organisms present in the cheese. Many manufacturers are installing filtered and refrigerated air systems in rooms and buildings which house their cottage cheese operation. Yeasts and molds present a special problem in cottage cheese keeping quality

TABLE VI

YEAST AND MOLD COUNTS FOR 64 SAMPLES OF COTTAGE CHEESE HELD AT 5° C. FOR 0, 7 AND 11 DAYS

Sample number	Days of storage			Sample number	Days of storage		
	0	7	11		0	7	11
1	*	*	*	33	2	0	60
2	*	*	*	34	0	20	20
3	*	*	*	35	0	300	300
4	*	*	*	36	20	220	380
5	*	*	*	37	0	0	1,300
6	*	*	*	38	0	0	180
7	*	*	*	39	0	220	440
8	200	0	200	40	0	0	20
9	160	32	18	41	20	40	7,000
10	0	60	1,200	42	4	2,600	57,000
11	2	2,000	102,000	43	0	0	2,200
12	2	2	20,000	44	0	6	1,000
13	0	20	400	45	2	20	10,000
14	10	3,600	50,000	46	2	40	20
15	2	20	320	47	20	24,000	44,000
16	0	0	7,800	48	640	260	800
17	10	2,900	9,000	49	0	20	140
18	4	1,200	75,000	50	40	140	20
19	14	600	586,000	51	40	20	0
20	220	1,800	14,000	52	60	0	0
21	40	40	27,200	53	0	0	0
22	0	2	60	54	0	0	0
23	0	0	420	55	0	0	196,000
24	0	0	14	56	0	0	32,000
25	0	6	6	57	0	220	35,000
26	0	4	200	58	0	900	11,000
27	0	20	5,700	59	0	60	460
28	6	0	30	60	0	180	120
29	0	0	0	61	20	20	17,000
30	0	0	160	62	0	30,000	65,000
31	20	45,000	236,000	63	17,000	60	40
32	6	0	0	64	0	0	240

* Yeast and mold counts were not made for the first seven samples.

because they are capable of proliferating well at low temperature and at the pH range of cottage cheese. Cottage cheese which contains any yeast or mold on the day made may deteriorate rapidly. The wide variation in yeast and mold counts reported in Table VI for sample number 8 through 64 was thought to be largely due to variations in the environment under which the cheese was made. Yeast and mold determinations were not made for sample one through seven. During the winter months a forced air system of heating was used in the cheese room. It was felt that this type of heating system contributed to yeast and mold contamination through moving dust particles. In the summer months windows to the cheese room were kept open. Building construction and a public highway nearby kept the atmosphere around the creamery in a dusty condition during dry periods in the summer months. Although no distinct line can be drawn in this study to indicate a change in rate of yeast and mold contamination for different seasons of the year, it can be noted that the series of samples for 10 through 21 which were made during the winter months of November, December and January generally had high counts. Similarly the series of samples from 55 through 62 which were made during the summer months of June and July generally had high counts. Other high counts were scattered at random throughout the study. The use of yeast and mold counts in a quality control system for cottage cheese within

a plant will aid in detecting inefficient pasteurization, carelessness of employees in cleaning and handling of equipment and the quality of general plant sanitation.

Chemical data.

Butterfat, moisture, pH, and total chloride determinations were made for each of the 64 lots of cheese studied.

Butterfat content ranged from 2.0 to 6.0 per cent, moisture 78.0 to 82.0 per cent, total chlorides 0.80 to 1.40 per cent with averages of 3.98, 79.99 and 1.00 per cent respectively. The pH of fresh cheese ranged from 4.85 to 5.50. There was no appreciable change in pH noted over an 11 day storage period, but several samples showed a slight decrease in pH after 7 and/or 11 days of storage. No correlation could be made in this study between pH change during storage and bacterial or organoleptic deterioration.

The variation in chemical composition reported herein and recorded in Table VII indicate the need for strict control procedures during the manufacturing process. Slight variation in chemical composition of the cheese milk, heat treatment given the cheese and slight deviations from the cheese making procedure from day to day was responsible for part of the variation in chemical composition of the cheese. The cheese making procedure must be standardized from beginning to end if close tolerances in chemical composition

are to be maintained.

Organoleptic data.

Flavor scores and criticisms are recorded in Table VIII for each of the 64 samples after 1, 8, 11 and 15 days of storage at 5° C.

