A STUDY OF THE EFFECT OF ADDED MONOGLYCERIDES ON THE BODY AND TEXTURE OF NEUFCHATEL AND CREAM CHEESE

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A STUDY OF THE EFFECT OF ADDED MONOGLYCERIDES ON THE BODY AND TEXTURE OF NEUFCHATEL AND CREAM CHEESE

By

RONALD MAX MILLER

AN ABSTRACT

Submitted to the College of Agriculture
Michigan State University of Agriculture and
Applied Science in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE

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Approved Charles M Stine

ABSTRACT

Nine different monoglycerides were used in the manufacture of Neufchatel and cream cheese in order to evaluate their effect on the body and texture of the resulting cheese. Milk containing 3.5 and 5.0 per cent butterfat was used in making Neufchatel cheese and mix containing 16 per cent butterfat was used in the manufacture of cream cheese. The pasteurized homogenized mix was coagulated with both rennet and a lactic starter. The conventional Neufchatel and cooked curd processes were used in the manufacture of the cheese.

The fresh cheese keyed, but otherwise unidentified, were evaluated for flavor, body and texture by a panel of four experienced judges. The hedonic rating system was used by the judges in scoring the body and texture of the cheese. The cheese containing monoglycerides generally scored 0.5 to 1.5 points higher in body and texture than the corresponding controls. Slightly soft or pasty cheese sometimes resulted when certain monoglycerides were used. The smaller the iodine number of the monoglyceride used the softer the resulting cheese.

Tendency of the cheese to synerese was observed after storage in a 50° F. incubator for two weeks, and the larger the iodine number of the monoglyceride used the more the resulting cheese wheyed-off. A "Precision" Penetrometer was used to measure the softness of cream cheese made in this experiment. Cream cheese having penetrometer readings between 235.0 and 257.0 showed maximum smoothness and firmness in body and texture. Generally cream cheese having a penetrometer reading below 235.0 was hard and crumbly; whereas, a penetrometer

reading above 257.0 indicated the cheese was soft. All monoglycerides improved the spreadability and smoothness of the finished cheese and in general, gave a softer cheese as indicated by rheological measurements.

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INTRODUCTION

Surplus milk has been of major concern to the dairy industry in the United States. Neufchatel and cream cheese are two products which offer good use of surplus milk and are profitable items for the dairy plant. These cheese are nutritious foods because of their fat, mineral and protein content.

The production of Neufchatel and cream cheese in the United States during 1959 was 8.5 and 89 million pounds, respectively. The 1959 production of cream cheese represents a 6 per cent increase over the previous year. One particular advantage in the manufacture of either of these cheese is the relatively small amount of equipment needed for small scale production.

A common complaint of the consumer has been that Neufchatel and cream cheese are coarse and crumbly when spread with a knife. Since monoglycerides have been used to prevent leakage of moisture from margarine, and as emulsifiers in ice cream, the goal of this project was to evaluate the possibility of employing monoglycerides to improve the body and texture of Neufchatel and cream cheese.

LITERATURE REVIEW

Cream cheese, one of America's contributions to the cheese world (17), is a relatively new product which originated in the eastern part of the United States (34), and has been developed commercially since 1920. The traditional Neufchatel process (38) was developed in France. According to Lundstedt (15), Neufchatel cheese was first manufactured commercially during the Civil War period by William A. Lawrence of Chester, Orange County, New York.

Van Slyke and Price (38) state that in the manufacture of Neufchatel cheese either whole milk or whole milk enriched with cream may be used. Preparation of a mix for making cream cheese involves the use of milk containing 16 to 20 per cent butterfat. The Food and Drug Administration definition specifies that cream cheese should contain not less than 33 per cent fat nor more than 55 per cent moisture. Neufchatel cheese is defined by the Food and Drug Administration as containing not less than 20 per cent fat but less than 33 per cent, and not less than 65 per cent moisture. Stabilizers may be used individually or in combination if their total solids content does not exceed 0.5 per cent of the weight of the cheese.

Dahlberg and Marquardt (7) observed that cream cheese has the general characteristics of Neufchatel cheese except that it is higher in milk fat, richer in flavor, smoother and more buttery in body and texture. Neufchatel and cream cheese may be used in a greater number of ways than other varieties because they are soft in texture and blend well with most foods (18).

Literature reports (10, 18, 19, 26) indicate that milk used for

Neufchatel cheese should contain 3.5 to 5.0 per cent butterfat. Cream containing 15 to 20 per cent butterfat is recommended for the making of cream cheese (13, 17, 20, 21, 30, 34, 39). According to earlier research (20, 31, 34), increasing the fat content of the cream used for cream cheese results in smoother body, richer flavor and better keeping quality of the finished cheese.

Marcus (17) pointed out that pasteurization of milk or cream intended for use in making Neufchatel or cream cheese, should eliminate nearly all bacteria, yeasts and molds in order to provide a good base for the cheese making. Various workers (8, 19, 30, 32) recommend a pasteurization temperature of 143° F. for 30 minutes, while Marquardt (20) and Marcus (17) prefer 180° F. for 30 minutes. Matheson and Cammack (18) as well as Marquardt (23), observed that pasteurization of milk renders the resulting cheese safe from disease-producing organisms, improves keeping qualities of the cheese and increases the yield from one-half to one per cent.

Lundstedt (15) suggests the use of 0.3 to 0.4 per cent locust bean gum in the finished cream cheese as it will increase the viscosity of the whey, and upon cooling of the cheese it will prevent syneresis or seepage of whey in the package. Marcus (17) stated that 0.1 to 0.2 per cent locust bean gum flour should be added to the milk prior to pasteurization.

Any homogenization pressure between 2000 and 4000 pounds per square inch is adequate when Neufchatel or cream cheese is to be made from the resulting milk (5, 8, 17, 20, 21, 30, 39). Dahlberg (5) stated that homogenization of the cream or milk at any temperature above 105° F. produced a suitable body and texture. The primary purpose of homo-

genization is to reduce fat losses in whey (5, 19, 20, 21, 23, 31, 39). Marquardt (20, 21) pointed out that homogenization also improved the texture of the finished cheese. Difficulties are encountered in attempting to drain curds produced from milk or cream homogenized above 4000 pounds pressure (20).

