JULY, 1940 RESEARCH BULLETIN 319

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

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The Effect of Standardizing The Acidity In The Manufacturing of Cottage Cheese and Cultured Buttermilk

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(Publication Authorized July 16, 1940)

COLUMBIA, MISSOURI

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*In cooperative service with the U. S. Department of Agriculture.

The Effect of Standardizing The Acidity In The Manufacturing of Cottage Cheese and Cultured Buttermilk

L. E. Mull, W. H. E. Reid, and W. S. Arbuckle.

INTRODUCTION

Acidity is known to have an important influence upon the behavior of dairy products. In numerous instances, acidity has been shown to exert a definite effect upon the physical and chemical properties of various dairy products. For some time it has been thought that the true dairy products flavor of cottage cheese and cultured buttermilk is submerged by the ordinary concentration of lactic acid present. It is believed that when a high quality starter is used, and the acidity standardized at some step in the manufacturing process, a full-flavored, clean, mild product will be obtained.

To date, little research has been conducted to determine the effect of acidity adjustment upon the quality of cottage cheese and cultured buttermilk. The object of this investigation was to determine the effects of the adjustment of acidity in cottage cheese and cultured buttermilk upon the physical and chemical properties of these products.

REVIEW OF LITERATURE

A study of the literature reveals that no investigations have been made directly concerned with this subject.

Pasteurization.—Lucas (5)* found that skim milk for cottage cheese manufacture should be pasteurized at 145 degrees Fahrenheit for 20 minutes rather than for 30 minutes, to obtain proper firmness and texture in the resulting curd.

Martin (7) states that skim milk pasteurized at 145 degrees Fahrenheit for 30 minutes, or flashed at 165 degrees Fahrenheit for 15 seconds was satisfactory for cottage cheese from the standpoint of destroying undesirable bacteria.

Thurston (21) observed that more rapid firming occurred in the curds from milks pasteurized at 145 degrees Fahrenheit for 30 minutes than in milks pasteurized at higher temperatures. He found that high temperatures denatured the protein and destroyed the cohesive and firming properties of the casein.

Wilson (26) found that one of the most important factors in the control of flavor in the finished cheese was pasteurization. Heating

*See list of references on page 35.

to either 145 degrees Fahrenheit for 30 minutes, or flash pasteurization at 160-165 degrees Fahrenheit was satisfactory is properly controlled.

Short-Time Method.—Goss and Mutten (4) found that cooling the milk after pasteurization to 90 degrees Fahrenheit and adding 5 per cent starter produced coagulation in about four hours.

Martin (7) states that the coagulation time can be greatly shortened by adding 7-10 cubic centimeters of rennet and 5-7 gallons of starter to 1000 pounds of milk and setting at 80-87 degrees Fahrenheit.

Price and Kelly (14) found that the ordinary method of making cottage cheese required 20-24 hours. Their studies, however, showed that the time could be cut down to eight hours by using a larger amount of starter culture, by the addition of rennet, and by holding milk at a slightly higher temperature.

Thurston and Gould (22) concluded that a setting temperature of 90 degrees Fahrenheit was preferable to 70 degrees Fahrenheit because coagulation time was shortened and off-flavors due to fermentations were less apt to be present.

Tracy and Ruehe (24) found that the time necessary to make the cheese was shortened by using 10 per cent of starter, slightly increasing the amount of rennet used and setting at 90 degrees Fahrenheit. With this procedure, the curd was ready to cut in four or five hours.

Acidities and Heating.—Goss and Mutten (4) showed that the whey immediately after cutting should have an acidity of .45-.50 per cent. They concluded that acidities above .55 per cent resulted in a slightly grainy, rough curd.

Lucas (5) states that after cutting, cooking temperatures commonly vary from 100-120 degrees Fahrenheit, that the higher temperature is more commonly used in commercial practice, but that the lower temperatures necessitating longer heating produce a better texture.

Parfitt (10) found that a soft, pasty curd was due to not heating the curd to a high enough temperature, or not heating long enough; permitting too much acid to develop before cutting; using too much rennet or pepsin; or using milk pasteurized at too high a temperature. He also found, that a tough hard curd was due to heating to too high a temperature or holding at the cooking temperature for too long a time; not permitting enough acid to develop before cutting and heating the curd; or by not using enzymes or not using enough of the enzymes.

Price and Kelly (14) stated that adding water at 100-105 degrees Fahrenheit immediately after cutting caused the curd to firm more rapidly and imparted a better flavor.

Thurston (21) found that batches of cheese cut at acidities ranging between .41-.54 per cent did not become rubbery. Too rapid heating at the beginning of the cooking process caused the formation of a tough coat on the curd particle making it difficult to expel whey from the center of the curd.

Tracy and Ruehe (24) concluded that cottage cheese had its best body if cut when developed acidity in the whey was .55-.60 per cent.

Wilson and Trimble (27) stated that the acidity of the whey at cutting should not be less than .50 per cent nor more than .55 per cent, and that the final cooking temperature varied from 118-130 degrees Fahrenheit.

Rennet.—Thurson and Gould (22) concluded that the important function of rennet extract was to prevent matting rather than to produce coagulation.

Washing.—Goss and Mutten (3) found that the warm curd would not mat if all of the whey was not drawn off before adding cold wash water, and that the curd retained the cube form better if not cooled too rapidly. A second and usually a third application of cold water was necessary to bring the temperature of the curd to 60 degrees Fahrenheit.