With the exception of 5 samples which had onion flavor in the cream, flavor scores ranged from 37.5 to 40.0 the day after cheese was made. Scores for onion samples ranged from 32.0 to 36.0. Cheese which was given a flavor score of 39.0 or higher was not criticized for flavor. High acid, storage and stale flavors were the ones most commonly encountered in this study. Storage flavor almost invariably developed after 8 or 11 days of storage. No correlation could be made between the organoleptic quality for fresh cheese and organoleptic quality after storage up to 15 days. Close examination of Table VIII indicates that flavor scores in most instances declined very little up to 11 days of storage, but in many cases dropped a considerable amount with an additional 4 days of storage. Only one sample in the entire study showed surface growth after 15 days of storage. The chief criticisms on body and texture were soft and mealy. In many cases the mealy characteristic was not noted on the first day, but seemed to develop by the time cheese was judged on the eighth day. Lots of cheese which were cut with five-

eighths inch curd knives shattered more easily and were generally criticized as lacking uniformity. Results obtained in this study indicate that an average plant should be able to maintain two weeks shelf life on its cottage cheese.

TABLE VII

CHEMICAL COMPOSITION DATA FOR 64 SAMPLES OF COTTAGE CHEESE

Sample	Butterfat per cent	Per cent moisture	Total chloride per cent	pH 0 days	pH 7 days	pH 11 days	Sample	Butterfat per cent	Per cent moisture	Total chloride per cent	pH 0 days	pH 7 days	pH 11 days
1	-	80	-	5.30	5.00	4.95	33	3.8	80.6	0.95	4.90	4.98	4.90
2	2.0	82	1.30	4.96	5.00	4.98	34	4.0	80.2	1.10	4.90	4.90	4.93
3	3.6	79	0.95	5.00	4.95	4.90	35	4.0	79.6	1.00	4.90	4.90	4.90
4	4.40	80	1.40	4.95	5.00	5.00	36	3.8	80	1.20	4.85	4.93	4.90
5	3.6	79.6	1.00	4.90	4.90	5.03	37	3.2	80.4	0.90	4.98	4.99	4.90
6	2.6	81.6	1.30	4.95	4.98	5.03	38	3.0	80.0	0.85	5.50	5.50	5.50
7	3.6	79.2	1.10	4.97	5.01	5.03	39	4.8	82.0	0.95	4.85	4.88	4.88
8	3.5	80.4	1.00	5.01	5.00	5.04	40	4.4	79.2	0.90	5.02	5.00	5.00
9	3.2	81.8	0.95	5.01	5.03	5.03	41	4.0	79.0	0.95	4.92	4.92	4.92
10	5.0	79.6	1.00	5.02	5.00	5.00	42	4.0	79.0	1.10	5.00	5.00	4.95
11	4.0	79.6	1.05	4.99	5.02	5.02	43	3.6	80.0	0.95	5.00	5.00	5.00
12	3.9	79.6	1.05	5.00	5.09	5.06	44	4.6	78.0	0.90	4.92	4.92	4.90
13	4.3	80.8	1.00	5.05	5.05	5.05	45	4.0	79.0	0.90	5.00	5.00	5.00
14	3.4	79.6	1.00	5.03	5.03	5.03	46	4.0	80.6	0.85	5.00	5.00	5.00
15	4.0	80.0	1.00	5.00	5.00	5.00	47	4.0	79.0	1.00	4.95	4.95	4.95
16	3.7	80.4	1.00	5.10	5.10	5.15	48	4.0	79.0	1.00	5.00	4.90	4.90
17	5.2	79.2	1.00	4.94	4.94	4.93	49	4.0	79.0	1.05	4.89	4.89	4.88

TABLE VII (continued)

