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# The Effects of Salt Content and Temperature on Eye Formation in Swiss Cheese

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# THE EFFECTS OF SALT CONTENT AND TEMPERATURE ON EYE FORMATION IN SWISS CHEESE

by

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# INTRODUCTION

## Importance of project

The size, shape, and handling of the large Swiss cheese wheels have given rise to problems of labor, marketing, and waste in cutting. At the present time there is a trend to produce a smaller Swiss cheese which will enable the manufacturer and marketing agencies to overcome the difficulties in handling the large wheels.

It may be practical to manufacture Swiss cheese by combining methods used in manufacturing both cheddar and Swiss cheese. To do this, there should be a study made to determine whether or not a method can be adapted from these two types of cheese that will produce a Swiss cheese of a smaller loaf type with sufficient and proper eye formation and with good flavor.

## Purpose of investigation

Since it is believed that proper eye formation in Swiss cheese will help produce a high grade product, the purpose of this experiment is to make Swiss cheese in a twenty pound loaf and study the eye formation as affected by the concentration of salt in the cheese and the temperature in the warm room. A saturated solution of sodium chloride was used as brine, and the cheese submerged in this solution for twenty-four, thirty-six and forty-eight hours. Three different warm room temperatures were used; low (75°F.), medium (80°F.), high (85°F.), where the cheese was held until proper eye formation was observed. The determination of the best salt concentration and temperature may offer a clue for making a high grade twenty pound Swiss cheese.

Complete observation and analysis was made when the cheese was 75 days old to determine score, eye formation, moisture, pH, NaCl content, body, flavor, texture, color and surface appearance.

## REVIEW OF LITERATURE

### Quality of milk

High quality milk is one of the essentials in making high quality dairy products. Considerable work has been conducted relative to the effect of quality of milk upon quality of swiss cheese. Peter (21) states that the most important preliminary function for producing a high quality swiss cheese is to have a high quality of milk; also a proper degree of ripeness is desirable. The ripeness of the milk is usually determined by the methylene blue reduction test.

There has been a number of observations made on the quality of the milk as determined by the methylene blue reduction time of the original milk. Sandle (24) has collected a considerable amount of this data and has made the statement that if the methylene blue reduction time is under 3 hours chances are that there will be twice as many under grade cheese as cheese graded A or B. When the reduction time was over 3 hours these chances are reversed.

Farrer (8) found an increase in the quality of cheese by introducing a program to influence the farmer in the care of the milk on the farm. He increased the methylene blue reduction time ranging from 1.5 to 5.5 hours. When the milk was received, he sorted the milk according to the methylene blue test and put the short reduction time milk in one kettle and the milk with a longer reduction time in another kettle. The good milk yielded 19.5 per cent grinders and the poor milk yielded 78.6 per cent grinders.

Erikson et al. (7) and Rogers et al. (23) agree that if the milk

being made into swiss cheese has a methylene blue reduction time of between 3 to 6 hours and the pH of the curd at dipping is between 6.3 to 6.5 chances are greater in getting a high quality cheese.

Frazer et al. (11) attempted to ripen milk for swiss cheese by adding S. lactis and S. thermophilus and holding over-night at 20-25°C. This proved of no importance. However, when the milk was ripened with S. thermophilus for 30 to 60 minutes and the methylene blue reduction time was from 5 to 6 hours, the cheese was of a higher quality. They recommend ripening a portion of the milk with S. thermophilus during certain seasons of the year.

Samuis (21) has stated that if there is a presence of too many gas producing organisms in the original milk there will be a formation of eyes either on the press or in the brine tank. These bacteria find their way into the milk through manure, silage, or improper sanitation both on the farm and in the plant; therefore, it is necessary to examine the milk at various intervals to check on number of gas producing organisms present.

Standardization

Price and North (22) decided that if the biological and mechanical procedures are kept constant that the cheese with the lower fat content will grade higher than the one with high fat. When the fat content was 44.5 per cent on the dry basis of the cheese, the grade was one point higher (on a numerical score) than the cheese with fat content reaching 44.8 per cent on dry basis. Eye formation is one of the important factors in determining the grade of the cheese. This cheese was graded by pulling one or two plugs per wheel and examing the eyes, odor, and taste. The cheese in this experiment were graded on the eye formation

and it was found where there was a low fat content the eyes were more desirable, but when the fat content was increased the flavor and body were of a higher quality according to a numerical score given each wheel.

Sanders et al. (26) correlated the percentage of fat with quality of cheese produced. They found where the cheese had between 45 and 46 per cent fat on dry matter basis the cheese was of the highest quality. Where the cheese contained more than 46 per cent the quality was higher than in the case where the fat content was below 45 per cent. There were no data on the procedures used in grading this cheese.

Standardization of the fat content of milk being used for swiss cheese seems to be necessary. Samis (24) states that too much fat in the kettle milk tends to produce irregular eyes and a short undesirable body.

Clarification

Clarification of milk which is to be used in the manufacture of swiss cheese has been found to be beneficial. Matheson (17) and Samis (24) state that if the kettle milk has been clarified there is a decrease in the number of eyes, which will give rise to larger and better shaped eyes. In comparing cheese made from clarified and unclarified milk, they observed that the grade of the cheese made from the unclarified milk was lower because of the greater number of small eyes. Clarification was most desirable when mastitis milk was present.

Starters

According to Frazier et al. (14) Lactobacillus bulgaricus is an important organism to use in making swiss cheese. He also states that it should be used in conjunction with Streptococcus thermophilus to acquire the best results. If these two strains of bacteria are used in

The growth of L. bulgaricus was followed through the cheese making process by Frazier et al. (9), (10) and Elliker (6). They found that there was no increase in the kettle and usually a decrease in numbers at the time of dipping. After the cheese has been on the press for 6 to 8 hours this organism began to increase at a rapid rate. It grew at such a rapid rate that it lowered the pH of the curd to a minimum of 5.0, 12 to 14 hours after dipping. Proper acid production by this bacteria controlled the growth of undesirable gas producers; however, there is a chance of producing too much acid which will harm the cheese later on in the curing room.

Sherman (27) states that L. casei has been known to control over-swelling of Ementhal cheese. He has found that it will check the development of eyes in the cold room after the proper eye formation has been developed.

It is necessary to control too rapid acid production while the cheese is on the press. Frazier et al. (12) finds that if the L. bulgaricus starter has a titratable acidity of 1.0 to 1.09 it will give the best results. He also stated that the manufacturer should know the characteristics of the type of Lactobacillus used. If the L. bulgaricus can be controlled to give a pH of 6.0 to 6.1 in the curd three hours after dipping, there will be a definite increase in the quality of the cheese. If a high grade of milk is used, the pH need not decrease so fast. A pH of 6.1 to 6.25 of the curd three hours after dipping is sufficient acid for high quality milk. With a good quality milk and proper preparation and use of cultures along with good making technique, a swiss cheese of acceptable quality will be produced.

Peppler and Frazier (19 and 20) Voss and Frazier (32) made a study

of the effects of incubation time and temperatures and storage on swiss cheese starters. They found that there can be a great variation in the time and temperature for incubating swiss cheese cultures. They produced a strain of S. thermophilus that was very heat tolerant. They also incubated L. bulgaricus at a temperature low enough that it would grow in the cheese storage room. These heat and cold tolerant bacteria had no influence on the cheese. However, it may be desirable at certain times or places to be able to have such bacteria to produce a better grade of cheese.