Lactic acid starter is used to produce the acid required for coagulation and for development of the characteristic mild-acid flavor of Neufchatel and cream cheese. Dahle (8) and Marcus (17) recommend 0.75 and 1.0 per cent lactic culture, respectively, for the long set method. Van Slyke and Price (38) state that 5.0 per cent lactic culture is desirable for the short set method. Reports (18, 20, 32) indicate that there is no advantage in using more than 5.0 per cent starter as excess culture has a tendency to hinder rather than encourage drainage, because of the addition to the mix of unhomogenized milk in the form of starter.

Marquardt (20) found that the combined use of culture and rennet is most satisfactory when making Neufchatel or cream cheese. Rennet aids in coagulation and facilitates the drainage of whey (12). Dahle (8) recommends the use of 1.0 ml. of rennet for each 1000 pounds of milk or cream. The use of too much rennet causes a brittle cheese (18).

Goss (13) as well as Marcus (17), prefer a ripening temperature of 75° F. for the long set method and Van Slyke and Price (38) suggest a temperature of 90° F. for the short set. Neufchatel or cream cheese is sufficiently ripened when the titratable acidity of the mix reaches 0.6 to 0.8 per cent (17, 20, 30, 31, 34, 39). Reichart (31) reported that low acidities fail to give complete drainage. If acidity is too high the cheese is slightly sour (20). According to Marcus (17) acidity

development to the extent of 0.6 to 0.8 per cent improves the keeping quality of both Neufchatel and cream cheese.

According to the procedure of Roundy and Price (34) the ripened cream cheese should be cooked when the titratable acidity of the mix reaches 0.6 per cent. The cheese is cooked by heating slowly, with constant stirring, to a temperature of 120° to 130° F. (16, 17, 31). It has been observed (30) that cooking cream cheese increases the rate of drainage of whey from the bagged curd. Cooling the cream cheese mix to 50° F. after cooking and prior to drainage is an added precaution to lessen fat losses in the whey (20).

Most procedures (8, 13, 18, 25) involve bagging of the curd to facilitate drainage of whey. Dahle (8), as well as Matheson and Cammack (18), reported that the bags should be piled in a rack with ice, using a layer of ice and a layer of bags, for drainage. Once or twice during drainage the bags are re-piled. Pressure from the ice and bags is sufficient for drainage. Cooling curd during drainage increases the keeping quality of both Neufchatel and cream cheese (23). When drainage is completed one pound of salt should be added to each 100 pounds of curd (18).

A hot pack method for manufacturing cream cheese was developed about 1928 (16). The following procedure is typical of many used for hot packing cream cheese (8). After removing the curd from the bags, 0.70 per cent salt and 0.50 per cent stabilizer are added and the entire mass is well mixed. After heating to 170° F. and homogenizing at 2500 pounds pressure (single valve) the cheese is hot packaged directly from the homogenizer into the final container. As one would anticipate, hot pack cream cheese has better keeping qualities than cold pack (9, 15).

Neufchatel and cream cheese are generally wrapped in aluminum or tin foil (11, 18, 19, 26). Downs (10) reported that suitable containers are needed for hot pack cream cheese which will withstand the temperature of the hot material at the time of packaging. According to Downs (10) Neufchatel and cream cheese should be stored as near 32° F. as possible because they are perishable and must be sold while fresh. Reichart (30) believes that exclusion of air from the package increases the keeping quality of the cheese by preventing development of surface spoilage. Roundy and Price (34) found that cheese with high moisture tends to deteriorate more rapidly and to leak moisture during storage.

Previous work (2, 15, 18, 19, 25, 37) has shown that Neufchatel as well as cream cheese serves well as a sandwich spread and in salads and dressings. Neufchatel and cream cheese may be made into spreads containing various condiments. For example pimentos seem to improve the keeping quality of Neufchatel and cream cheese, either acting as a preservative or tending to cover up any undesirable flavor (18).

Dahlberg and Marquardt (7) introduced a procedure for making cream cheese called the Geneva Method (6, 22, 23). This method consists of the solidification of hot cream by pressure (3). The process actually introduces a new principle in cheese making, namely, pressure coagulation accompanied by the aggregation of the fat into large clusters. The high pressure combined with the high fat content produces a very complete fat clumping and protein coagulation. Marquardt (24) used skim milk powder to standardize the mix when preparing cream cheese by the Geneva Method. Frozen cream containing 50 per cent butterfat may be used to standardize Neufchatel and cream cheese mixes. Frozen cream gives a more open and fluffy texture which the original observers attribute to

a ''stabilizing'' effect of the proteins and phospholipids during the long time freezing (15). Taylor (37) has described a cheese called ''double cream cheese'' which was made from cream containing 60 to 70 per cent fat. Normally cream containing 16 to 20 per cent fat is used in the manufacture of cream cheese.

Sheuring (35) reported that pasteurization of cream for cream cheese at 170° F. for 30 minutes plus the addition of 0.05 per cent nordihydroguaiaretic acid (N D G A) solution based on the weight of the milk fat is effective in retarding oxidation.

Attempts to assess the body and texture qualities of cream cheese have been primarily subjective. Organoleptic scores by judges are most widely employed but cannot be satisfactorily compared to an arbitrary standard. The use of rheological instruments, such as the penetrometer, have proven successful in measuring the softness of pasteurized process cheese spreads, margarines, shortenings, butter and cream cheese (4, 14, 28, 33). Haighton (14) recommends 5 seconds as standard time for penetration when a penetrometer is used to measure the softness of margarine and fats.

Neufchatel and cream cheese with better spreadability would be desirable. A search of the literature failed to reveal any application of monoglycerides in the manufacture of Neufchatel or cream cheese. However, since these fat derivatives have improved so many food products they might also find application in the cheese industry. Monoglycerides are easily prepared synthetically and have important industrial uses (1). Commercial monoglycerides are used in large quantities as emulsifying agents in shortenings and in smaller amounts in many other applications. The addition of mono- and di-glycerides in ice cream is claimed to be

beneficial, inhibiting the formation of large ice crystals and promoting the incorporation of air in the product (1). Ordinary mono- and diglycerides as prepared for incorporation into superglycerinated shortenings are quite effective "antileaking" agents when added to margarine in concentrations as low as a few tenths of one per cent.