Sample	Butterfat per cent	Per cent moisture	Total chloride per cent	pH 0 days	pH 7 days	pH 11 days	Sample	Butterfat per cent	Per cent moisture	Total chloride per cent	pH 0 days	pH 7 days	pH 11 days
18	3.9	80.4	1.00	4.90	4.88	4.88	50	4.0	79.6	0.95	4.90	4.90	4.90
19	4.2	79.6	1.00	4.90	4.92	4.92	51	3.9	79.0	0.95	5.00	5.00	5.00
20	4.9	79.8	1.00	4.90	4.92	4.88	52	4.6	81.0	0.80	4.93	4.92	4.92
21	6.0	80.0	1.10	4.91	4.92	4.88	53	4.4	81.0	0.85	4.93	4.93	4.89
22	2.8	80.0	1.10	4.89	4.90	4.91	54	4.1	79.6	0.95	5.00	4.98	4.90
23	3.5	81.0	1.05	4.85	4.88	4.89	55	5.8	80.8	1.00	4.98	4.98	4.95
24	3.6	80.6	1.05	4.89	4.89	4.89	56	4.0	78.8	0.95	5.00	5.00	5.00
25	4.0	79.6	0.90	4.85	4.85	4.85	57	4.4	80.8	0.95	5.05	5.00	5.00
26	3.8	80.0	0.95	4.90	4.91	4.91	58	4.4	79.0	1.05	4.95	5.08	5.05
27	3.6	80.0	1.15	4.93	4.95	4.95	59	5.0	80.0	1.00	4.95	5.03	5.05
28	4.4	80.8	1.15	4.90	4.87	4.89	60	4.8	80.0	0.95	4.98	5.00	5.00
29	3.8	79.8	1.00	4.90	4.98	4.98	61	3.8	80.2	0.90	5.00	4.95	4.95
30	3.6	81.2	0.95	4.93	4.92	4.90	62	4.2	79.8	1.00	5.05	5.00	5.00
31	2.8	79.6	0.95	4.90	4.90	5.00	63	3.8	79.8	0.90	4.90	4.90	4.90
32	3.8	79.6	1.00	5.00	4.95	4.95	64	4.2	79.0	0.95	5.00	5.00	5.00

TABLE VIII

FLAVOR SCORES AND CRITICISMS FOR 64 SAMPLES OF COTTAGE CHEESE AFTER 1, 8, 11 AND 15 DAYS STORAGE AT 5° C.

Sample number	Days of storage				Flavor criti-cism*	Sample number	Days of storage				Flavor criti-cism*
	1	8	11	15			1	8	11	15	
1	40.0	40.0	38.0	-	1	33	38.0	38.0	38.0	38.0	1
2	38.0	38.0	38.0	-	1	34	39.0	38.0	38.0	37.5	1,2
3	38.5	38.5	38.0	-	1	35	39.0	38.0	38.0	37.0	1,2
4	40.0	39.0	38.0	32.0	1,6,7	36	38.0	38.0	37.5	37.5	1
5	37.5	38.0	38.0	38.0	1,2	37	39.5	39.5	39.0	39.0	NC
6	38.0	38.0	38.0	36.5	1,3	38	39.5	39.5	39.0	39.0	NC
7	40.0	38.0	37.5	37.0	1	39	36.0	37.5	37.0	36.0	1,3
8	38.5	38.0	36.5	32.0	1,3	40	39.5	39.0	39.0	38.0	2
9	39.0	37.0	37.0	36.0	1,3	41	38.5	38.5	38.0	38.0	1,2
10	38.0	38.0	37.0	36.0	1,3	42	32.0	32.0	32.0	32.0	3
11	40.0	38.0	38.0	38.0	2	43	38.5	38.5	37.0	37.0	1,2
12	40.0	39.0	39.0	36.0	2,3	44	39.0	38.5	38.0	37.5	2
13	38.0	38.0	38.0	37.0	2	45	36.0	36.5	36.0	36.0	2,3
14	38.0	38.0	37.5	36.0	1,3	46	38.0	37.0	36.0	36.0	1,2
15	39.0	39.0	38.0	38.0	2	47	36.0	36.0	36.0	36.0	3,5
16	38.0	38.0	36.5	34.0	1,2,3	48	39.0	38.0	37.5	36.0	1,2
17	38.5	39.0	38.0	37.0	1,2	49	38.0	38.0	38.5	36.5	3
18	39.0	38.5	39	37.5	1,2	50	39.0	39.0	37.0	37.0	2
19	39.0	37.5	38.0	37.0	2	51	38.5	38.5	38.0	36.0	2,3
20	39.0	39.0	38.0	37.0	1,2	52	36.0	36.0	37.0	36.0	2,3,5
21	39.0	39.0	39.0	37.5	2	53	36.0	36.0	37.0	36.0	2,3,5
22	38.5	38.5	37.0	36.5	1,3	54	38.0	38.0	36.0	32.0	1,2,4
23	38.5	38.0	37.5	37.5	1,2	55	39.0	39.0	38.0	36.0	2,3
24	38.5	37.0	37.0	37.0	1,3	56	39.0	39.0	38.0	32.0	2,4
25	39.0	38.0	37.5	36.5	1,2,3	57	38.0	38.0	38.0	37.0	1,2
26	36.0	37.5	37.5	32.0	2	58	39.0	39.0	37.5	36.0	2,3
27	38.0	37.0	37.0	36.0	1,2,3	59	39.0	38.5	38.5	37.5	2
28	38.0	38.0	38.0	37.0	1,2	60	39.0	38.5	37.0	37.0	2
29	38.0	37.5	37.5	36.0	1,2,3	61	39.0	38.0	37.5	36.0	2,3
30	39.0	38.0	38.0	36.5	1	62	39.0	38.0	36.5	22	2,3,4**
31	38.0	37.5	37.5	37.5	1,2	63	39.0	39.0	38.5	36	2
32	38.0	38.0	39.0	37.5	1,2	64	39.0	39.0	37.5	36.0	2,3