Frazier et al. (13) found that the addition of S. thermophilus starter to swiss cheese improved the quality of the cheese in two ways. First, it improved the general quality of the cheese, and second, the improvement was greatest in eye formation, texture, and flavor. He also found that cheese made from "raw" or kettle whey starters showed no improvement over the ones made from pure cultures. Different strains of S. thermophilus isolated from whey starters showed different results, and many of the cheese made with S. thermophilus showed a tendency toward checking and glassiness.

Frazier et al. (12) made a study to determine the very best titrable acidity for milk starter S. thermophilus. He concluded that a titrable acidity of .70 to .75 per cent yielded the highest quality cheese.

Dutcy et al. (1), Frazier et al. (10) and Dutcy (4) agree that the S. thermophilus grow very little in the kettle milk, but when the cheese is on the press for the first 6 to 8 hours they increase very rapidly. They play an important part in the production of acid which enables the expulsion of whey and also controls the undesirable gas producers to grow. If the cheese cools too fast on the outside, the

whey at the center of the cheese may be trapped, due to fast growth of bacteria at the outer surface causing the curd to knit too firm.

There has been some work on the heat treatment of the starter milk. Tyler and Weiser (29) found that milk treated at 100°C. for 2 to 4 hours increased the rate of acid produced over that milk which was heated a shorter or longer period. It is suggested that the difference in the activity of swiss cheese starters may be due to variations in the oxidation reduction potential in milk, and the growth factor content of milk from different sources.

Orla-Jensen (18) states that the process of fermentation of sugar or calcium lactate whereby it is converted into propionic, acetic, carbonic acid is of particular interest in the eye formation of swiss cheese. The author isolated Bacterium acidi propionici which was responsible for this fermentation; it was a non-spore forming, non-motile, gram-positive rod. The propionic acid-producing bacteria is similar to Sc. lactis but does not coagulate milk. He also states that the normal eyes have nothing in them but carbon dioxide. The eyes should not be allowed to form until the body of the cheese has become pliable enough to have the eyes form round and smooth.

The quality of Emmenthal cheese is not judged entirely by the sweet, nutty flavor but Clark (5) stated that it is also characterized by the eye formation. During 1896 to 1912 the ideal size for an eye was agreed upon by some prominent men in the swiss cheese field; they decided that an eye 1.2 to 2.0 cm. in size was most desirable.

He states further that cheese curd goes to press with a number of small nuclei which may induce the formation of eyes. Too much agitation after the eye former was added produced "nessler" cheese and,

if there was too little agitation, it caused blow holes in the cured cheese. The nesslers were noticed when removed from the press and the blown cheese was observed in about 2 weeks. Eyes do not form where there is a large concentration of the gas-producing bacteria. When rapid gas is produced, there is a formation of nessler cheese and with slow gas production the eyes are well distributed and are larger in size.

Sherman (27) states that a propionic acid-producing bacteria is necessary in swiss cheese in order to get the proper formation of eyes and the desirable flavor which are both outstanding characteristics of swiss cheese. It appears to be able, almost by itself, to produce the desirable qualities of swiss cheese, but it plays little part in the controlling of undesirables.

Matheson (17) and Frazier (10) agree that it is necessary to add an eye and flavor culture to the kettle milk, however, this bacteria do not increase in numbers in the kettle, but do most of their work in the warm curing room.

Harper (15) has said that proper size and distribution of eyes are important in normal swiss cheese. Eyes that are normal, vary in size from .5 inches to 1.25 inches and should be spaced from 1 to 3 inches apart. Carbon dioxide and nitrogen are the gases found in the eyes with carbon dioxide being the most important. It should be assumed that an eye forms where there is a colony of gas producing organisms; however, this is found to be impossible and has been demonstrated that the gas diffuses through the body of the cheese and accumulates at a point of least resistance in the curd mass. The characteristic change brought about by the propionic acid bacteria is the breakdown of lactic acid according to this reaction: $3CH_3CHOHCOOH \rightarrow 2CH_3CH_2COOH + CH_3COOH + H_2O + CO_2$.

Propionibacterium shermanii will ferment lactose and lactic acid, producing carbon dioxide, propionic and acetic acid from succinates, glycerol peptone, and perhaps to a slight degree from butter fat. Peptone gives rise to more propionic and acetic acid than any of the other substances. Aspartic acid is the main source of carbon dioxide and acetic acid; however; the propionic acid organisms are influenced to some extent by other organisms making material available by their fermentation processes.

Hammer also states that at one time it was believed that the propionic bacteria were necessary for eye formation, but recent investigations lead us to believe they may have little importance in the formation of eyes. It was also thought eye formation and flavor were closely related, but it has been found that one can be present without the other.

Improper eye formation and the abnormalities in the body of the cheese were studied by Burkey et al. (2, 3) found Bacillus vulgatus to produce a bitter flavor and reddish spots; the B. coli and A. aerogenes when found in large numbers produced a gassy cheese known as pressaler; also a contaminating type of propionic acid bacteria was found which produced a reddish or brown spot where the eye was formed. These organisms can be controlled by proper sanitation measures, by having an addition of salt to the kettle and heavy salting during curing.

Matheson (17) says that improper eye formation is also controlled by high cooking temperatures which inactivate the coli-aerogenes group of gas producers.

Salting

Samuis (24) and Peter (21) recommend a saturated solution of sodium chloride be used in salting the cheese. The cheese should be left in the

brine for 2 to 6 days depending on the size of the cheese. After being removed from the brine, the cheese should be placed in a room with a temperature ranging from 40° to 50°F. It is left in this room from 10 to 14 days in order for the salt to permeate through the cheese.

Peter (21) states that salt content of the curd mass controls the eye formation. Too long brining causes the eyes to form in the center of the cheese and too short brining period causes cheese to have eyes on the surface.

Curing

Sanders et al. (25) did considerable work to find out which was the best moisture content for the cheese to have the best eye formation. He found that the best moisture content was 39 per cent on the green cheese (one day old). He also stated that too high a moisture usually produced too small and too many eyes; this is known as "over setting".

Recommendations have been made by Sawals (24) and Peter (21) on the time and temperatures of the warm curing room. They agree that the temperature should be between 68 and 75°F. and it will take approximately 8 to 12 weeks to get the proper eye formation. The cheese in this room is turned over every other day and is rubbed with a brine solution. Experience will determine correct eye formation by the sound and swell of the cheese. He also states that if a larger eye is desirable the warm room can be adjusted to 75° to 77°F.; however, best flavor and texture is accomplished if the room is kept at a lower temperature.

Orla-Jensen (18) states that in order to produce eyes of desirable size and shape the cheese is moved into a room of 64.5° to 68°F. when it is two weeks old. At this temperature the propionic acid bacteria

will be accelerated in growth, thus forming the eyes. This temperature also speeds up the curing of the cheese. The time that is usually required to open the eyes is from 4 to 6 weeks. After the proper eye formation is reached, the cheese is moved into a cold room (40° to 45°F.), which stops the eye formation and the growth of the propionic acid bacteria. Eye formation can be controlled somewhat by applying larger amounts of salt which slows the growth of the propion bacteria. Too dry a cheese may produce ragged eyes.

Samuis (24) and Peter (21) both agree that the humidity of the eye forming room should be between 80° and 85°. Rooms for curing should be held between 35° and 40°C. and the period held is between 4 to 12 months according to market demands. This is recommended by Samuis (24) and he also states that the longer period in the curing room the finer the body, flavor, and texture.