EXPERIMENTAL PROCEDURES

1.) Milk supply.

Fresh skim milk and cream used in this study were obtained from the Michigan State University Dairy Plant. The milk was standardized to the desired per cent fat and stored at 32° F. until it was used, usually a period of one to four days. The total solids content of the raw milk was determined.

2.) General outline of procedure.

Each trial included a control vat of cheese plus one to three vats of cheese containing different monoglycerides. The term monoglyceride as used in this manuscript refers to commercial monoglyceride concentrates which contain approximately 92 to 94 per cent monoglyceride. Di- and Tri-glycerides constitute the remaining components. Prior to use each monoglyceride was mixed with an equal weight of 1,2-propanediol (propylene glycol) to facilitate the incorporation of the monoglyceride into the mix.

Throughout the procedures various percentages of locust bean gum, monoglyceride, starter and salt were used with the percentages being based on the initial weight of milk. Samples containing monoglycerides were made in the same manner as the control samples except the monoglyceride was added immediately after addition of locust bean gum. In the manufacture of Neufchatel and cream cheese, 0.15 per cent and 0.2 per cent monoglycerides were added, respectively, unless otherwise noted in a specific trial.

3.) Manufacture of cream cheese.

Eight pounds of raw mix containing 16.0 per cent butterfat was

poured into a stainless steel can and heated to 140° F. in a steam heated water bath, at which point 0.1 per cent locust bean gum was added. The pasteurization process was completed by heating the mix to 160° F. (flash).

The mix was homogenized twice in a 75 gallon Manton-Gaulin homogenizer at 2000 pounds pressure (single valve) and cooled to 90° F. Five per cent lactic starter was added to the pasteurized homogenized mix. Rennet was also added at the rate of 1 ml. for each 1000 pounds of mix. The rennet was diluted by mixing with ten times its volume of cool tap water prior to addition to the mix.

The thoroughly stirred milk was poured into stainless steel beakers which were placed in a water-jacketed steam heated cheese vat containing water adjusted to 90° F. When the titratable acidity of the mix reached 0.6 to 0.7 per cent, 2.5 per cent salt dissolved in 500 ml. of water was added. Steam was slowly added to jacket of the cheese vat at a constant rate and the mix was cooked by heating to 130° F. within 45 to 60 minutes. The mix was stirred constantly throughout the cooking process.

The cooked cheese was poured into muslin bags which were hung in a 32° F. cooler and left 12 to 15 hours to drain. The bags of cheese were then removed from the hangers and placed on a wooden rack in the cooler so that drainage could be completed. A weighted stainless steel tray was placed on each bag in order to facilitate whey drainage.

When the moisture content of the cheese reached 55.0 per cent or less, drainage was stopped. The cheese was then removed from the muslin bags, analyzed for fat, packaged in rigid polystyrene containers (12 ounce) and placed in a 32° F. cooler.

After 24 hours the packaged Neufchatel and cream cheese were removed from the cooler and checked for flavor. The body and texture were examined by a panel of four judges using the hedonic preference rating with a high of nine and a low of one. A penetrometer was used for making rheological measurements of the cream cheese.

pH determinations using the glass electrode were made routinely on all cheese immediately after packaging. A sample of each cheese was placed in a 50° F. incubator for two weeks to observe the degree of syneresis.

4.) Manufacture of Neufchatel cheese.

Twelve pounds of mix containing 5.0 per cent butterfat were used in the manufacture of Neufchatel cheese. The procedure followed in the manufacture of this cheese was identical to the one used in the manufacture of cream cheese except that the Neufchatel cheese was drained without being cooked.

5.) Analytical procedures.

a. Fat and total solids analyses of the milk and cheese were performed by the Mojonnier method (27).

b. Acidity determinations in this study were made by titrating a nine-gram sample with 0.10 normal sodium hydroxide, using 4 drops of a 1.0 per cent alcoholic phenolphthalein solution as the indicator. All titratable acidities were expressed in percentages of lactic acid.

c. Rheological measurements were made with a "Precision" Universal Penetrometer equipped with a universal penetrometer cone (102.5 gr.) (29). Prior to making measurements the packaged cheese was removed from the cooler and held at room temperature 4 to 5 hours in order for the cheese temperature to equilibrate to 70° F. A five second penetration time was used and the results were recorded as cone penetration in tenths of millimeter.

EXPERIMENTAL RESULTS

1.) Monoglycerides used in this study.

Nine different monoglycerides were used in this study in order to evaluate their effect on the body and texture of Neufchatel and cream cheese. The monoglycerides were furnished by Eastman Kodak Company (Myverol), Atlas Powder Company and Top-Scor Products Inc. (Mono-Mul). Table I contains known information concerning these monoglycerides. An intensive study was made of the use of monoglycerides in the manufacture of cream cheese. Monoglycerides were also used in the manufacture of Neufchatel cheese.

A one gram sample of commercial monoglyceride preparation 18-00 was fractionated using a 100-200 mesh silicic acid column prepared according to the procedure of Smullin and Olsanski (36). The triglyceride fraction was removed from the column with benzene and was found to be 1.90 per cent of the weight of material placed on the column. A mixture of benzene plus 10 per cent ethyl ether was used to remove the diglyceride portion which amounted to 5.95 per cent of the initial weight. The monoglyceride was removed with ethyl ether and was 93.67 per cent of the original weight. Thus the total recovery was 101.52 per cent.