Manus (6) found that washing the curd twice with warm water, and then washing twice again with cold water and storing in a salt solution, improved both flavor and keeping quality. The curd produced in this manner was not only soft but sweet in flavor.

Reichert and Davis (15) reported that changing the temperature gradually, prevented shattering and increased yield. They found that washing the curd the first time with water at 100 degrees Fahrenheit, the second with lukewarm water at 60 degrees Fahrenheit and the third washing with cold water produced cheese with better standing-up qualities and an improved flavor and keeping quality.

Reid and Painter (18) found that the keeping qualities of uncreamed cottage cheese were improved 80 per cent by rinsing in a chlorine rinse. Their work indicated that cottage cheese treated with chlorinated water and subsequently creamed showed deterioration on the fourteenth day, as compared with the control sample which began to deteriorate on the seventh day.

Sommer (20) found that excessive washing produced a product that was flavorless, and with certain types of water, due to solvent action, produced a slippery curd.

Van Slyke and Price (25) state that a very sweet cheese was produced by replacing the whey with fresh, clean water at the temperature of the curd, draining when the curd was firm, washing first with water at 70 degrees Fahrenheit, and again with water at 50 degrees Fahrenheit.

Wilson and Trimble (27) found that two or three washings using the coldest water obtainable was usually sufficient.

Standardization of Acidity.—Very little work has yet been done on the standardization of acidities in the cheese curd. Associates of Rogers (1) state that somewhat unsatisfactory results were obtained when basic substances, accompanied by pasteurization, were used to standardize high acid milk previous to its use in cheese making.

Phillips (12) observed that two or more washings of the curd were necessary in order to produce a mild flavored cottage cheese, and that a small amount of neutralizer was sometimes added to the last wash water to produce a cottage cheese with lower acid content.

Salting.—Phillips (12) stated that the curd should be salted as soon as possible after manufacture, because the preservative action of salt aided in the keeping quality of the cheese.

Ruehe (19) found that if the curd was to be held for a few days, it was best to store it uncreamed and unsalted at 32-40 degrees Fahrenheit.

Sommer (20) found it best to add salt at the rate of one pound of salt to 100 pounds of curd for its flavoring and preservative properties.

Tracy (23) concluded that if cheese was to be held frozen, the curd may be either salted or unsalted.

Van Slyke and Price (25) stated that curd salted at the rate of one pound of salt to 100 pounds of curd was satisfactory.

Gelatin.—Martin (7) reported that gelatin gave cottage cheese a glossy appearance, and made possible the use of a lower test cream when added to the cream at the rate of .25-1.0 per cent of the weight of the cream.

Parfitt (8) concluded that gelatin could be added either in a 10 per cent solution, or directly to the cream to improve the quality of the cheese and to supply muscle building material when used with other foods.

Parker (11) stated that gelatin had its greatest value in the storage of cottage cheese in the spring, for summer or fall use. His work showed that gelatin enabled the thawed curd to hold its shape so that each individual curd retained its identity the same as fresh curd.

Reid (16) found that the addition of gelatin for storage improved aroma, flavor, body and texture at the completion of the storage period. Absorption of moisture reduced the size of ice crysals and the amount of whey formed when thawed. A smooth body and medium close texture was formed, and the flavor was mildly acid.

Storage.—Ellenberger (2) found that cottage cheese held in cold storage for four to five months was of better quality at the end of the storage period than some of the fresh cheese then being sold on the market. His work further showed that cottage cheese held frozen for seven and one-half months developed a decidedly disagreeable flavor and was more granular than before storage. He concluded that there was no difference in the keeping quality of salted and unsalted curds.

Parfitt (9) stated that cottage cheese curd could be kept very satisfactory for a period of time up to six months if frozen hard. The curd could be either salted or unsalted, but there would be a slight reduction in flavor, and the body would be coarse. The cheese must remain frozen during storage, and not be permitted to thaw so as to make re-freezing necessary.

Phillips (12) found that cottage cheese held frozen for several months came out in condition satisfactory for food and market purposes.

Tracy (23) concluded that cheese experts could detect slight off-flavors in stored cottage cheese.

Sunlight.—Phillips (13) observed that cottage cheese in clear glass containers exposed to the sunlight developed flavor defects. He found that when creamed cottage cheese was exposed to the sunlight for one-half hour it developed an oxidized flavor, while cheese exposed two hours to the sunlight developed a tallowy odor and flavor. Uncreamed cottage cheese given identical treatment also developed characteristic and objectionable flavor defects.

Reid and Brock (17) stated that cheese held in the absence of light maintained its desirable physical qualities for a period of twenty days, while samples of cottage cheese exposed to artificial and direct sunlight deteriorated in direct proportion to the length of time exposed and the intensity of the light.

Tracy and Ruehe (24) observed that a disagreeable burnt flavor resulted from exposure of cottage cheese in glass or open containers to either direct or indirect sunlight.

PROCEDURE

Commercial conditions were maintained throughout this investigation, so that the information obtained could be more readily applied in modern commercial dairy plants.