## PROCEDURE

### The manufacture of swiss cheese

The milk used in this experiment was manufacturing milk and was produced by dairymen in Cache county, Utah. The cheese was made in the months of December, 1950, and January, 1951.

The milk was mixed in a large vat and standardized to 3.2 per cent butter fat and was then heated to 94° F. and clarified. The milk was divided into three 725 pound lots and placed into three small stainless steel American cheese vats.

The milk was then checked for quality by means of the titratable acidity test, methylene blue reduction test and pH. These tests were all run according to the procedures outlined in Standard Methods (28).

The starters used in this problem were obtained from the Cache Valley Dairy Association's swiss cheese plant at Smithfield, Utah. Three types of bacteria were used: Streptococcus thermophilus, Lactobacillus bulgaricus, and Propionibacterium shermanii. The milk used for both the L. bulgaricus and S. thermophilus was whole milk, and was sterilized at 15 pounds pressure for 15 minutes.

The strains of Lactobacillus bulgaricus were used. These two strains were propagated separately each day at the rate of 2 drops per 100 ml. of milk.

Three strains of Streptococcus thermophilus were used. They were transferred daily at the rate of 3 drops per 100 ml. of sterilized milk. All strains of both cultures were incubated at 100°F. for 14 to 16 hours.

The Propionibacterium shermanii was grown in broth containing 5 grams

beta lactose, 10 grams tryptone, and 10 grams peptone made up to 500 ml. with water. One ml. of the culture was transferred to 250 ml. of the broth which had been sterilized at 15 pounds pressure for 15 minutes. The culture was then incubated at 86°F. for three days. After being incubated for three days the broth had a cloudy appearance which indicated good growth of the organism. This was the only test made on the P. shermanii to determine the activity of the bacteria in the broth.

The L. bulgaricus and S. thermophilus were titrated for acidity each morning, and also the pH of each was taken before they were added to the milk. These two tests gave a general idea as to the quality and activity of the starter.

The milk was tempered to 91°F. and the starter was added. Propionibacterium shermanii was added at the rate of 50 ml. of culture per 1000 pounds of milk. L. bulgaricus was added at the rate of 300 ml. per 1000 pounds of milk and S. thermophilus was added at the rate of 600 ml. per 1000 pounds of milk. Rennet was added at the rate of 60 ml. per 1000 pounds of milk.

The S. thermophilus, L. bulgaricus, and P. shermanii were mixed together before being placed in the milk. The milk was stirred for approximately two minutes after the cultures were added. The rennet was diluted in cold water and added to the milk which was being constantly agitated. Agitation was continued for two or three minutes after the rennet was added. The vats were covered during setting. The setting time ranged from 25 to 30 minutes.

The curd was cut when it was firm enough to break when rolled over with a scoop. The curd was cut with quarter inch knives using the method used in cutting cheddar. After the curd was in quarter-inch cubes, a one-half inch vertical knife was used in place of a harp to cut the

curd into particles about the size of a kernel of wheat. Cutting was continued for approximately 10 minutes. After the curd had reached the correct size, it was stirred with a paddle for 15 minutes and then heated to 100°F. in 15 minutes. The curd was allowed to settle and about one-half of the whey was drained. Heating to the cooking temperature of 124° F. was completed after the matted curd had been broken up. The temperature was increased at the rate of 2° every five minutes for the first six degrees and then gradually reaching final cooking temperature in 15 more minutes. The cooking temperature was reached 30 minutes after the curd had settled and part of the whey drained.

The cooking end point was determined by the rate at which the curd sank in a salt solution. This solution contained 8.5 grams of NaCl per 100 ml. of solution. Curd was collected and dropped into a beaker containing this solution, if it sank in 15 to 30 seconds the cheese was ready to be dipped. When the dipping point was reached according to the salt solution it was squeezed in the hand to get a general idea of the feel of the curd or the cook.

The whey was drained similar to the methods used in cheddar; however the curd was stirred until the whey just barely covered the curd. The drain screen was removed from the spout and a screen the same length as the vat was placed down one side of the vat. The curd was then forced to the opposite side of the vat and the rest of the whey was drained. The curd when forced to one side of the vat was held by bracing against the screen and was held in this position for 10 to 15 minutes until the whey had drained and the curd had matted. The curd at this point was held in a mass the width of a 20 pound Wilson hoop. After the curd had matted for 10 to 15 minutes, it was cut into blocks approximately the size of the hoop. The screens were removed and the blocks were then

surrounded by the liner of the hoop. When the liner was in place, the body of the hoop was placed over the liner and the cheese was then very gently turned over and the lid placed on the hoop. Each vat yielded 3 hoops of cheese which were then piled on top of one another in the bottom of the vat, with the top side of the curd when it was in the vat facing down; this was to get a good knit of the curd on top of the cheese. The hoops were rearranged every 3 to 5 minutes in order to get pressure on all the cheese. After 15 to 20 minutes of piling in the vat, the cheese were removed from the hoops and wrapped in muslin cloths and put in the cheddar press after they were replaced in the hoops.

The cheese were pressed in the same manner as cheddar. They were taken from the press the next morning, weighed and placed in a saturated solution of NaCl which was held at 54°F. One cheese from each vat remained in this salt solution for 24 hours. The second cheese remained in the brine for 36 hours and the third cheese remained in the brine for 48 hours. The cheese were submerged in the brine by pressure. When the cheese were taken from the brine they were drained free of moisture for 5 to 10 minutes and then wrapped in parakote and placed into hoops and pressed for 4 to 5 hours. This was done to get a tight fit between the parakote and cheese. The cheese were then placed into a wooden box and strapped with metal straps and placed in a room at a temperature of 54°F. for seven days. Cheese from each of the brine periods was then placed in warm rooms where temperatures were maintained at 74, 84, and 94°F. The cheese were removed from these warm rooms when there was a 5/8" bulge noted in the box. The cheese was placed in a curing room held at a temperature of 45°F. The cheese were examined in 75 days from the day of making.

When the cheese were examined they were graded for flavor, body and texture, eye formation, appearance and color. Each cheese was examined for the above and a score was given each cheese. Each cheese was analyzed for fat, moisture, pH, and the NaCl content. Fat was determined by the Babcock method as outlined in Van Slyke and Price (31) except for a slight modification to the procedure. They advise adding 10 ml. of $H_2O$ at 130°F. to the 9 grams of cheese and then adding the acid in three portions. When this was done the result was excessive boiling; therefore, the temperature was decreased to 120°F. which worked satisfactorily. The moisture and salt content was determined as outlined in Official Methods (16), the pH was determined with a model G Beckman pH meter using a glass and a calomel electrod. This same meter was used for all pH valuations throughout the experiment.

The cheese was graded according to the following score card:

| | |
|---|---|
| Flavor | 40 |
| Appearance on Trier-eyes | 25 |
| Texture and Body | 20 |
| Salt | 10 |
| Make-up and Finish | 5 |
| Total | 100 |

## RESULTS AND DISCUSSION

### Effect of salting time on scores and composition

The cheese that was held in the brine solution for 48 hours developed eyes at a slower rate than the loaves that were held for 24 and 36 hours; also the 36 hour brined cheese was slower than the cheese of the 24 hour brining time. Table 2 is supporting evidence of the above statement. The averaged days for the 24 hour brine treatment is 15.83, the 36 hour brine time had an average of 16.57 days, and the 48 hour treatment remained in the warm room for 18.04 days before eyes were formed.