* (1) High Acid (2) Storage (3) Stale (4) Musty (5) Onion (6) Rancid (7) Unclean (8) Sour (NC) No Criticism

** Surface Growth

CHAPTER V

SUMMARY AND CONCLUSIONS

The bacteriological, chemical and organoleptic characteristics of 64 samples of cottage cheese manufactured in the University of Tennessee Creamery over an eleven month period were studied with the aim or recommending bacterial standards.

Total, coliform, phychrophilic and yeast and mold plate counts were made on cheese stored at 5° C. for 0, 7, and 11 days. This study indicated that by using high quality raw materials and recommended manufacturing methods, cottage cheese with an initial total bacteria count of less than 50,000 per gram could be manufactured in an average plant and this count could be maintained up to a week of storage. Using the logarithmic average of the last four samples as recommended for milk by the American Public Health Association (1), all 64 samples of cheese studied remained within this suggested standard for total bacteria count after 0 and 7 days of storage. Likewise it was found that it was possible to maintain coliform bacteria counts at less than 10 per gram throughout an 11 day storage period at 5° C. Using the three out of four method as recommended for milk by the American Public Health Association (1),

there was no case in this study where the suggested standard of less than 10 per gram was exceeded. Since coliform organisms do not grow at ordinary refrigeration temperatures for cottage cheese (below 40° F.), it was concluded that the standard of less than 10 per gram should be maintained throughout the storage period.

A standard for psychrophilic bacteria was not recommended. Of the 64 samples studied, 51 had psychrophilic bacteria counts of 1000 or less per gram on the day cheese was made. It was felt that low psychrophilic counts encountered in this study as contrasted to extremely high counts reported in other studies (37, 20, 12) would not warrant recommending a standard without further study. A standard for yeast and mold counts was not suggested from this study because of wide variations encountered. It was felt that yeast and mold contamination was the result of the atmosphere in the cheese making room which included forced air heating in winter and many open windows in summer. Although no distinct line could be drawn to indicate the rate of yeast and mold contamination in relation to season of the year, samples manufactured during summer and winter months made up the bulk of the high yeast and mold counts.

The 64 samples of cottage cheese studied ranged from 2.0 to 6.0 per cent butterfat, 78.0 to 82.0 per cent moisture and 0.80 to 1.40 per cent total chlorides. No

attempt was made to determine why the chemical composition varied over these wide ranges. However, it was felt that a high degree of standardization in the cheese making process should be maintained in order to keep the variation in chemical composition within a reasonable range.

Organoleptic examination of the 64 samples of cottage cheese indicated high acid, storage and stale as off flavors most commonly encountered. Flavor scores declined very little up to 11 days of storage at 5° C., but in most cases dropped considerably with an additional four days of storage. Only one of the 64 samples studied was judged unfit for retail sale after 15 days of storage. It was, therefore, concluded that an average plant should be able to maintain two weeks shelf life on cottage cheese.