The monoglycerides used in this work are solid at room temperature. In preparing the monoglyceride for the first few batches of cheese the desired amount of the solid monoglyceride was weighed and stirred into the pasteurized milk immediately prior to homogenization. However, this method of adding the monoglyceride to the mix was not satisfactory because 50 to 60 per cent of the monoglyceride was found in the homogenizer when it was disassembled. The following procedure permitted the

TABLE I

INFORMATION CONCERNING MONOGLYCERIDES

SUPPLIED BY MANUFACTURERS

Monoglyceride	Source	Minimum Monoester Content (%)	Iodine Value
Myverol			
18-00	Prepared from edible, fully hydrogenated lard	90	1
18-30	Prepared from edible animal fat	90	40
18-40	*	90	50
18-85	Prepared from refined cottonseed oil	90	85
8-20	Proprietary blend. Contains 20 % hydrogenated vegetable oil by weight	70	22
Atlas			
80	*	42	60
84	*	42	2
300	*	56	*
Top-Scor Products			
Mono Mul (M-M)	Unknown Proprietary Blend	60	*

* Information not supplied by manufacturers.

entire amount of monoglyceride to be incorporated into the mix. A 50-50 mixture by weight of each monoglyceride and 1,2-propanediol was prepared. Prior to use, an erlenmeyer flask containing the mixture was placed in a beaker of warm water and heated sufficiently to melt the mixture. A desired amount of the monoglyceride-propylene glycol liquid mixture was promptly weighed and stirred into the milk which was at 150° F. Pasteurization of the mix was completed and the mix was then homogenized.

In order to determine the effect of 1,2-propanediol on the body and texture of cream cheese, two batches of cheese were made, one of which served as a control and the other contained 0.2 per cent propanediol. The data in Table II indicate that the 1,2-propanediol did not improve the body and texture of cream cheese, in fact, the cheese containing propylene glycol possessed a coarser body and texture than the corresponding control.

TABLE II

EFFECT OF 0.20 PER CENT 1,2-PROPANEDIOL ON

BODY AND TEXTURE OF CREAM CHEESE

1,2-Propanediol	Total Solids in Raw Milk (%)	Acidity of Mix (%)	Moisture in Cheese (%)	Penetrometer Reading (0.1 MM)	Body and Texture Score	Fat in Cheese (%)
Control	23.59	0.65	54.33	234.0	7.50	34.5
0.20 %	23.59	0.65	53.31	215.5	7.00	34.7

2.) Neufchatel cheese trials.

The milk used in making Neufchatel cheese was standardized to 5.0 per cent butterfat and contained an average of 14.3 per cent total solids. Four different monoglycerides were used in the manufacture of Neufchatel cheese. These monoglycerides included the "Top-Scor" monoglyceride as well as the 18-00, 18-30 and 18-85 "Myverol" monoglycerides. In the manufacture of experimental Neufchatel and cream cheese the monoglycerides were used individually and never blended. Various amounts ranging from 0.1 to 0.5 per cent were added to the cheese. Fifteen-hundredths per cent was found to be the optimum amount of monoglyceride to use in the manufacture of Neufchatel cheese in order to improve body and texture without introducing a bitter flavor, except that 0.1 per cent was the optimum amount of the 18-00 monoglyceride. Slightly soft cheese sometimes resulted when 0.15 per cent of the 18-00 monoglyceride was added.

The data in Table III show the results of experimental trials involving monoglycerides in the manufacture of Neufchatel cheese. At the 0.15 per cent concentration the four monoglycerides mentioned above resulted in a smoother cheese with more desirable spreading properties than the corresponding controls.

When added in amounts of 0.2 per cent or more, some of the monoglycerides tended to introduce a bitter flavor in the finished Neufchatel cheese. At 0.2 per cent and higher concentrations, the 18-85 monoglyceride produced a more distinct bitter flavor in the cheese than any of the other monoglycerides used.

The pH of all cheese listed in Trials I through VIII ranged from 4.45 to 4.62. Since the pH of the cheese was reasonably constant, acidity was not responsible for any differences noted in flavor, body

TABLE III

EFFECT OF 0.15 PER CENT MONOGLYCERIDE ON THE BODY AND TEXTURE OF NEUFCHATEL CHEESE MADE FROM MILK CONTAINING 5.0 PER CENT FAT

Sample	Acidity of Whey (%)	Moisture in Cheese (%)	Body and Texture Score
	Trial No. I		
Control	0.42	64.90	8.5
18-30	0.42	65.00	7.5
	Trial No. II		
Control	0.50	64.83	8.0
18-30	0.50	64.56	8.5
	Trial No. III		
Control	0.45	64.21	8.0
18-00	0.45	64.28	8.5
	Trial No. IV		
Control	0.45	63.45	7.5
M-M	0.45	64.38	8.5
	Trial No. V		
Control	0.40	64.52	8.0
M-M	0.40	64.38	8.0
	Trial No. VI		
Control	0.40	64.40	8.0
18-00*	0.40	61.72	8.5
	Trial No. VII		
Control	0.40	63.79	8.0
18-30	0.40	64.93	8.5
	Trial No. VIII**		
Control	0.55	63.98	7.0
18-30	0.55	62.75	8.0
M-M	0.55	63.61	8.0

* The experimental sample of cheese contained only 0.1 per cent of the 18-00 monoglyceride.

** All three samples were made from milk containing 3.5 per cent butterfat.

and texture.

The experimental samples of Neufchatel cheese containing monoglycerides invariably were smoother in body and texture than the control cheese (Trials I through VIII of Table III). However, one control sample possessed a higher body and texture score than the corresponding experimental cheese (Trial I). Some monoglycerides caused the Neufchatel cheese to be excessively soft or pasty. When this body and texture defect occurred the experimental samples were scored lower than the controls.

The 18-30 sample of cheese in Trial I was smoother than the control, but slightly pasty. The control and the sample of cheese containing the M-M monoglyceride listed in Trial V of Table III were given the same body and texture score; however, in the previous trial the cheese containing the M-M monoglyceride possessed a more desirable body and texture than the corresponding control. The higher moisture content could have been responsible for a more desirable body and texture of the cheese containing the M-M monoglyceride (Trial IV). Neufchatel cheese containing monoglycerides showed more improvement in body and texture, compared to corresponding controls, when the moisture content of the cheese decreased from 65 to 60 per cent. Experimental Neufchatel cheese was generally scored from 0.25 to 0.50 points higher in body and texture than the corresponding controls.

A control sample of Neufchatel cheese made from milk containing 3.5 per cent butterfat and drained to 63.98 per cent moisture contained 20.15 per cent fat; whereas, a control sample of Neufchatel cheese made from milk containing 5.0 per cent butterfat was drained to 64.40 per cent moisture and contained 22.25 per cent fat. As one might anticipate the

control samples of Neufchatel cheese made from milk containing 5.0 per cent butterfat were smoother in body and texture than control samples made from milk containing 3.5 per cent butterfat.