It is shown on plate one that the cheese of the higher salt concentration did not develop swelling as quickly as the lower salt content; therefore, some of the cheese with higher salt content did not extrude from the boxes when held for an extended period.

When the cheese was scored there was a marked difference in the score of the cheese at the different salt levels. On an average the cheese at the 24 hour brine time was best in flavor, body and texture; however the eye formation score was lower. This was caused by the lots which bloated out of the box giving rise to a lower score on the eye formation. When the last five lots are averaged (these lots were taken from the warm room when the desired swelling was reached), the 24 hour brine time was 22.36, the 36 hour was 22.14, and the 48 hour brine time was 22.06. These figures show that the best eye formation was found in the cheese held in brine for 24 hours. At the higher temperatures there were too many eyes which resulted in a lower score.


Plate one
Effects of salt and temperature
upon the development of eyes

The percentage of moisture and fat and the pH of the curd at 75 days was not influenced by the different salt concentrations. As the brine time increased the salt content of the cheese increased. The curd absorbs salt rapidly in the first 24 hours then it diminishes. It is shown in table 3 that after 24 hours of brining the cheese had absorbed .80% salt and at 36 hours there was an average of .88% and 48 hours .99% salt. These figures show that the greatest quantity of salt is taken in by the curd in the first 24 hours of brining.

Effect of warm room temperatures on scores and composition

As it is shown on plate one, there is an influence of temperature on the development of eyes. This picture is a typical example of what happened to the cheese when held at the different temperatures. You will notice that the high temperature increased the rapidity of the eye formation. There is a gradual increase in the swelling shown on the photograph at the different temperatures. In reviewing table 2 it is noted that the 74°F. treatment of the cheese had a much longer time in the warm room than the other temperature employed. The average days the cheese was held in warm room at 74°F, was 24.62 days; at 84°F. 13.66 days and at 94°F., 12.16 days.

The eye formation was definitely effected by the different temperatures. The scores given to eye formation was highest in the 74 degree warm room. The average score on eye formation for the 74, 84, and 94°F. warm room was 25.66, 21.13, and 20.60 respectively. The differences are large enough to consider when grading is so prominent in marketing cheese. When you review table 1, you can immediately see that the 74 degree temperature was the best suited for the eye formation. The

Table 1. Effects of salt concentration and temperature on average score and analysis of swiss cheese.

| Items scored and analyzed | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Curing Temperature in F° | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| Flavor* | 37.70 | 34.80 | 34.50 | 35.10 | 35.20 | 34.30 | 35.20 | 34.90 | 34.40 |
| Trier-eye* | 23.90 | 20.70 | 20.50 | 23.70 | 21.50 | 20.40 | 23.40 | 21.20 | 20.90 |
| Body and texture* | 19.50 | 18.50 | 18.20 | 18.70 | 18.50 | 18.10 | 18.80 | 18.20 | 18.00 |
| Total* | 93.10 | 90.00 | 88.50 | 91.90 | 89.90 | 88.10 | 92.40 | 89.20 | 87.00 |
| % moisture | 34.76 | 33.98 | 34.50 | 34.42 | 34.34 | 34.32 | 34.34 | 33.62 | 34.30 |
| % fat | 29.80 | 30.10 | 30.40 | 30.60 | 29.70 | 30.80 | 30.20 | 30.30 | 30.30 |
| pH | 5.60 | 5.65 | 5.66 | 5.65 | 5.67 | 5.60 | 5.61 | 5.66 | 5.65 |
| % salt | | .80 | | | .88 | | | .99 | |

*score
% salt was run on one cheese from each of the brine times.

different salting times had some effect on the score given the eye formation, but was minor when compared with the differences that were shown between the temperatures of the warm rooms.

The score of cheese was influenced by the temperature at which the warm room was regulated. Greater differences were noted in flavor score than in any of the other items used in scoring. Table 1 shows that the flavor score of the cheese held at a temperature of 74°F. was considerable higher than that of the cheese maintained at a temperature of 84°F. and 94°F., at all of the different salt levels. The 84°F. and 94°F. treated cheese had a very small difference in the score for flavor as is shown in table 5. In reviewing table 5 we note the flavor score of the 74 degree cheese had an average total score of 34.60, the 84 degree had an average flavor score of 34.97, and the 94 degree room average flavor score was 34.40. The most common flavor defect encountered in cheese held at the higher temperature was stringent. A fruity flavor was also noted.

Body and texture scores were influenced by the different warm room temperatures. The highest score was given to the lower temperature; this was because of the desirable texture which was developed in the low temperature. The general criticism given all the cheese on body and texture was "too dry". This could be changed by cooking procedures.

It is shown in table 5 that the 74 degree warm room had an average total score of 92.47. This score is 2.77 points higher than the 84 degree room and 4.60 points higher than the 94 degree room.

The moisture content, fat content, and pH showed no significant differences in the cheese held at different temperatures.

Table 2. Number of days in warm room required to develop eyes.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 16 | 14 | 14 | 25 | 14 | 14 | 25 | 14 | 14 |
| 2 | 20 | 14 | 14 | 22 | 14 | 14 | 28 | 14 | 14 |
| 3 | 27 | 15 | 11 | 27 | 13 | 13 | 27 | 13 | 13 |
| 4 | 19 | 11 | 13 | 30 | 13 | 11 | 30 | 11 | 10 |
| 5 | 24 | 10 | 16 | 24 | 13 | 6 | 28 | 21 | 10 |
| 6 | 28 | 17 | 10 | 29 | 15 | 10 | 23 | 15 | 16 |
| 7 | 18 | 8 | 12 | 23 | 15 | 9 | 27 | 17 | 14 |
| 8 | 22 | 12 | 15 | 23 | 11 | 10 | 26 | 14 | 9 |
| Avg. | 21.75 | 12.62 | 13.12 | 25.37 | 13.50 | 10.85 | 26.75 | 14.87 | 12.50 |

Table 3. Average scores of 8 lots of cheese, when comparing the different lengths of time in brine.

| Items scored | Hours in Brine | | |
|---|---|---|---|
| | 24 | 36 | 48 |
| Flavor | 35.66 | 34.86 | 34.83 |
| Trier-eye | 21.70 | 21.86 | 21.86 |
| Body and texture | 18.73 | 18.43 | 18.33 |
| Total | 90.53 | 89.66 | 89.53 |

Table 4. Average analysis of 8 lots of cheese, when comparing the different lengths of time in brine.

| Items analyzed | Hours in Brine | | |
|---|---|---|---|
| | 24 h | 36 | 48 |
| Moisture | 34.41 | 34.36 | 34.09 |
| Fat | 30.10 | 30.40 | 30.30 |
| Salt | .80 | .88 | .99 |
| pH | 5.64 | 5.64 | 5.64 |

Table 5. Average scores of 8 lots of cheese, when comparing the different warm room temperatures.

| Items scored | Warm Room in Degrees F. | | |
|---|---|---|---|
| | 74 | 84 | 94 |
| Flavor | 36.00 | 34.97 | 34.40 |
| Trier-eyes | 23.66 | 21.13 | 20.60 |
| Body and texture | 19.00 | 18.40 | 18.10 |
| Total | 92.47 | 89.70 | 87.87 |

Table 6. Average analysis of 8 lots of cheese, when comparing the different warm room temperatures.

| Items analyzed | Warm Room in Degrees F. | | |
|---|---|---|---|
| | 74 | 84 | 94 |
| Moisture | 34.51 | 35.98 | 34.37 |
| Fat | 30.20 | 30.03 | 30.50 |
| pH | 5.62 | 5.66 | 5.64 |

## SUMMARY

In producing high grade swiss cheese there appears that an optimum temperature is to be used in the warm room. The temperature which gave best results under the conditions employed was 74°F. When the flavor, eye, body and texture, and total scores are compared in table 1, it is definitely shown that the 74°F. yields the highest score and 94°F. the lowest.