Cottage Cheese

Studies were made to determine the effect upon the physical and chemical properties of cottage cheese in which variable increments of standardizing agent, Minsol, were added to the skim milk, to the wash water, to the storage water, and to the cream used for creaming the curd. In addition to studying the effect of adding the standardizing agent at only one definite setp in the manufacturing process, it was deemed advisable to study the effect of adding it at two or more steps in the process on the same lot of cheese.

Equipment.—The equipment used was of the latest type. Stainless steel, cheese vats with a capacity of 50 gallons were used. The curd was cut with vertical and horizontal stainless steel, wire curd knives.

pH determinations were made at 70 degrees Fahrenheit, using a Beckman glass electrode pH-meter, and acidity determinations were made at the same temperature using the Nafis Acidity Tester. The percentages of moisture and total solids were determined with the Mojonnier Milk Solids Tester.

Standardizing Agent.—The standardizing agent used in this investigation contained anhydrous dextrose, calcium hydroxide, magnesium hydroxide and sodium chloride. In determining its standardizing value, a one gram sample was completely dissolved in a standard solution of HCl. The excess HCl used was back-titrated with a standard solution of NaOH using phenolphthalein as the indicator. Thus, the actual amount of HCl used was determined and converted into terms of its equivalent of lactic acid. Calculations revealed that six pounds of the standardizer exactly standardized one pound of lactic acid. This value for the standardizer was used throughout this investigation.

In determining the speed of the reaction between the skim milk and the standardizer, the amount of standardizer required to reduce the acidity of the skim milk to 0.05 per cent was calculated and added to the skim milk. The titratable acidity was determined every five minutes, timed by an interval timer, and it was found that the reaction was practically complete in approximately thirty minutes.

In standardizing the acidity in the skim milk, the total acidity, calculated as lactic acid, was determined. The amount of standardizing agent required was dissolved at the rate of one pound by

weight of standardizer to four pounds by weight of water at 100 degrees Fahrenheit, and added directly to the milk.

As a result of acidity standardization in the skim milk and certain other variations in the manufacturing procedure, a new short-time method for manufacturing cottage cheese which requires approximately two and one-half hours was developed.

Method of Manufacture.—The short time, 5-hour method of manufacture was employed. A high quality skim milk obtained from the University dairy herd was pasteurized at 143 degrees Fahrenheit for thirty minutes, and immediately cooled to the setting temperature of 90 degrees Fahrenheit. Samples were taken and examined for flavor, aroma, acidity, extraneous matter and bacteria. Unless otherwise stated, 10 per cent of starter and 1.25 cubic centimeters of rennet per 1000 pounds of skin milk were used as coagulating agents. When the titrable acidity of the whey reached .53 to .55 per cent, the curd was cut with one-half inch curd knives, first into horizontal strips with the horizontal knife the long way of the vat, and then into vertical strips, first lengthwise and then crosswise of the vat with the vertical knife. Water at 115 degrees Fahrenheit, equal in volume to one-half the volume of whey, was added directly to the vat and gentle heating was begun immediately. After reaching the final heating temperature of 115 to 118 degrees Fahrenheit, the curd was held until firm and then drained. The firmness of the curd was tested by placing several of the curd particles in cold water for one minute. In all, eight batches of cottage cheese were made. The amount of skim milk used in each lot ranged from 137 to 344 pounds, depending upon the amount of curd needed to supply the desired number of samples.

Washing.—Two wash waters were used in washing the curd. The first wash water was at a temperature of 65 degrees Fahrenheit, and was allowed to remain on the curd for five minutes. The second wash water was at a temperature of 45 degrees Fahrenheit, and it was allowed to remain on the curd for ten minutes.

The wash waters were either plain or alkaline. The alkaline wash waters were made by dissolving the standardizing agent at the rate of one part by weight of standardizer to four parts by weight of water at 100 degrees Fahrenheit, then adding enough cold water to make eight gallons. In all cases, the total volume of each wash water used was equal to the volume of whey drawn from the vat. After removing the last wash water, the curd was allowed to drain thoroughly before receiving any further treatment.

Creaming.—A high quality, fresh, sweet cream with an acidity of .12 per cent and a fat content of 22 per cent was used for creaming

the curd. The acidity of the cream was built up to .20 per cent by adding a high quality lactic ferment culture, pasteurizing at 150 degrees Fahrenheit for 30 minutes and rapidly cooling to 40 degrees Fahrenheit. One portion of this cream was used without adjusting its acidity, and two other portions were reduced to acidities of .10 and .00 per cent respectively by adding directly to the cream the calculated amounts of standardizing agent necessary.

Storage.—Four methods of storing the curd were practiced, namely; as dry curd, in plain water, in alkaline water, and as creamed curd. Alkaline storage waters were prepared in the same manner as were the wash waters and cooled to 40 degrees Fahrenheit before storing the curd in them. All samples, both creamed and uncreamed were stored in quart glass jars at a temperature of 40 degrees Fahrenheit.

Quality Observations.—The curd was observed as the raw curd in some instances, and as the creamed curd in others. Each sample was observed for flavor, body, and keeping quality on the day of manufacture, and every third day thereafter during the storage period. No numerical score was given. The judges determined the flavor by the sense of taste and the body was determined by the feel of the curd in the mouth and the firmness of the curd when pressed between the tongue and the palate. Keeping quality was classed as "good", "medium" and "poor", in which good was referred to as being desirable, medium as only satisfactory, and poor as unsatisfactory and unsalable. Immediately following each quality observation, a pH determination was made on each sample of curd.