Results indicated that the higher the per cent fat in the original mix the more effective the monoglyceride was in improving the smoothness of Neufchatel cheese. For example, 0.15 per cent of the monoglycerides appeared to be more effective in improving the body of Neufchatel cheese made from milk containing 5.0 per cent fat than in cheese made from milk containing 3.5 per cent fat. The degree of unsaturation of the monoglyceride added appeared to affect the finished cheese more than any other characteristic of the monoglyceride listed in Table I.

The 18-40 monoglyceride was also used in the manufacture of Neufchatel cheese, but the results are not listed in Table III since no samples in a given trial were drained to within one per cent moisture content of one another. Different monoglycerides of approximately the same degree of unsaturation (18-30 and 18-40) appeared to impart similar characteristics to the cheese. Neufchatel cheese containing 0.15 per cent 18-40 monoglyceride was slightly soft, resembling cheese containing the 18-00 monoglyceride. During the initial part of this experiment it was anticipated that upon storage of Neufchatel cheese containing a monoglyceride, a bitter flavor might develop due to hydrolysis of the monoglyceride. However, bitter flavors did not occur when 0.15 per cent monoglyceride was added.

Two batches of skim milk Neufchatel (''baker's cheese'') were made by the same procedure followed in the manufacture of Neufchatel cheese (experimental procedures). One batch of cheese served as a control and the other contained 0.2 per cent 18-00 monoglyceride. There was no

apparent difference in the body and texture of the two batches of baker's cheese as both samples were coarse and the sample containing the monoglyceride possessed a definitely bitter flavor. Therefore, the addition of a monoglyceride to the original mix apparently does not improve the body and texture of baker's cheese which is practically free from fat (38) and contains a maximum of 80 per cent moisture.

3.) Cream cheese trials.

In the manufacture of cream cheese only one standardized mix was used and it contained 16.0 per cent butterfat. Each of the nine monoglycerides listed in Table I were used in the manufacture of cream cheese. The optimum amount was determined to be 0.2 per cent for maximum improvement in body and texture. Higher concentrations introduced a bitter flavor and interfered with drainage of the cheese.

The control and experimental samples of cheese in each trial were drained to within one per cent moisture content of each other, if possible, so that comparative rheological measurements could be made and interpreted. The pH of the fresh cream cheese was 4.5 to 4.65. Syneresis studies indicated that whey was liberated from cream cheese containing the 18-85 monoglyceride 24 hours earlier than from other cream cheese samples. Other experimental cheese held at 50° F. did not expel whey any faster than the corresponding controls.

The containers of refrigerated cream cheese were placed at room temperature for 4 to 5 hours so that the temperature of the cheese could equilibrate to 70° F. for rheological measurements. Rheological measurements were made on four samples from each vat of cream cheese. The results of the four penetrometer readings were averaged, except occasional results were discarded which were obviously adventitious and

were attributed to air pockets in the cheese. When this occurred only three readings were averaged.

Two monoglycerides, 80 and 18-85, caused cheese to expel whey excessively when warmed to 70° F. for rheological measurements, but at refrigeration temperatures cream cheese containing the 80 monoglyceride did not appear to expel whey any faster than other samples of cheese. The 18-85 sample of cream cheese listed in Trial V of Table IV contained 0.5 per cent locust bean gum, which prevented the cheese from expelling whey excessively at room temperature.

Results listed in Table IV indicate that rheological measurements varied, but generally the samples of cream cheese containing monoglycerides had a higher penetrometer reading than the control samples, indicating that the experimental samples of cheese were softer. Cream cheese containing high moisture or fat should have a higher penetrometer reading than cheese containing less moisture or fat. Cream cheese samples listed in Trials III, IV (except the 18-30 sample) and V of Table IV have similar fat and moisture contents for a given trial. Penetrometer readings of the cheese listed in the three trials mentioned above indicate that the 18-00 monoglyceride produced a softer cheese than any of the other monoglycerides used.

In this experiment samples of cream cheese containing monoglycerides were smoother in body and texture than the corresponding controls; however, the addition of monoglycerides to the mix resulted in a soft cheese in some instances. The cheese samples containing the 18-00 and 8-20 monoglycerides (Trial I of Table IV) were extremely smooth, but sometimes too soft and gummy. The 18-00 monoglyceride resulted in a slightly smoother cream cheese than any of the other monoglycerides used.

TABLE IV

EFFECT OF 0.20 PER CENT MONOGLYCERIDE ON

BODY AND TEXTURE OF CREAM CHEESE

Sample	Total Solids in Raw Milk (%)	Acidity of Mix (%)	Moisture in Cheese (%)	Penetrometer Reading (0.1 mm)	Body and Texture Score	Fat in Cheese (%)
			Trial No. I			
Control	23.51	0.65	54.60	242.5	7.50	33.8
18-00	23.51	0.65	53.84	278.0	6.50	37.8
8-20	23.51	0.65	54.71	234.7	7.25	35.5
18-85	23.51	0.65	52.55	218.3	7.25	34.4
			Trial No. II			
Control	23.79	0.67	54.95	236.7	7.50	34.3
18-30	23.79	0.67	53.37	246.0	8.00	35.8
18-40	23.79	0.67	52.15	245.3	8.00	35.8
18-85	23.79	0.67	54.86	264.7	7.75	33.3
			Trial No. III			
Control	24.06	0.62	51.99	230.3	7.50	37.1
80	24.06	0.62	51.81	260.0	7.25	36.9
84	24.06	0.62	52.44	249.0	7.20	37.2
300	24.06	0.62	52.00	251.3	7.50	36.6
			Trial No. IV			
Control	24.22	0.60	50.06	221.3	7.00	38.4
18-00	24.22	0.60	50.34	257.0	7.00	38.1
18-30	24.22	0.60	49.44	271.0	8.00	37.8
18-85	24.22	0.60	50.34	253.6	7.50	39.1
			Trial No. V			
Control	24.22	0.65	54.75	233.0	7.50	35.6
M-M	24.22	0.67	54.22	268.3	7.75	35.3
18-85*	24.22	0.60	54.16	272.7	7.00	34.8
			Trial No. VI			
Control	23.50	0.65	52.74	220.3	7.50	35.5
18-00	23.50	0.65	52.36	273.0	7.00	37.3

* The sample of cheese containing the 18-85 monoglyceride also contained 0.5 per cent locust bean gum.