When the different lengths of time the cheese was held in the brine tank was considered, there seems to be a trend in the scores and brining times. The scores were highest where the cheese was brined for 24 hours. The flavor, body and texture, and total scores were all highest in the 24 hour brining time.

## CONCLUSION

When adapting cheddar equipment and methods to produce 20 pound loaf cuts cheese the best warm room temperature is near 74°F. and the cheese should be exposed to the temperature for 25 to 27 days. The best salt content is obtained by holding the cheese in a saturated salt solution for 24 hours at 54°F.

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# APPENDIX

SWISS CHEESE MAKE SHEET

Maker K. Greer Date 12/23/50

U.S.A.C. Lot 1 Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | Raw | Raw | Raw |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 1½ hrs. | 1½ hrs. | 1½ hrs. |
| Grade of milk | C | C | C |
| Amount of milk | 725# | 725# | 725# |
| Amount of coccus added | 580 ml. | 580 ml. | 580 ml. |
| Amount of rod added | 290 ml. | 290 ml. | 290 ml. |
| Amount of propion added | 37 ml. | 37ml. | 37 ml. |
| Amount of rennet added | 57 ml. | 57 ml. | 57 ml. |
| Acidity of rod | 1.04 | 1.04 | 1.04 |
| Acidity of coccus | .80 | .80 | .80 |
| Acidity of milk before setting | .17 | .17 | .17 |
| Acidity of whey at cutting | .11 | .11 | .11 |
| Acidity of whey at dipping | .15 | .15 | .15 |
| pH of rod | 4.06 | 4.06 | 4.06 |
| pH of coccus | 4.34 | 4.34 | 4.34 |
| pH of milk before setting | 6.49 | 6.49 | 6.49 |
| pH of whey at cutting | 6.47 | 6.47 | 6.47 |
| pH of whey at dipping | 5.95 | 6.15 | 6.20 |
| pH of cheese 5 hrs. on press | 5.59 | 5.80 | 5.75 |
| pH of cheese days after making | | | |
| Time adding starter | 5:10 | 5:01 | 5:55 |
| Time adding rennet | 5:12 | 5:03 | 5:57 |
| Time of cutting | 5:37 | 5:28 | 6:20 |
| Time of dipping | 6:35 | 7:07 | 7:30 |
| Time hooped | 6:45 | 7:15 | 7:40 |
| Time (hours) in press | 14 | 14 | 13 |
| Time (hours) in brine | 24, 36, and 48 hrs. | | |
| Time (days) in cold room | 10 days | | |
| Temperature of setting | 94°F. | 94°F. | 94°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 54°F. | 54°F. | 54°F. |
| Temperature of cold room | 54°F. | 54°F. | 54°F. |
| Temperature of warm room | 74, 84, and 94°F. | | |
| Weight of cheese out of hoop | 64# | 69# | 71# |
| Yield per cwt. of milk | 8.8# | 9.5# | 9.8# |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker [illegible] Date 12/26/50

U.S.A.C. Lot 2 Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | [illegible] | [illegible] | [illegible] |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 2 hrs. | 2 hrs. | 2 hrs. |
| Grade of milk | 4 | 4 | 4 |
| Amount of milk | 725 | 725 | 725 |
| Amount of coccus added | 720 ml. | 720 ml. | 720 ml. |
| Amount of rod added | 360 ml. | 360 ml. | 360 ml. |
| Amount of propion added | 35 ml. | 35 ml. | 35 ml. |
| Amount of rennet added | 57 ml. | 57 ml. | 57 ml. |
| Acidity of rod | .60 | .60 | .60 |
| Acidity of coccus | .57 | .57 | .57 |
| Acidity of milk before setting | .17 | .17 | .17 |
| Acidity of whey at cutting | .10 | .10 | .10 |
| Acidity of whey at dipping | .11 | .11 | .11 |
| pH of rod | 4.38 | 4.38 | 4.38 |
| pH of coccus | 4.70 | 4.70 | 4.70 |
| pH of milk before setting | 6.50 | 6.50 | 6.50 |
| pH of whey at cutting | 6.40 | 6.35 | 6.30 |
| pH of whey at dipping | 6.30 | 6.28 | 6.30 |
| pH of cheese hrs. on press | | | |
| pH of cheese days after making | | | |
| Time adding starter | 4:07 | 4:06 | 4:03 |
| Time adding rennet | 4:08 | 4:08 | 4:05 |
| Time of cutting | 4:32 | 4:32 | 4:29 |
| Time of dipping | 5:40 | 5:40 | 5:37 |
| Time hooped | 5:50 | 6:10 | 6:05 |
| Time (hours) in press | 24 hrs. | 24 hrs. | 24 hrs. |
| Time (hours) in brine | | 24, 36, and 48 hrs. | |
| Time (days) in cold room | | 10 days | |
| Temperature of setting | 91°F. | 91°F. | 91°F. |
| Temperature of cooking | 121°F. | 121°F. | 121°F. |
| Temperature of brine | 51°F. | 51°F. | 51°F. |
| Temperature of cold room | 51°F. | 51°F. | 51°F. |
| Temperature of warm room | | 75, 81, and 91°F. | |
| Weight of cheese out of hoop | [illegible] | [illegible] | [illegible] |
| Yield per cwt. of milk | 9.25# | 8.70# | 9.30# |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker [illegible]  Date 12/20/50

U.S.A.C.  Lot 3  Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | [illegible] | [illegible] | [illegible] |
| Fat test of milk | 3.6 | 3.6 | 3.6 |
| Methylene blue of milk at setting | 5 hrs. | 5 hrs. | 5 hrs. |
| Grade of milk | 6 | 6 | 6 |
| Amount of milk | [illegible] | [illegible] | [illegible] |
| Amount of coccus added | 6% c. | 6% c. | 6% c. |
| Amount of rod added | 330 c. | 330 c. | 330 c. |
| Amount of propion added | 35 c. | 35 c. | 35 c. |
| Amount of rennet added | 57 c. | 57 c. | 57 c. |
| Acidity of rod | 1.20 | 1.20 | 1.20 |
| Acidity of coccus | .63 | .63 | .63 |
| Acidity of milk before setting | .17 | .17 | .17 |
| Acidity of whey at cutting | .10 | .10 | .10 |
| Acidity of whey at dipping | .11 | .11 | .11 |
| pH of rod | 3.85 | 3.85 | 3.85 |
| pH of coccus | 4.71 | 4.71 | 4.71 |
| pH of milk before setting | 6.51 | 6.51 | 6.51 |
| pH of whey at cutting | 6.12 | 6.12 | 6.12 |
| pH of whey at dipping | 6.19 | 6.19 | 6.19 |
| pH of cheese 5 hrs. on press | 5.70 | 5.85 | 5.80 |
| pH of cheese [illegible] days after making | | | |
| Time adding starter | 12:13 | 12:15 | 12:18 |
| Time adding rennet | 12:33 | 12:16 | 12:40 |
| Time of cutting | 12:35 | 12:42 | 1:05 |
| Time of dipping | 2:00 | 2:50 | 2:45 |
| Time hooped | 2:35 | 2:55 | 3:00 |
| Time (hours) in press | 16 hrs. | 16 hrs. | 16 hrs. |
| Time (hours) in brine | | 24 hrs. at 16 hrs. | |
| Time (days) in cold room | | 7 days. | |
| Temperature of setting | 91°F. | 91°F. | 91°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 51°F. | 51°F. | 51°F. |
| Temperature of cold room | 51°F. | 51°F. | 51°F. |
| Temperature of warm room | | 74 hrs. at 74°F. | |
| Weight of cheese out of hoop | [illegible] | [illegible] | [illegible] |
| Yield per cwt. of milk | [illegible] | [illegible] | [illegible] |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker K. Greer Date 1/2/51