Cultured Buttermilk

In making a further investigation into the effect of acidity standardization in dairy products, a study of cultured buttermilk was made in which variable increments of standardizing agent were used to adjust the acidity at different steps in the manufacturing process.

Equipment.—The equipment consisted of a starter cabinet, electrically heated, and equipped with the thermostats for maintaining a constant temperature. The milk was set in well-tinned containers. Acidity and pH determinations were made with the same equipment used in the cottage cheese studies.

Viscosity determinations were made by recording the number of seconds required for 100 cubic centimeters of the sample being tested to flow by gravity from a standard 100 cubic centimeter pipette at a temperature of 40 degrees Fahrenheit. The viscosity of water was used for the purpose of comparison.

Standardizing Agent.—A standardizing value of six pounds of standardizer to one pound of lactic acid was given to the standardizing agent. The calculated amounts of standardizer were added directly to the milk and buttermilk.

Method of Manufacture.—Clean, fresh skim milk standardized to 1.0 per cent butterfat with fresh, sweet cream, was pasteurized at 180 degrees Fahrenheit for 45 minutes and immediately cooled to the setting temperature. A high quality butter culture was used as the coagulating agent. A setting temperature of 70 degrees Fahrenheit and 1 per cent of starter was used unless otherwise specified. When the desired acidity was attained after coagulation, the curd was carefully broken and the buttermilk cooled to 40 degrees Fahrenheit. The buttermilk was bottled in one-half pint bottles and stored at 40 degrees Fahrenheit.

Quality Observations.—The buttermilk was observed for flavor, body and keeping quality at 1, 3, 5, and 7 days and pH and acidity determinations were made immediately following each quality observation. The flavor was determined by the sense of taste, and the body was compared with that of a high quality buttermilk. The keeping quality was determined in the same manner as that of the cottage cheese.

EXPERIMENTAL DATA

Cottage Cheese

Eight batches of cottage cheese were made in this investigation from which the various series were taken, and each series was divided into individual lots to determine the effect of variable acidity treatments of each lot. The series into which each batch was divided are as follows:

EXPERIMENTAL SERIES

Control series:
- Batch I—Control:—Comparison of Washing and Storage Procedures.
- Batch II—Comparison of Washing and Creaming Procedures.

Acidity standardization of skim milk:
- Batch III—Effect of Acidity Adjustment of Skim Milk to 0.00 Per Cent, and Acid Standardization of Cream Used for Creaming Curd.
- Batch IV—Effect of Acidity Adjustment of Skim Milk to 0.05 Per Cent, and Acid Standardization of Cream Used for Creaming Curd.
- Batch V—Effect of Acidity Adjustment of Skim Milk to 0.10 Per Cent, and Acid Standardization of Cream Used for Creaming Curd.
- Batch VI—Effect of Acidity Adjustment of Skim Milk to 0.05 Per Cent After Adding Starter, and Acid Standardization of Cream Used for Creaming Curd.
- Batch VII—Effect of Acidity Adjustment of Skim Milk to 0.05 Per Cent After Adding Starter and Rennet, and Acid Standardization of Cream Used for Creaming Curd.

New short-time method:

Batch VIII—Effect of Acidity Adjustment of Skim Milk to 0.05 Per Cent, the Addition of 20 Per Cent Starter and 1.5 Cubic Centimeters of Rennet per 1000 Pounds of Skim Milk, and Acid Standardization of Cream Used for Creaming Curd.

The manufacturing data of each of the eight batches are shown in Table 1. With the exception of Batch VIII all batches were identical with respect to percentage of starter used, rate of adding rennet, setting temperature and cutting temperature.

Table 2 shows a comparison of the variations observed in making the different batches. A difference of only 3 degrees Fahrenheit was noted in the heating procedure, .06 per cent in acidity at cutting, and .15 in the pH reading of the whey at cutting.

Batches III to VII inclusive, in which the acidity of the skim milk was standardized indicate that the time of manufacture can be reduced if certain steps in the manufacturing process are varied. Upon this assumption, the following procedure was followed:

1. Skim milk of good quality was pasteurized at 143 degrees Fahrenheit for 30 minutes and then cooled to 90 degrees Fahrenheit.
2. The acidity of the skim milk was reduced to 0.05 per cent.
3. Starter and rennet were added at the rate of 200 pounds of starter and 1.5 cubic centimeters of rennet, respectively, per 1000 pounds of skim milk.
4. The curd was cut into cubes of uniform size when it showed a clean break, and the whey had an acidity of .50 per cent.
5. Warm water (115 degrees Fahrenheit) equal in volume to one-half the volume of skim milk was added to the whey and curd.
6. Curd was heated to 118 degrees Fahrenheit and held at this temperature until it was properly firmed.
7. The whey was drained and an equal volume of cold water at 65 degrees Fahrenheit was added. This water was drained after 5 minutes and another equal volume of cold water (45 degrees Fahrenheit) was added in which the curd was submerged for 10 minutes and then thoroughly drained.
8. The curd was then stored at 40 degrees Fahrenheit.