The addition of 18-40, 18-85, 8-20, M-M, 80, 84 and 300 monoglycerides produced cheese with a firmer body than the 18-00 monoglyceride. Experimental samples of cream cheese containing the 18-30 and M-M monoglycerides were the most desirable because they possessed a smooth body which was generally firmer than other samples of cheese.

The data in Table V show the results obtained when various amounts of different monoglycerides were used in the manufacture of cream cheese. The data indicate that the higher concentrations of monoglycerides (0.5 and 0.75 per cent) do not appreciably improve the smoothness of cream cheese. Cream cheese containing either 0.5 or 0.75 per cent of the 18-00 monoglyceride would not drain to the legal moisture limit, and after four days draining and pressing, liquid remained in the muslin bags. The same amount of rennet was added to each of the four batches of cheese shown in Trial I of Table V and the acidity developed uniformly, but the cheese containing 0.5 and 0.75 per cent of the 18-00 monoglyceride did not coagulate. The cooking process did not result in whey separation in the cheese mix containing 0.5 and 0.75 per cent of the 18-00 monoglyceride. When this mix was poured into muslin bags there was some leakage which continued until the mix was cooled. After the mix was cooled drainage virtually ceased and it was impossible to induce further drainage, even when pressure was applied.

Control and experimental cream cheese containing 0.2 per cent monoglyceride required 30 to 48 hours to drain to a legal moisture content. Seven days were required for cream cheese containing 0.5 per cent of either 18-30 or 18-85 monoglyceride to drain to a legal moisture standard, and nine days were required for cream cheese containing 0.75 per cent of either of the monoglycerides to drain to a legal moisture content.

TABLE V

EFFECT OF 0.20, 0.50 AND 0.75 PER CENT MONOGLYCERIDE

ON BODY AND TEXTURE OF CREAM CHEESE

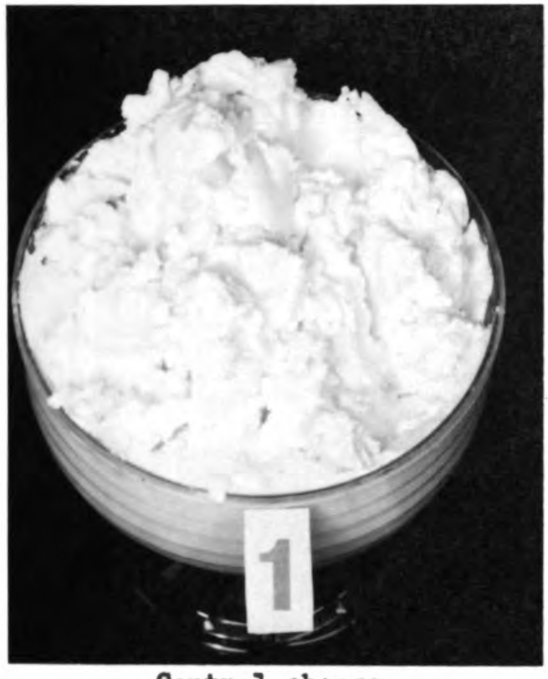
Sample	Total Solids in Raw Milk (%)	Acidity of Mix (%)	Moisture in Cheese (%)	Penetrometer Reading (0.1 MM)	Body and Texture Score	Fat in Cheese (%)
			Trial No. I (18-00)			
Control	24.01	0.60	53.43	247.1	7.50	34.1
0.20 %	24.01	0.60	50.37	258.7	7.25	39.8
0.50 %	24.01	0.60	56.26	*	*	*
0.75 %	24.01	0.60	53.17	*	*	*
			Trial No. II (18-30)			
Control	24.06	0.62	53.87	237.3	7.50	36.4
0.20 %	24.06	0.62	53.74	265.7	8.00	37.5
0.50 %	24.06	0.62	52.77	235.5	8.00	35.5
0.75 %	24.06	0.62	54.68	285.5	7.00	34.1
			Trial No. III (18-85)			
Control	23.73	0.63	53.86	225.0	7.50	35.9
0.20 %	23.73	0.63	54.30	239.5	8.00	35.5
0.50 %	23.73	0.63	54.24	242.7	8.20	35.6
0.75 %	23.73	0.63	54.08	279.0	7.00	35.6

* Data not obtained.

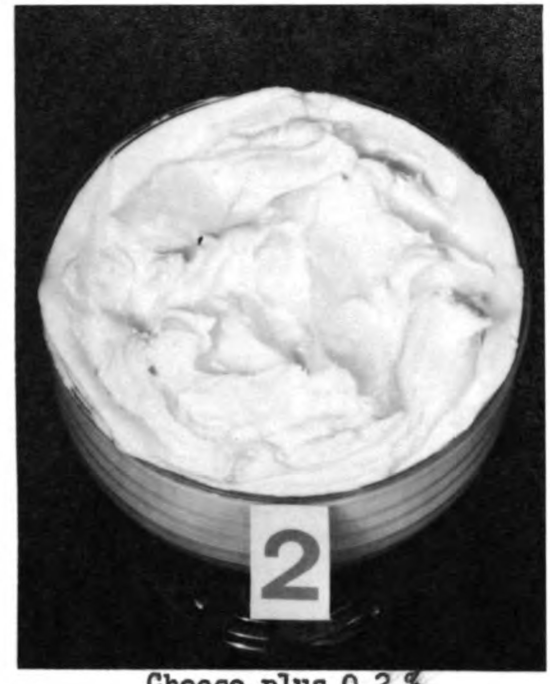
Penetrometer readings of the cheese listed in Table V indicate that samples containing 0.75 per cent of a monoglyceride were softer than other samples of cream cheese and this concentration of the 18-85 monoglyceride caused a bitter flavor (Trial III of Table V). Absolutely no advantage was gained by incorporating more than 0.2 per cent of any monoglyceride used in this experiment.