U.S.A.C. Lot 4 Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | Raw | Raw | Raw |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 2½ hrs. | 2½ hrs. | 2½ hrs. |
| Grade of milk | C | C | C |
| Amount of milk | 725# | 725# | 725# |
| Amount of coccus added | 438 ml. | 438 ml. | 438 ml. |
| Amount of rod added | 219 ml. | 219 ml. | 219 ml. |
| Amount of propion added | 35 ml. | 35ml. | 35 ml. |
| Amount of rennet added | 57 ml. | 57ml. | 57 ml. |
| Acidity of rod | 1.57 | 1.57 | 1.57 |
| Acidity of coccus | .69 | .69 | .69 |
| Acidity of milk before setting | .16 | .16 | .16 |
| Acidity of whey at cutting | .11 | .11 | .11 |
| Acidity of whey at dipping | .11 | .11 | .11 |
| pH of rod | 3.30 | 3.30 | 3.30 |
| pH of coccus | 4.35 | 4.35 | 4.35 |
| pH of milk before setting | 6.42 | 6.42 | 6.42 |
| pH of whey at cutting | 6.41 | 6.41 | 6.41 |
| pH of whey at dipping | 6.28 | 6.25 | 6.30 |
| pH of cheese 5 hrs. on press | 5.50 | 5.50 | 5.50 |
| pH of cheese days after making | | | |
| Time adding starter | 2:00 | 2:01 | 3:03 |
| Time adding rennet | 2:00 | 2:00 | 3:03 |
| Time of cutting | 2:24 | 2:25 | 3:27 |
| Time of dipping | 3:35 | 3:40 | 4:50 |
| Time hooped | 3:50 | 3:55 | 5:05 |
| Time (hours) in press | 15 hrs. | 15 hrs. | 15 hrs. |
| Time (hours) in brine | | 24, 36, 48 hrs. | |
| Time (days) in cold room | | 7 days | |
| Temperature of setting | 94°F. | 94°F. | 94°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 54°F. | 54°F. | 54°F. |
| Temperature of cold room | 54°F. | 54°F. | 54°F. |
| Temperature of warm room | | 74, 84, and 94°F. | |
| Weight of cheese out of hoop | 65# | 66# | 69# |
| Yield per cwt. of milk | 9.0# | 9.1# | 9.5# |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker K. Greer — Date 1/7/51

U.S.A.C. — Lot 5 — Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | Raw | Raw | Raw |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 1¼ hrs. | 1¼ hrs. | 1¼hrs. |
| Grade of milk | C | C | C |
| Amount of milk | 725# | 725# | 725# |
| Amount of coccus added | 510 ml. | 510 ml. | 510 ml. |
| Amount of rod added | 255 ml. | 255 ml. | 255 ml. |
| Amount of propion added | 35 ml. | 35 ml. | 35 ml. |
| Amount of rennet added | 57 ml. | 57 ml. | 57 ml. |
| Acidity of rod | .88 | .88 | .88 |
| Acidity of coccus | .53 | .53 | .53 |
| Acidity of milk before setting | .17 | .17 | .17 |
| Acidity of whey at cutting | .12 | .12 | .12 |
| Acidity of whey at dipping | .13 | .13 | .13 |
| pH of rod | 3.91 | 3.91 | 3.91 |
| pH of coccus | 4.48 | 4.48 | 4.48 |
| pH of milk before setting | 6.60 | 6.60 | 6.60 |
| pH of whey at cutting | 6.50 | 6.50 | 6.43 |
| pH of whey at dipping | 6.42 | 6.35 | 6.30 |
| pH of cheese 5 hrs. on press | 5.81 | 5.76 | 5.80 |
| pH of cheese days after making | | | |
| Time adding starter | 12:35 | 12:44 | 1:22 |
| Time adding rennet | 12:37 | 12:45 | 1:24 |
| Time of cutting | 1:02 | 1:10 | 1:45 |
| Time of dipping | 2:00 | 2:15 | 2:45 |
| Time hooped | 2:10 | 2:25 | 3:00 |
| Time (hours) in press | 17 | 17 | 17 |
| Time (hours) in brine | 24, 36, 48 hrs. | | |
| Time (days) in cold room | 7 days | | |
| Temperature of setting | 94°F. | 94°F. | 94°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 54°F. | 54°F. | 54°F. |
| Temperature of cold room | 54°F | 54°F | 54°F. |
| Temperature of warm room | 74, 84, and 94°F. | | |
| Weight of cheese out of hoop | 68# | 67# | 67# |
| Yield per cwt. of milk | 9.4# | 9.25# | 9.25# |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker K. Creer — Lot 6 — Date 8/20/51

U.S.A.C. — Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | Raw | Raw | Raw |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 7 hrs. | 7 hrs | 7 hrs. |
| Grade of milk | A | A | A |
| Amount of milk | 725# | 725# | 725# |
| Amount of coccus added | 435 ml. | 435 ml. | 435 ml. |
| Amount of rod added | 218 ml. | 218 ml. | 218 ml. |
| Amount of propion added | 36 ml. | 36 ml. | 36 ml. |
| Amount of rennet added | 57 ml. | 57 ml. | 57 ml. |
| Acidity of rod | 1.14 | 1.14 | 1.14 |
| Acidity of coccus | .57 | .57 | .57 |
| Acidity of milk before setting | .16 | .16 | .16 |
| Acidity of whey at cutting | .11 | .11 | .11 |
| Acidity of whey at dipping | .11 | .11 | .11 |
| pH of rod | 3.68 | 3.68 | 3.68 |
| pH of coccus | 4.53 | 4.53 | 4.53 |
| pH of milk before setting | 6.66 | 6.66 | 6.66 |
| pH of whey at cutting | 6.55 | 6.59 | 6.6 |
| pH of whey at dipping | 6.5 | 6.5 | 6.5 |
| pH of cheese 5 hrs. on press | 5.7 | 5.53 | 5.68 |
| pH of cheese days after making | | | |
| Time adding starter | 10:40 | 10:32 | 11:05 |
| Time adding rennet | 10:42 | 10:33 | 11:07 |
| Time of cutting | 11:07 | 10:57 | 11:33 |
| Time of dipping | 12:30 | 12:19 | 12:55 |
| Time hooped | 12:45 | 12:40 | 1:05 |
| Time (hours) in press | 16 | 16 | 16 |
| Time (hours) in brine | 24, 36, and 48 | | |
| Time (days) in cold room | 7 | 7 | 7 |
| Temperature of setting | 94°F. | 94°F. | 94°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 54°F. | 54°F. | 54°F. |
| Temperature of cold room | 54°F. | 54°F. | 54°F. |
| Temperature of warm room | 74, 84, and 94°F. | | |
| Weight of cheese out of hoop | 69# | 68# | 68# |
| Yield per cwt. of milk | 9.5# | 9.4# | 9.4# |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker K. Creer  Lot 7  Date 1/25/51