The data for Batch VIII in Table 2 show that the time required from setting to cutting, cutting to draining, and setting to draining was considered less than the regular method presented in the same table by Batches I and II. This reduction in time may be due to the following:

1. A clean, sweet, neutral medium for bacterial growth and lactic

TABLE 1.—MANUFACTURING DATA OF THE EXPERIMENTAL BATCHES OF COTTAGE CHEESE.

Batch Number	I	II	III	IV	V	VI	VII	VIII
Pounds of Milk	344	212	137.6	137.6	137.6	137.6	68.8	137.6
Acidity of Milk	.15	.16	.18	.20	.17	.17	.20	.18
pH of Milk	6.55	6.50	6.50	6.45	6.65	6.55	6.50	6.50
Ounces of Standardizer	...	...	30.5	24.0	9.0	34.0	16.0	17.0
Acidity after Standardizing	...	...	0.00	0.05	0.10	0.05	0.05	0.05
Pounds of Starter	34.4	21.2	13.7	13.7	13.7	13.7	6.8	27.4
Percentage of Starter	10	10	10	10	10	10	10	20
Cubic Centimeters of Rennet	.50	.26	.17	.17	.17	.17	.09	.20
Setting Temperature (Deg. F)	90	90	90	90	90	90	90	90
Cutting Temperature (Deg. F.)	90	90	90	90	90	90	90	90
Acidity of Whey at Cutting (Per Cent)	.54	.52	.54	.54	.53	.56	.53	.50
pH of Whey at Cutting	4.50	4.50	4.60	4.60	4.50	4.50	4.60	4.65
Time Set to Cut (Hrs.: Mins.)	4-25	4-15	3-50	3-30	2-55	2-55	4-0	2-30
Time Set to Drain (Hrs.: Mins.)	1-15	1-30	1-15	1-15	1-5	0-55	1-25	0-55
Temperature of Heating (Deg. F.)	116	118	116	116	116	116	115	118
pH of Whey after Heating	4.50	4.80	4.60	4.60	4.60	4.60	4.60	4.65
Moisture in Curd (Per Cent)	80.55	80.55	86.88	80.08	79.98	80.10	80.12	82.05
Total Solids in Curd (Per Cent)	19.45	19.45	13.12	19.92	20.02	19.90	19.88	17.95
Yield Per 100 Pounds of Milk (Pounds)	18.10	18.10	19.18	18.17	18.21	18.00	17.95	19.70

TABLE 2.—A COMPARISON OF PROCEDURE VARIATIONS IN THE MANUFACTURE OF THE EXPERIMENTAL BATCHES OF COTTAGE CHEESE.

Batch	Temperature Degrees Fahrenheit			Cutting		Time Required						Rennett cc. per 1000		Yield Per 100
				Acidity		Set to Cut		Cut to Drain		Set to Drain		Pounds of	Moisture	Pounds of
Number	Set	Cut	Drained	Per Cent	pH	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.	Milk	Per Cent	Milk
I	90	90	116	.54	4.50	4	25	1	15	5	40	1.25	80.55	10.10
II	90	90	118	.52	4.50	4	15	1	30	5	45	1.25	80.55	18.10
III	90	90	116	.54	4.60	3	50	1	15	5	5	1.25	86.88	19.18
IV	90	90	116	.54	4.60	3	30	1	15	4	45	1.25	80.08	18.17
V	90	90	116	.53	4.50	2	55	1	5	4	00	1.25	79.98	18.21
VI	90	90	116	.56	4.50	2	55	0	55	3	50	1.25	80.10	18.00
VII	90	90	115	.53	4.60	4	00	1	25	5	25	1.25	80.12	17.95
VIII	90	90	118	.50	4.65	2	30	0	55	3	25	1.50	82.05	19.70

acid production was acquired by standardizing the acidity of the skim milk.

2. An increase in rennet caused a more rapid change of calcium caseinate to calcium paracaseinate.
3. A high percentage of active starter in an improved medium resulted in rapid lactic acid production and a correspondingly rapid change in insoluble calcium salts to soluble calcium salts.
4. Rapid production of both calcium paracaseinate and soluble calcium salts hastened the coagulation of the skim milk.

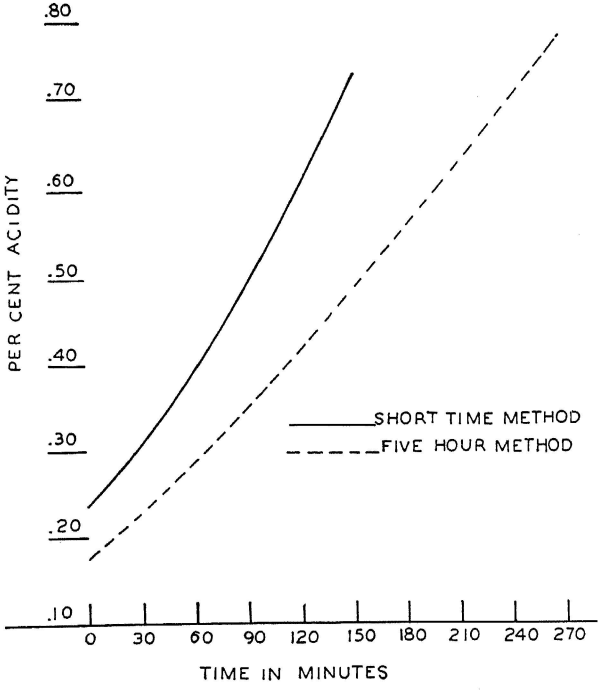

Fig. 1.—A Comparison of the Rate of Acidity Increase During the Manufacturing Process of Cottage Cheese by the New Short-Time Method and the Five-Hour Method.