A spatula was used to spread four different samples of packaged cream cheese (control, 18-00, 18-30 and 18-85) in order that the relative smoothness could be observed in photographs (Figs. 1 to 4). The physical and chemical characteristics of the four samples of cheese mentioned above are described in Trial IV of Table IV.

Figure 5 shows the "Precision" Penetrometer used for making rheological measurements of cream cheese.



Control cheese



Cheese plus 0.2 %
18-00 monoglyceride

Cheese plus 0.2 %
18-30 monoglyceride

Cheese plus 0.2 %
18-85 monoglyceride

Figures 1 to 4. Control and experimental samples of cream cheese.

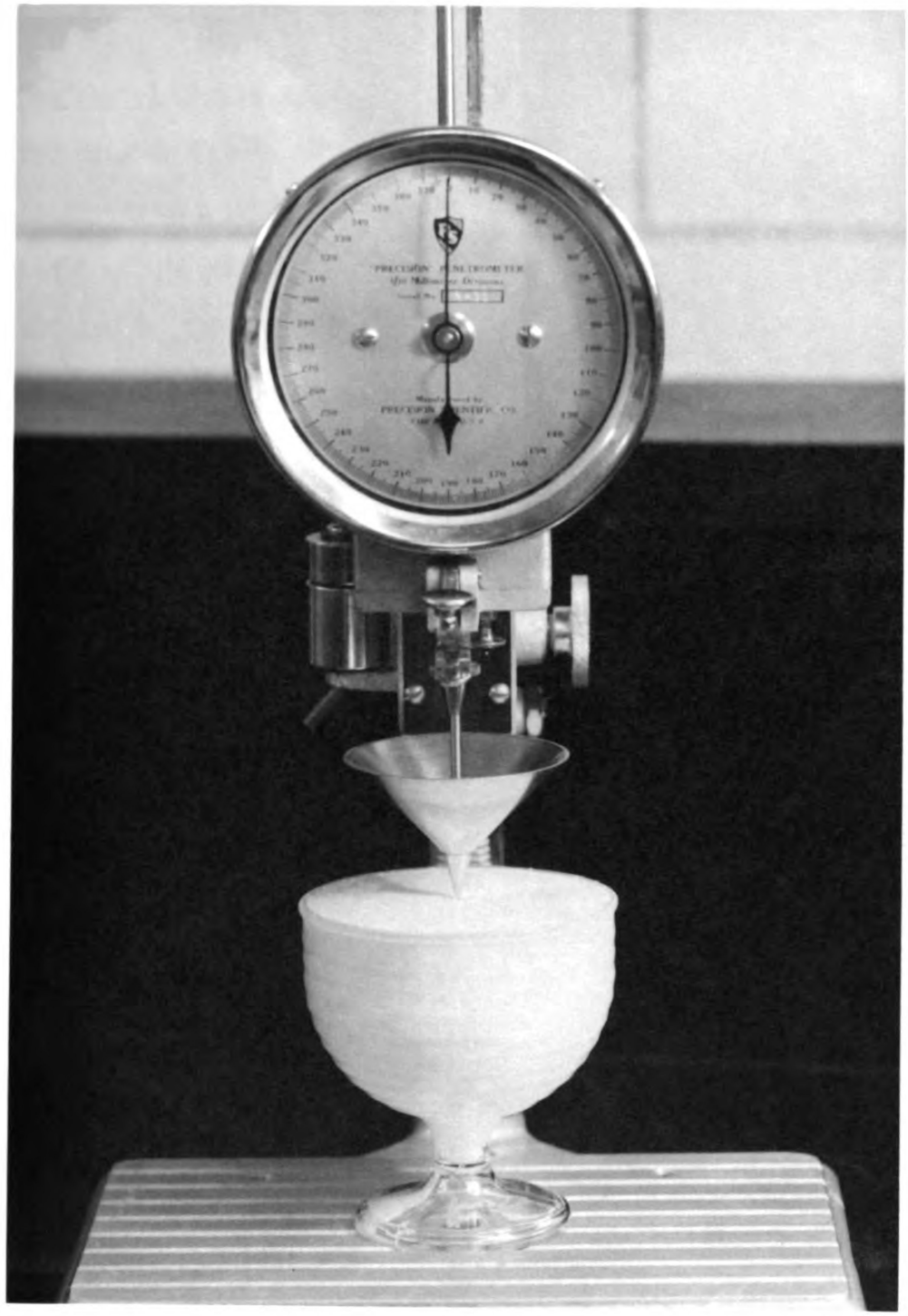


Figure 5. "Precision" Penetrometer used for making rheological measurements.

DISCUSSION

1.) Neufchatel cheese trials.

The data in Table III indicate that the 18-30 (iodine no. 40) and M-M monoglycerides produce the most desirable body and texture from the standpoint of smoothness and firmness of the finished Neufchatel cheese. The addition of the 18-00 monoglyceride to the initial mix produced an extremely smooth Neufchatel cheese, but a weak body sometimes occurred when the moisture content of this cheese was in the range of 63 to 65 per cent. Naturally a manufacturer may choose to drain Neufchatel cheese to the moisture level mentioned above in order to obtain maximum profits. Generally, when the moisture content of experimental cheese containing 0.15 per cent of the 18-00 monoglyceride was less than 63 per cent the cheese was firm and smooth.

The 18-85 monoglyceride was equally as effective as the 18-30 and M-M compounds in improving the body and texture of Neufchatel cheese. However, cheese containing 0.15 per cent 18-85 monoglyceride sometimes had a slight bitter flavor and this flavor was always present when 0.2 per cent of the monoglyceride was added. This flavor may not be due to the monoglyceride, per se, but to trace impurities of free fatty acids or fatty acid soaps in the monoglyceride.

When added at the 0.15 per cent concentration the monoglycerides did not appear to have any effect on the rate of drainage of the Neufchatel cheese. Cheese containing the 18-00 monoglyceride always appeared to contain more moisture than was actually present, and because of this characteristic the manufacturer may permit the cheese to drain to a moisture content much below the legal standard. Other monoglycerides

are not so deceiving in this respect.