U.S.A.C.  Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | Raw | Raw | Raw |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 1½ hr | 1½ hr | 1½ hr |
| Grade of milk | C | C | C |
| Amount of milk | 725# | 725# | 725# |
| Amount of coccus added | 435 ml. | 435 ml. | 435 ml. |
| Amount of rod added | 218 ml. | 218 ml. | 218 ml. |
| Amount of propion added | 37 ml. | 37 ml. | 37 ml. |
| Amount of rennet added | 58 ml. | 58 ml. | 58 ml. |
| Acidity of rod | 1.31 | 1.31 | 1.31 |
| Acidity of coccus | .65 | .65 | .65 |
| Acidity of milk before setting | .16 | .16 | .16 |
| Acidity of whey at cutting | .10 | .11 | .10 |
| Acidity of whey at dipping | .11 | .12 | .115 |
| pH of rod | 3.7 | 3.7 | 3.7 |
| pH of coccus | 4.43 | 4.43 | 4.43 |
| pH of milk before setting | 6.58 | 6.58 | 6.58 |
| pH of whey at cutting | 6.55 | 6.55 | 6.52 |
| pH of whey at dipping | 6.4 | 6.3 | 6.38 |
| pH of cheese 5 hrs. on press | 5.84 | 5.74 | 5.62 |
| pH of cheese days after making | | | |
| Time adding starter | 4:01 | 4:15 | 4:43 |
| Time adding rennet | 4:02 | 4:16 | 4:45 |
| Time of cutting | 4:26 | 4:47 | 5:15 |
| Time of dipping | 5:37 | 6:08 | 6:25 |
| Time hooped | 5:45 | 6:19 | 6:45 |
| Time (hours) in press | 14 | 14 | 14 |
| Time (hours) in brine | 24, 36, and 48 | | |
| Time (days) in cold room | 7 | 7 | 7 |
| Temperature of setting | 94°F. | 94°F. | 94°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 54°F. | 54°F. | 54°F. |
| Temperature of cold room | 54°F. | 54°F. | 54°F. |
| Temperature of warm room | 74, 84, and 94°F. | | |
| Weight of cheese out of hoop | 68# | 67# | 65# |
| Yield per cwt. of milk | 9.4# | 9.25# | 9.0# |

Bacterial plate count

SWISS CHEESE MAKE SHEET

Maker K. Creer Lot 8 Date 1/26/51

U.S.A.C. Dairy Mfg. Dept.

| | VAT NO. 1 | VAT NO. 2 | VAT NO. 3 |
|---|---|---|---|
| Treatment of Milk | Raw | Raw | Raw |
| Fat test of milk | 3.2 | 3.2 | 3.2 |
| Methylene blue of milk at setting | 2 hrs | 2 hrs | 2 hrs |
| Grade of milk | C | C | C |
| Amount of milk | 725# | 725# | 725# |
| Amount of coccus added | 435 ml. | 435 ml. | 435 ml. |
| Amount of rod added | 218 ml. | 218 ml. | 218 ml. |
| Amount of propion added | 37 ml. | 37 ml. | 37 ml. |
| Amount of rennet added | 58 ml. | 58 ml. | 58 ml. |
| Acidity of rod | 1.42 | 1.42 | 1.42 |
| Acidity of coccus | .56 | .56 | .56 |
| Acidity of milk before setting | .155 | .155 | .155 |
| Acidity of whey at cutting | .10 | .10 | .11 |
| Acidity of whey at dipping | .11 | .11 | .11 |
| pH of rod | 3.52 | 3.52 | 3.52 |
| pH of coccus | 4.45 | 4.45 | 4.45 |
| pH of milk before setting | 6.6 | 6.6 | 6.6 |
| pH of whey at cutting | 6.52 | 6.52 | 6.52 |
| pH of whey at dipping | 6.42 | 6.4 | 6.49 |
| pH of cheese 5 hrs. on press | 5.62 | 5.8 | 6.15 |
| pH of cheese days after making | | | |
| Time adding starter | 1:17 | 1:38 | 2:15 |
| Time adding rennet | 1:19 | 1:40 | 2:17 |
| Time of cutting | 1:47 | 2:10 | 2:47 |
| Time of dipping | 3:15 | 3:25 | 3:55 |
| Time hooped | 3:25 | 3:45 | 4:10 |
| Time (hours) in press | 16 | 16 | 16 |
| Time (hours) in brine | | 24, 36, and 48 | |
| Time (days) in cold room | 7 | 7 | 7 |
| Temperature of setting | 94°F. | 94°F. | 94°F. |
| Temperature of cooking | 124°F. | 124°F. | 124°F. |
| Temperature of brine | 54°F. | 54°F. | 54°F. |
| Temperature of cold room | 54°F. | 54°F. | 54°F. |
| Temperature of warm room | | 74, 84, and 94°F. | |
| Weight of cheese out of hoop | 68# | 68# | 68# |
| Yield per cwt. of milk | 9.4# | 9.4# | 9.4# |

Bacterial plate count

Table 7. Flavor score of swiss cheese 75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 35 | 35 | 34 | 35 | 35 | ** | 35 | 35 | 35 |
| 2 | 35 | 33 | 33 | 35 | 34 | 33 | 35 | 34 | 34 |
| 3 | 35 | 33 | 33 | 35 | 35 | 33 | 34 | 35 | 33 |
| 4 | 34 | 35 | 34 | 33 | 33 | 34 | 35 | 33 | 35 |
| 5 | 37 | 31 | 33 | 35 | 36 | 33 | 34 | 33 | 33 |
| 6 | 38 | 38 | 37 | 38 | 38 | 37 | 38 | 37 | 37 |
| 7 | 36 | 38 | 37 | 36 | 36 | 35 | 36 | 37 | 33 |
| 8 | 35 | 35 | 35 | 33 | 35 | 35 | 35 | 35 | 35 |
| Avg. | 37.5 | 34.8 | 34.5 | 35.1 | 35.2 | 34.3 | 35.2 | 34.9 | 34.4 |

Above scores are based on a total of 40 points for flavor.

Table 8. Appearance on trier-eye score of swiss cheese75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 25 | 25 | 20 | 25 | 25 | ** | 25 | 25 | 22 |
| 2 | 25 | 15 | 15 | 25 | 16 | 15 | 25 | 16 | 16 |
| 3 | 24 | 23 | 21 | 24 | 22 | 21 | 21 | 21 | 22 |
| 4 | 23 | 23 | 23 | 24 | 20 | 23 | 24 | 21 | 22 |
| 5 | 23 | 21 | 21 | 22 | 21 | 21 | 22 | 2 1 | 22 |
| 6 | 24 | 2 2 | 18 | 24 | 22 | 18 | 24 | 21 | 23 |
| 7 | 24 | 22 | 22 | 23 | 23 | 22 | 23 | 22 | 18 |
| 8 | 23 | 23 | 24 | 23 | 23 | 23 | 23 | 23 | 22 |
| Avg. | 23.9 | 20.7 | 20.5 | 23.7 | 21.5 | 20.4 | 23.4 | 21.2 | 20.9 |

Above scores are based on a total of 25 points for appearance on trier-e yes.