The comparatively low acidity at the time of cutting the curd was due to the partial reduction of apparent acidity of the milk, thus, the sum of the developed acidity and the partially reduced acidity was less than the sum of the total apparent acidity and the developed acidity.

The yield of cheese obtained by the new method was 9.39 per cent greater than the yield obtained by the old method. This increase

in yield was partially due to milk solids added by the increased amount of starter.

A comparison of the rate of acidity increase during the manufacturing process of cottage cheese by the short-time method and the five-hour method is shown by Figure 1. It will be observed that in the short-time method the curd was cut at an acidity of .73 per cent in 2½ hours, while in the regular five-hour method the curd was cut at an acidity of .78 per cent in 4½ hours. A comparison of the curd obtained by these two methods is shown by Figure 2.

The data on the flavor, body, keeping quality, and pH of the cheese curd produced by the new short-time method are presented in Lot VII, Table 3.

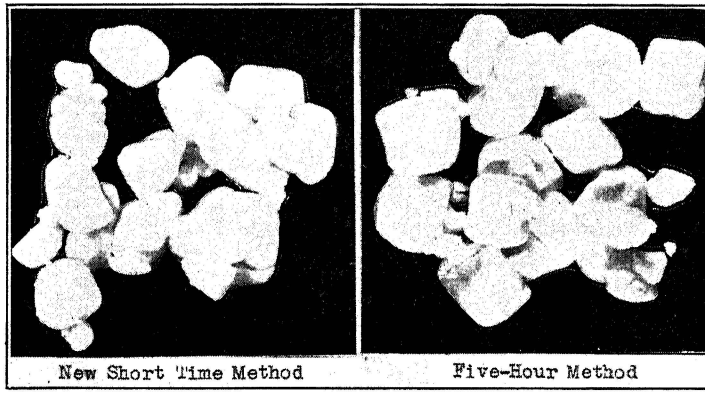

Fig. 2.—A Comparison of Cottage Cheese Curd Made by the New Short-Time Method and by the Five-Hour Method.

The Effect of Standardizing the Acidity of the Skim Milk Upon the Flavor, Body, Keeping Quality, and pH of Cottage Cheese Curd.—Seven lots of skim milk were treated to determine the effect of standardizing their acidity upon the various properties of the resulting curd:

Lot I—(Control) No treatment.
Lot II—Acidity standardized to 0.00 per cent.
Lot III—Acidity standardized to 0.05 per cent.
Lot IV—Acidity standardized to 0.10 per cent.
Lot V—Acidity standardized to 0.05 per cent after adding starter.
Lot VI—Acidity standardized to 0.05 per cent after adding starter and rennet.

Lot VII—Acidity standardized to 0.05 per cent, then 20 per cent starter and 1.5 cubic centimeters of rennet added per 1000 pounds of milk.

Table 3 shows that the control sample was lacking in flavor as its full, clean flavor was partially submerged by the acid retained in the curd. The most desirable flavor was observed in Lots II, III, and VII in which the acidity of the skim milk was reduced. Acidity standardization seems to cause the more desirable flavors to become more apparent. The addition of standardizer to Lots V and VI, after adding the starter, imparted a slight chalky, unnatural flavor to the curd. Best results were obtained by standardizing the acidity before adding the starter. The standardization of the acidity before or after adding rennet had no apparent effect upon the flavor of the curd.

Only slight body differences were observed in the seven lots of cottage cheese curd. There was, however, a tendency for the body of the treated lots to be slightly firmer and a little more dry than that of the control lot.

Lots I and IV had the most desirable keeping qualities and it seemed that as the amount of standardizer was increased there was a corresponding decrease in the keeping quality as shown by Lots II and V.

A close correlation was noted between the pH and the keeping quality of the different lots of cottage cheese curd. This probably is due to the increase in lactic acid which is known to be an important factor in reducing the keeping quality of cottage cheese curd.

The Effect of Using Variable Increments of Standardizing Agent in the Wash Waters Upon the Flavor, Body, Keeping Quality, and pH of Cottage Cheese Curd.—In determining the effect of using alkaline wash waters, one batch of cheese was divided into six equal portions and the following washing procedure practiced:

Lot I—(Control) No standardizer in either wash water.
Lot II—One-fourth pound of standardizer added to the second wash water.
Lot III—One-fourth pound of standardizer added to both wash waters.
Lot IV—One-half pound of standardizer added to both wash waters.
Lot V—One pound of standardizer added to second wash water.
Lot VI—One pound of standardizer added to both wash waters.

TABLE 3.—THE EFFECT OF STANDARDIZING THE ACIDITY OF SKIM MILK UPON THE FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE CURD.