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APPENDIX A

Date 12-2-58

COTTAGE CHEESE
MANUFACTURING REPORT

Cheesemaker J. V. Britton | Kind Curd 5/8 inch | Sample No. 15

Ingredients	Gals.	Lbs.	pH	Acid	% SNF	Remarks
Past. Fresh Skim	190	1634		0.17	9.0	Lac @ 88°
Water ____ %						Chlorine ____ 50% Acid ____
Low Heat Powder ____ %						
Skim-Powder						
Starter ____ %	10	86		0.92	9.0	Kind C-1 Activity ____
Total with Starter	200	1720		0.21	9.0	
Mineral Solution						Product ____

RIPENING AND COOKING

Time	(°F.) Temp.	Curd pH Acid	
6:35	90	0.21	Starter added
7:15	90	0.23	40 min. Check-Extra Starter %
7:15	90	0.23	Coag. Added (cc) 60 (oz)
			Check-Extra Starter % ____ Coag. cc oz. ____
			Jacket Temp.(°F.) ____ Cooking Remarks ____
11:05	90	0.52	Acidity Checked
11:05	90	0.52	Cut Curd - Cond Curd Firm
11:25	90	70°	Start Cooking
12:38	126	148°	Finish Cooking - Cond Curd Firm
12:55	126		Drain Whey
			1st Wash -
1.03	90		Amt. Chl. 6-8 p.p.m. 50% Acid pH 5.20
			2nd Wash -
1:13	68		Amt. Chl. 6-8 p.p.m. 50% Acid pH 5.35
			3rd Wash -
1:30	38		Amt. Chl. 6-8 p.p.m. 50% Acid pH 5.35
1:55	45		Creaming
2:05	45		Packaging

Lbs. Curd 315 | Lbs. Dressing 66 | Lbs. Salt 3 lbs. 2 oz. | Lbs. Creamed Curd 382

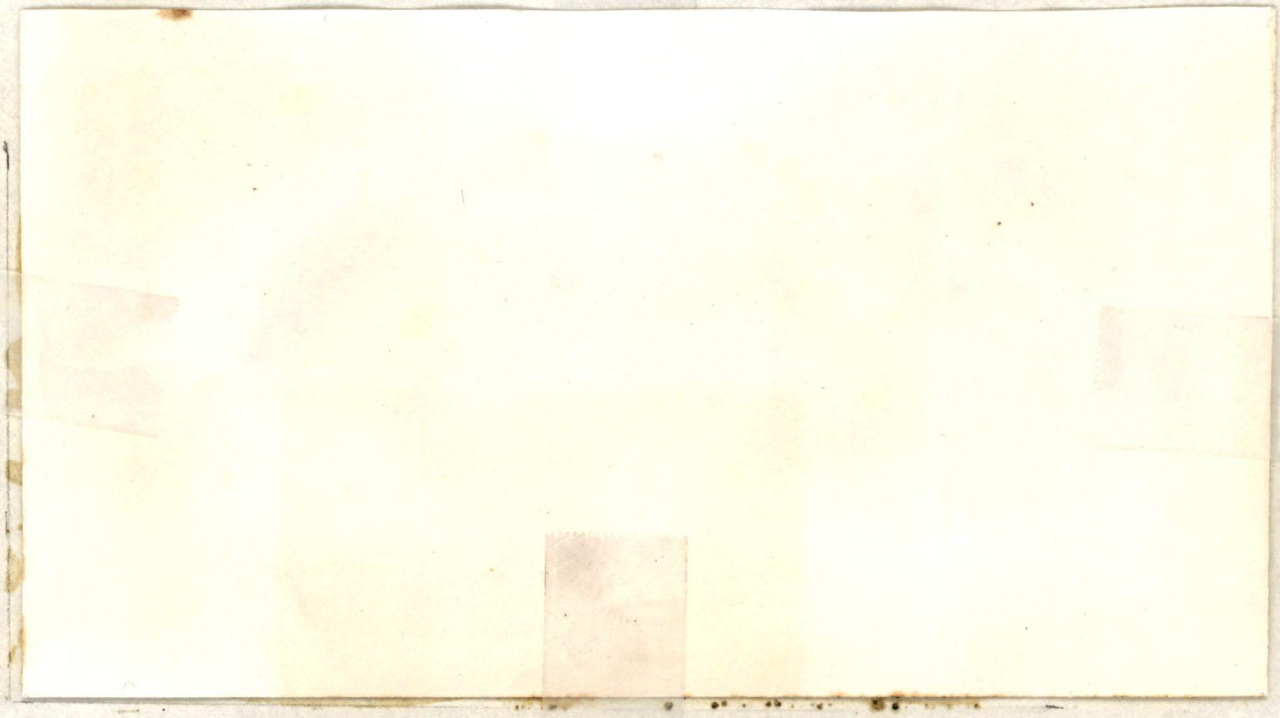
% Curd Yield 18.19 | % Moisture 80.0 | % Fat 4.0 | % Salt 1.0