Apparently, because of the lower fat content, Neufchatel cheese made from milk containing 3.5 per cent butterfat is coarser in body and texture than cheese made from mix containing 5.0 per cent fat. However, the addition of a monoglyceride to mix containing 3.5 per cent butterfat resulted in a smoother body and texture than was obtained in cheese made from mix containing 5.0 per cent fat and no monoglyceride.

Since the monoglycerides appeared to improve the body and texture of Neufchatel cheese more when a higher per cent fat was present in the initial milk, it is apparent that the beneficial action of the monoglyceride must be associated with lipid material in order to produce its effect on the finished Neufchatel cheese. An interesting study could be made to ascertain if the fat actually does associate in some particular fashion with the monoglyceride, and why this association produces the smoother and sometimes softer body observed in such cheese.

2.) Cream cheese trials.

It is noteworthy that the monoglycerides improved the smoothness of cream cheese more than they did the smoothness of Neufchatel cheese. The monoglycerides progressively improved the body and texture of the finished cheese as the fat content of the initial mix was increased.

The fat content of the cream cheese was 10 to 15 per cent higher than the fat content of Neufchatel cheese. Two-tenths per cent of the 18-85 monoglyceride produced a bitter flavor in Neufchatel cheese, but not in cream cheese which further indicates that the fat aids in masking the bitter flavor introduced by certain monoglycerides, particularly 18-85.

The moisture content of the finished cream cheese in a given trial could be controlled to a certain extent, but the fat content of the

finished cheese in a given trial was less precisely controlled because of variable fat losses in draining. In fact, the fat content of the samples in an individual trial sometimes varied as much as 2.0 per cent. Trial VI of Table IV is an instance in which the fat content of two samples of cheese varied more than one would anticipate.

At the concentrations used (0.2, 0.5 and 0.75 per cent) the monoglycerides apparently did not affect the fat content of the finished cheese. Minor variations in the fat content of the samples of cream cheese were attributed to the loss of small amounts of curd which was sometimes pushed through the bags by pressure during drainage. Another possible cause of variation in fat is that the monoglycerides present in the samples of cheese may have been incompletely and variably extracted in the Mojonnier fat test.

The total solids content of the mix used in making cream cheese varied as much as 0.72 per cent from one series of trials to another. Two reasons for variations of the total solids of the initial mix are: (1) variation in total solids content of the milk, and (2) the fat content of the standardized mix may have varied slightly above or below 16.0 per cent.

It is noteworthy that 0.5 per cent locust bean gum was more effective than 0.1 per cent in preventing syneresis of cream cheese containing the 18-85 monoglyceride. Possibly further investigation of other stabilizers, used singly or in blends, would reveal better means of preventing syneresis in cream cheese.

A few batches of cream cheese were "hot packaged" which eliminated most of the visible whey expulsion. The monoglycerides produced the same improvements in body and texture of both hot- and cold-pack cream cheese.

Cream cheese generally requires 16 to 24 hours longer to drain to a legal moisture content than Neufchatel cheese and cream cheese must contain 10 per cent less moisture than Neufchatel in order to be legal. After two weeks storage at 50° F. there was no noticeable difference in the flavor of control and experimental samples of cream cheese.

The data in Tables II, III, IV and V of this study indicate that the higher the degree of unsaturation of a given monoglyceride (18-85) used in the manufacture of Neufchatel and cream cheese, the firmer the finished cheese. The higher the degree of saturation of a monoglyceride (18-00) used in the manufacture of the above cheese, the smoother and softer the finished cheese. Three monoglycerides used in this study (18-30, 18-40 and M-M) resulted in maximum smoothness and firmness in body and texture.

SUMMARY

Forty-four batches of Neufchatel cheese were made from whole milk containing either 3.5 or 5.0 per cent butterfat. Five different monoglycerides were used in the manufacture of this cheese. Each of the monoglycerides improved the smoothness and spreadability of the finished cheese. Analyses were made on the cheese for pH and total solids content.

Seventy-nine batches of cream cheese were made from milk containing 16 per cent butterfat. Nine different monoglycerides were used in the manufacture of the cream cheese and each improved the smoothness and spreadability of the finished cheese. The standardized milk was analyzed for total solids. Cream cheese was analyzed for pH, fat and total solids. Rheological measurements were made to determine the softness of the finished cheese. One-tenth per cent of locust bean gum was used in the manufacture of both varieties of cheese. The cheese samples were examined by a panel of four experienced judges for flavor, body and texture.

In each trial the samples of cheese containing monoglycerides were smoother in body and texture than corresponding controls. The optimum amount of monoglyceride to use in the manufacture of Neufchatel and cream cheese was found to be 0.15 and 0.2 per cent, respectively. Propylene glycol (1,2-propanediol) was a suitable vehicle for the incorporation of the monoglycerides into the cheese mix. When 0.2 per cent of 1,2-propanediol was added to cream cheese mix without any monoglyceride there was no improvement in the body and texture of the cheese, indicating that the improvement was entirely attributable to the monoglycerides. The monoglycerides improved the body and texture of cheese made from a

high fat mix more than cheese made from a lower fat mix. When 0.2 per cent 18-00 monoglyceride was used in the manufacture of baker's cheese (skim milk Neufchatel) there was no improvement in body and texture of the cheese, apparently because of the absence of fat. A bitter flavor introduced by the 18-85 monoglyceride was less noticeable in cheese made from mix containing high per cent butterfat. Apparently fat tends to mask the bitter flavor sometimes introduced by monoglycerides and the monoglycerides associate with the butterfat in some manner to improve the smoothness and spreadability of the finished cheese.

The addition of a monoglyceride such as 18-30, with an iodine number of 40, results in a cheese with maximum smoothness and firmness in body and texture. The higher the degree of saturation of the monoglyceride added, the softer the finished cheese.

Results indicate that monoglycerides were more effective in improving the body and texture of cream cheese than Neufchatel, apparently because of the difference in fat content of the initial mixes.

Neufchatel and cream cheese samples were stored two weeks in a 50° F. incubator for syneresis studies. Cheese containing the 18-85 monoglyceride expelled whey earlier than other experimental cheese. Loss of whey was avoided in cream cheese containing 0.2 per cent of the 18-85 monoglyceride when the amount of locust bean gum was increased from 0.1 to 0.5 per cent.

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