Lot Number	Acidity Per Cent	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	.15	Med. Full Mild	Sl. Lacking Sl. Acid	Lacking Acid	Acid Sl. Bitter	Good	Good	Good	Medium
II	.00	Full, Mild Clean	Med. Full	Sl. Acid	Sl. Bitter Sl. Sour	Good	Medium	Poor	Poor
III	.05	Full, Mild Clean	Sl. Acid	Acid Sl. Bitter	Acid Bitter	Good	Poor	Poor	Poor
IV	.10	Full V. Sl. Acid	Sl. Full V. Sl. Bitter	V. Sl. Bitter Sl. Full	Sl. Bitter Unnatural	Good	Good	Good	Medium
V	.05#	Full, Creamy Mild, Chalky	Med. Full	Sl. Bitter Sl. Unnatural	Acid Sl. Fruity	Good	Medium	Medium	Poor
VI	.05*	Full, Sweet Mild, Chalky	Full Creamy	Med. Full Sl. Bitter	Sl. Bitter Sl. Unnatural	Good	Good	Medium	Medium
VII	.05†	Clean Full	Mild Full	Clean Full	Sour Sl. Fruity	Good	Good	Medium	Poor

Lot Number	Acidity Per Cent	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	.15	Med. Firm	Med. Firm	Med. Firm	Med. Firm	5.05	4.33	4.20	4.25
II	.00	Firm	Firm	Med. Firm	Med. Firm	4.90	4.60	4.30	4.40
III	.05	Sl. Dry	Sl. Dry	Sl. Dry	Sl. Dry	4.80	4.30	4.30	4.40
IV	.10	Med. Firm	Med. Firm	Med. Firm	Med. Firm	4.60	4.70	4.70	4.70
V	.05#	Smooth Mellow	Smooth Mellow	Smooth Mellow	Smooth Mellow	4.70	4.70	4.30	4.30
VI	.05*	Smooth Mellow	Mellow, Smooth Med. Firm	Med. Firm	Med. Firm	4.80	4.40	4.30	4.30
VII	.05†	Med. Firm	Med. Firm	Med. Firm	Med. Firm	4.70	4.80	4.90	4.90

#Acidity Standardized After Adding Rennet.
*Acidity Standardized After Adding Starter and Rennet.
†Twenty Per Cent Starter and 1.5 Cubic Centimeters of Rennet per 1000 pounds of milk.

Table 4 shows that during the early stages of the storage period, the best flavor was present in those lots treated with wash waters containing a moderate amount of standardizer. Lot I, was lacking in the full, clean, mild flavor which was typical of Lots II and III. During the later stages of the storage period considerable acid developed in Lot I which was undesirable from the standpoint of

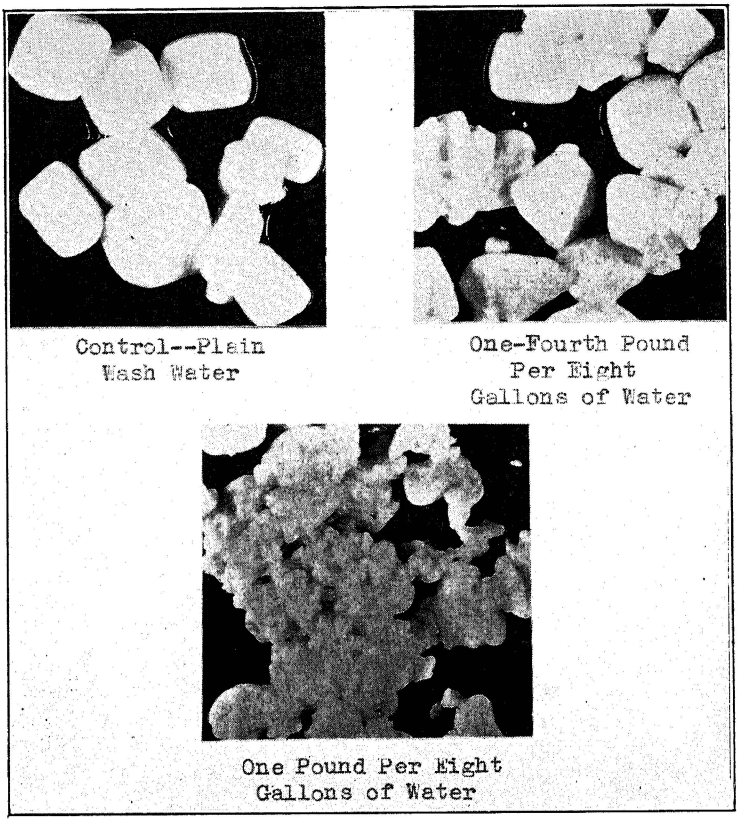

Fig. 3.—Samples of Cottage Cheese Curd Showing the Effect of Variable Increments of Standardizing Agent in the Wash Water.

flavor. Lots IV, V, and VI possessed an unnatural flavor, and Lots V and VI had a sweet, flat flavor due to the addition of an excessive amount of standardizer to the wash waters. Lot II seemed to possess the most desirable flavor as sufficient standardizer was used to remove the excess acid and bring out the desirable flavors.

The body of the control sample, while not objectionable, was not as desirable as Lot II. No apparent advantage was obtained from

TABLE 4.—THE EFFECT OF USING VARIABLE INCREMENTS OF STANDARDIZING AGENT IN THE WASH WATERS UPON THE FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE CURD.