Table 9. Body and texture score of swiss cheese 75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 20 | 20 | 20 | 20 | 20 | 20 | 19 | 20 | 20 |
| 2 | 20 | 19 | 19 | 19 | 19 | 19 | 20 | 19 | 19 |
| 3 | 19 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| 4 | 20 | 19 | 18 | 20 | 18 | 18 | 20 | 18 | 18 |
| 5 | 20 | 19 | 19 | 18 | 18 | 19 | 18 | 18 | 18 |
| 6 | 19 | 18 | 17 | 19 | 18 | 17 | 18 | 17 | 17 |
| 7 | 19 | 18 | 18 | 18 | 19 | 17 | 19 | 18 | 17 |
| 8 | 19 | 18 | 17 | 18 | 18 | 17 | 18 | 18 | 17 |
| Avg. | 19.5 | 18.5 | 18.2 | 18.7 | 18.5 | 18.1 | 18.8 | 18.2 | 18.0 |

Above scores are based on a total of 20 points for body and texture.

Table 10. Total score of swiss cheese at 75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 93.5 | 90.0 | 90.0 | 94.0 | 93.0 | *** | 93.0 | 94.0 | 92.0 |
| 2 | 94.0 | 83.0 | 82.0 | 93.0 | 83.0 | 82.0 | 94.0 | 84.0 | 84.0 |
| 3 | 88.0 | 92.0 | 88.0 | 89.0 | 90.0 | 89.0 | 90.0 | 87.0 | 88.0 |
| 4 | 92.0 | 92.0 | 90.0 | 92.0 | 86.0 | 90.0 | 94.0 | 87.0 | 90.0 |
| 5 | 95.0 | 86.0 | 88.0 | 90.0 | 90.0 | 88.0 | 89.0 | 87.0 | 88.0 |
| 6 | 96.0 | 93.0 | 89.0 | 96.0 | 93.0 | 89.0 | 95.0 | 91.0 | 92.0 |
| 7 | 94.0 | 93.0 | 92.0 | 92.0 | 93.0 | 89.0 | 93.0 | 92.0 | 83.0 |
| 8 | 92.5 | 91.0 | 91.0 | 89.5 | 91.0 | 90.0 | 91.5 | 91.5 | 89.0 |
| Avg. | 93.1 | 90.0 | 88.5 | 91.9 | 89.9 | 88.1 | 92.4 | 89.2 | 87.0 |

Above scores are based on a total of 100 points.

Table 11. Percent moisture of swiss cheese 75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 35.05 | 32.07 | 34.40 | 32.70 | 34.15 | ** ** | 28.85 | 32.66 | 31.79 |
| 2 | 35.66 | 32.57 | 33.45 | 36.69 | 35.07 | 31.86 | 35.43 | 31.61 | 35.13 |
| 3 | 32.76 | 32.05 | 34.37 | 33.79 | 35.01 | 34.76 | 34.85 | 32.65 | 34.10 |
| 4 | 33.88 | 34.48 | 33.54 | 33.61 | 33.61 | 32.45 | 36.39 | 33.44 | 33.46 |
| 5 | 33.40 | 33.60 | 34.40 | 34.97 | 31.47 | 33.79 | 33.28 | 33.25 | 33.45 |
| 6 | 34.55 | 33.57 | 34.94 | 34.30 | 34.41 | 34.86 | 32.90 | 32.90 | 33.72 |
| 7 | 36.37 | 36.31 | 35.83 | 35.47 | 35.56 | 36.41 | 36.50 | 35.74 | 36.50 |
| 8 | 36.47 | 36.58 | 35.10 | 33.83 | 35.43 | 36.17 | 36.53 | 36.74 | 36.28 |
| Avg. | 34.76 | 33.98 | 34.50 | 34.42 | 34.34 | 34.32 | 34.34 | 33.62 | 34.30 |

Table 12. Percentage of fat in swiss cheese 75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 30.0 | 31.7 | 31.5 | 32.0 | 30.0 | ** * | 31.0 | 30.0 | 30.0 |
| 2 | 30.0 | 29.0 | 28.0 | 30.0 | 29.3 | 30.5 | 30.0 | 30.0 | 30.0 |
| 3 | 27.5 | 29.5 | 30.5 | 30.2 | 28.5 | 34.5 | 30.0 | 29.5 | 30.5 |
| 4 | 29.5 | 30.5 | 30.5 | 31.0 | 29.5 | 30.7 | 29.7 | 31.5 | 30.7 |
| 5 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 31.0 |
| 6 | 30.0 | 30.0 | 30.5 | 30.0 | 30.0 | 30.2 | 30.2 | 30.5 | 30.5 |
| 7 | 30.5 | 29.5 | 30.5 | 30.5 | 30.5 | 29.5 | 29.5 | 30.0 | 30.0 |
| 8 | 30.5 | 30.0 | 31.0 | 30.5 | 30.6 | 30.0 | 31.0 | 30.5 | 30.0 |
| Avg. | 29.8 | 30.1 | 30.4 | 30.6 | 29.7 | 30.8 | 30.2 | 30.3 | 30.3 |

Table 13. pH of swiss cheese 75 days of age.

| Lot No. | Time in Brine | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 hours | | | 36 hours | | | 48 hours | | |
| | Temperature of Warm Room in Degrees F. | | | | | | | | |
| | 74 | 84 | 94 | 74 | 84 | 94 | 74 | 84 | 94 |
| 1 | 5.69 | 5.69 | 5.69 | 5.70 | 5.69 | * ** | 5.62 | 5.70 | 5.71 |
| 2 | 5.69 | 5.82 | 5.87 | 5.68 | 5.78 | 5.76 | 5.68 | 5.80 | 5.82 |
| 3 | 5.60 | 5.70 | 5.75 | 5.71 | 5.79 | 5.69 | 5.70 | 5.80 | 5.78 |
| 4 | 5.64 | 5.67 | 5.61 | 5.70 | 5.72 | 5.75 | 5.68 | 5.70 | 5.70 |
| 5 | 5.61 | 5.59 | 5.70 | 5.69 | 5.70 | 5.60 | 5.68 | 5.65 | 5.61 |
| 6 | 5.50 | 5.55 | 5.60 | 5.52 | 5.50 | 5.30 | 5.56 | 5.56 | 5.50 |
| 7. | 5.60 | 5.70 | 5.58 | 5.70 | 5.56 | 5.61 | 5.50 | 5.60 | 5.63 |
| 8 | 5.51 | 5.49 | 5.52 | 5.49 | 5.62 | 5.43 | 5.49 | 5.49 | 5.48 |
| Avg. | 5.60 | 5.65 | 5.66 | 5.65 | 5.67 | 5.60 | 5.61 | 5.66 | 5.65 |

Table 14. Percent salt in swiss cheese at 75 days of age.

| Lot No. | Time in Brine | | |
|---|---|---|---|
| | 24 hours | 36 hours | 48 hours |
| 1 | .85 | .85 | .86 |
| 2 | 1.05 | 1.08 | 1.25 |
| 3 | .72 | .83 | 1.08 |
| 4 | .79 | .82 | .95 |
| 5 | .72 | .79 | .81 |
| 6 | .79 | 1.02 | .98 |
| 7 | .62 | .83 | 1.03 |
| 8 | .86 | .81 | .95 |
| Avg. | .80 | .88 | .99 |