MICROBIOLOGICAL

Fresh Cheese	(0 days) pH5.0	(7 days) pH 5.0	(11 days) pH 5.0
Spc Total	6,000	6,000	7,000
Coliform	[illegible]	[illegible]	<1
Psychrophilic	[illegible]	[illegible]	1,200
Yeast & Mold	[illegible]	[illegible]	320

[redacted]

APPENDIX B



Judged by:
Dr. W. W. Overcast
J. V. Britton

COTTAGE CHEESE SCORE CARD

Sample

~~CONTESTANT~~ NO. **15**

1 Day 8 Days 11 Days 15 Days

Perfect Score	Criticisms	Sample Number 1	2	3	4	5	6	7	8	9	10
Flavor 45	Contestant Score →	39.0		39.0		38.0		38.0			
	Score										
	Grade on criticism										
Normal range 32-42	Bitter										
	Feed or weed										
	Flat										
	Foreign										
	Fruity or fermented										
40-45= no criticism	High acid										
	High salt										
	Malty										
	Medicinal										
	Metallic										
	Musty										
	Oxidized										
	Rancid										
	Sour										
	Stale										
	Storage										
	Unclean										
	Yeasty										
BODY AND TEXTURE 35	Contestant Score →	34.5		34.0		34.0		34.0			
	Score										
	Grade on criticism										
Normal range 31-34.5	Gelatinous										
	Mealy or grainy										
	Pasty										
	Rubbery										
	Too firm										
	Weak or soft										
COLOR AND APPEARANCE 15	Contestant Score →	14.5		14.0		14.0		14.0			
	Score										
	Grade on criticism										
Normal range 11-14.5	Free whey										
	Lacks cream										
	Lacks uniformity										
	Matted										
	Overcreamed										
	Shattered curd										
	Slimy										
	Surface discoloration										
	Translucent										
	Unnatural color										
PACKAGE 5	Contestant Score →										
	Score										
	Grade on criticism										
Normal range 4-5	Broken										
	Container not full										
	Insanitary closure										
	Leaky										
	Soiled										
	Total score each sample										
TOTAL 100	Total Grade										

SCORING GUIDE FOR COTTAGE CHEESE - FLAVOR

Flavor Defects	Slight	Distinct	Strong	Excellent 45-40	Good 39.5-38.5	Fair 38-36.5	Poor 36-32	Bad 31.5-0
Flat	39.5	39	38.5		*Sl. D. S.			
Feed	39	38.5	37.5		Sl. D.	S		
High Salt	38.5	38	37		Sl.	D. S.		
Acid	38.5	38	36		Sl.	D	S	
Storage	38	36	34			Sl.	D. S.	
Sour	37	34	32			Sl.	D. S.	
Medicinal	37	34	31			Sl.	D	S
Foreign	37	34	31			Sl.	D	S
Stale	36.5	32	29			Sl.	D	S
Bitter	36	32	28				Sl. D.	S
Unclean	36	31	27				Sl.	D. S.
Malty	35.5	30	25				Sl.	D. S.
Metallic	35	29	24				Sl.	D. S.
Fruity or Fermented	35	28	23				Sl.	D. S.
Musty	34	27	22				Sl.	D. S.
Oxidized	33.5	25	18				Sl.	D. S.
Yeasty	33	24	15				Sl.	D. S.
Rancid	32	23	14				Sl.	D. S.

*Sl. - Slight (barely detectable)
D. - Distinct
S. - Strong

Defects listed in order of increasing objectionableness

SCORING GUIDE FOR COTTAGE CHEESE - BODY & TEXTURE

Body and Texture Defects	Slight	Distinct	Strong	Excellent 35-34.5	Good 34-32.5	Fair 32 - 30	Poor 29.5 - 0
Firm or Hard	34	33	32		Sl. D.	S	
Weak	33.5	32.5	31.5		Sl. D.	S	
Mealy	33	32	31		Sl.	D. S.	
Rubbery	32.5	31.5	30		Sl.	D. S.	
Pasty	32	31	28			Sl. D.	S
Gelatinous	31.5	29	26			Sl.	D. S.

SCORING GUIDE FOR COTTAGE CHEESE - APPEARANCE

Appearance Defects				Excellent 15-14.5	Good 14 - 13	Fair 12.5-11	Poor 10.5 - 0
Lacks Uniformity	14.5	13.5	12.5	Sl	D. S.		
Overcreamed	14	13	12		Sl. D.	S	
Lacks Cream	13.5	12.5	11.5		Sl.	D. S.	
Shattered Curd	13	12	11		Sl.	D. S.	
Matted	13	12	11		Sl.	D. S.	
Unnat. Color	12.5	11.5	10			Sl. D.	S
Free Whey	12	11	9			Sl. D.	S
Translucence	11.5	10	8			Sl.	D. S.
Surface Dis-coloration	11	9	7			Sl.	D. S.
Slimy	10	8	5				Sl. D. S.

GLOSSARY OF TERMS USED IN SCORING COTTAGE CHEESE*

Flavor

Bitter - An astringent puckery taste.

Feed or Weed - The aromatic flavor characteristic of certain weeds.

Flat - Lack of characteristic flavor.

Foreign - Any objectionable flavor not characteristic of the product and specifically listed.

Fruity or Fermented - The aromatic flavor of orange, pineapple, strawberry, etc., usually due to bacterial action.

High acid - An excess acid over and above that considered desirable, but which is clean and sharp.

High salt - Excessive salt over that desired by consumer.

Malty - A malt-like flavor due to bacterial action.

Medicinal - Chemical - The smell and taste of disinfectant, chlorine, iodine or phenolic compounds.

Metallic - A metal taste. Astringent. (A similar taste is noted when a penny is placed in the mouth.)

Musty - The odor of a damp poorly ventilated cellar or refrigerator.

Oxidized - A cardboard flavor.

Stale - A lack of freshness.

Storage - Odors absorbed from storage rooms or refrigerators.

Sour - Excessive acid usually associated with other bacterial defects such as fruity, fermented, etc. and is not clean.

Unclean - Reminiscent of the odor of dirty equipment, possibly due to inferior milk.

Body and Texture

Gelatinous - A sticky jello-like character.

Mealy - A character of curd which resembles corn meal in the mouth.

Pasty - A soft weak curd which resembles a flour-water paste.

Rubbery - An elastic, resilient curd.

Too firm - A curd which is hard and does not break easily in the mouth.

Weak - Curd which is soft and lacks body.

Color and Appearance

Free whey - The presence of a thin watery fluid.

Lacks cream - A dry curd lacking sufficient cream.

Lacks uniformity - Lack of uniformly sized particles.

Matted - The agglomeration of two or more particles of curd.

Overcreamed - The presence of too much free cream.

Shattered curd - Curd which has been broken due to handling or packaging, which may exhibit curd dust.

Slimy - A slippery film on the curd surface due to chemical or microbial agents.

Surface discoloration - A non-characteristic color on the surface due to the growth of micro-organisms.

Translucent - A lack of opaqueness caused by chemical or microbial agents.

Unnatural color - Curd which does not present a creamy, white color.

Package

Broken - A broken, torn or damaged carton.

Container not full - A carton not containing the declared amount of cheese, or not full within ½ inch from the cover seat.

Insanitary closure - In which the closure is inset in the carton and not over the lip of the carton.

Leaky - A non-waterproof carton or one which leaks whey or cream. A soggy carton.

Soiled - A carton or closure presenting an unattractive exterior appearance because of the presence of cheese, cream, or foreign matter.

IDEAL COTTAGE CHEESE

The flavor of cottage cheese should be similar to fresh, clean, skimmilk or cream (if creamed). Cottage cheese should have a slightly acid, salty taste with the delicate flavor and aroma of a good lactic starter (diacetyl).

The body of cottage cheese should be uniform, smooth and meaty (not too firm or too soft and pasty).

The curd particles should be discrete, uniform in size (regardless of style) and of a natural creamy, white color.

Creamed cottage cheese should have a uniform layer of cream around the curd particles with a minimum of free cream. Any excess cream should be of a thick consistency (not whey-like or watery).

* Recommendation of the Cottage Cheese Score Card Committee of The American Dairy Science Association. June, 1957.