Lot Number	Standardizer Added Pounds	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	None	Med. Full Mild	Sl. Lacking Sl. Acid	Lacking Acid	Acid Sl. Bitter	Good	Good	Good	Medium
II	.25*	Full, Mild Clean	Med. Full Mild, Clean	Med. Full V. Sl. Acid	Acid Sl. Bitter	Good	Good	Good	Medium
III	.25†	Med. Full Mild, Clean	Mild Clean	Sl. Acid	Metallic Sl. Bitter	Good	Good	Good	Poor
IV	.50†	Clean Sl. Unnatural	Mild Sl. Flat	Sl. Acid Unnatural	Unnatural Acid	Good	Good	Medium	Medium
V	1.00*	Sweet, Mild Sl. Unnatural	Mild	Sl. Acid	Acid Sl. Bitter	Good	Good	Good	Medium
VI	1.00†	Mild, Sweet Unnatural	Mild Unnatural	Sl. Acid Sl. Bitter	Sl. Acid Sl. Bitter	Good	Good	Poor	Poor

Lot Number	Standardizer Added Pounds	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	None	Med. Firm Smooth	Med. Firm Smooth	Med. Firm Smooth	Med. Firm Smooth	5.05	4.33	4.20	4.25
II	.25*	Mellow Smooth	Mellow Smooth	Mellow Smooth	Sl. Weak Smooth	5.00	4.32	4.20	4.25
III	.25†	Mellow Smooth	V. Sl. Weak Smooth	V. Sl. Weak Sl. Watery	Sl. Weak Sl. Watery	5.00	4.30	4.20	4.25
IV	.50	Mellow	Sl. Pasty	Sl. Weak	Sl. Weak	5.00	4.80	4.50	4.40
V	1.00*	Sl. Weak	Sl. Weak Weak	Sl. Weak Weak	Weak Weak	4.95	4.31	4.20	4.30
VI	1.00†	Sl. Weak	Gelatinous	Watery	Watery	5.08	4.37	4.30	4.35

*Pounds of Standardizer in the Second Wash Water.
†Pounds of Standardizer in the First and Second Wash Waters.

using standardizing agent in both wash waters, since the first wash water was drained after remaining on the curd for only five minutes. It seemed desirable to remove the whey with untreated water and then continue the acid reduction with standardizer in the second wash water. The use of more than one-fourth pound of standardizer in either, or both of the wash waters, seemed to have a detrimental effect upon the curd.

Figure 3 shows the effect of variable increments of standardizing agent in the wash water upon cottage cheese curd. No difference was observed between the lot washed in plain water and the lot washed in water containing 0.25 pounds of standardizing agent per eight gallons of water. However, one pound of standardizing agent per eight gallons of water caused disintegration and matting of the curd particles.

The best keeping quality was observed in Lots I, II, and V. Lots III and IV, in which standardizer was used in both wash waters, did not have as good a keeping quality as Lots II and V. Lot VI had the poorest keeping quality of the group.

A close correlation was noticed between the pH and keeping quality of the cottage cheese curd. It was also observed that there was a general tendency for the curd to reach its minimum pH on the 6th day of storage, and then to increase slowly and uniformly during the remainder of the storage period. This increase in pH may have been due to the break-down of the protein with formation of alkaline compounds.

The Effect of Using Variable Increments of Standardizing Agent in the Storage Water Upon the Flavor, Body, Keeping Quality, and pH of Cottage Cheese Curd.—In determining the effect alkaline storage water would have, six lots of cottage cheese curd were stored in water containing a standardizing agent dissolved in water in the following amounts:

Lot I—(Control) No treatment.
Lot II—One-eighth pound per eight gallons of water.
Lot III—One-fourth pound per eight gallons of water.
Lot IV—One-half pound per eight gallons of water.
Lot V—One pound per eight gallons of water.
Lot VI—One-fourth pound per eight gallons of water; changed to fresh storage water of the same concentration on the third day.

The data, Table 5, shows that the quality of cottage cheese curd stored in alkaline water was inferior to treating the curd in alkaline

TABLE 5.—THE EFFECT OF VARIABLE INCREMENTS OF STANDARDIZING AGENT IN THE STORAGE WATER* UPON FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE CURD.

Lot Number	Standardizer Added Pounds	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	None	Med. Full Mild	Sl. Lacking Sl. Acid	Lacking Acid	Acid Sl. Bitter	Good	Good	Good	Medium
II	.125	Mild, Mellow Med. Full	Mild, Mellow Med. Full	Mild V. Sl. Bitter	Metallic	Good	Good	Good	Poor
III	.25	Mild, Mellow Med. Full	Mild, Mellow V. Sl. Sweet	Sl. Acid Sl. Bitter	Acid Bitter	Good	Good	Good	Medium
IV	.50	Mellow, Mild Med. Full	Sl. Acid V. Sl. Bitter	Sl. Acid Sl. Bitter	Sl. Acid Bitter	Good	Good	Medium	Medium
V	1.00	Mellow, Mild Sl. Sweet Unnatural	Sweet, Flat Unnatural	Sl. Acid Sl. Bitter	Acid Bitter Unclean	Good	Good	Medium	Poor
VI	.25**	Full V. Sl. Acid	Unclean V. Sl. Bitter	Sweet, Mild Bitter Unnatural	Sweet Unnatural	Good	Good	Poor	Poor

Lot Number	Standardizer Added Pounds	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	None	Sl. Dry	Sl. Dry	Sl. Dry	Sl. Dry	5.05	4.33	4.20	4.25
II	.125	Sl. Weak	Sl. Weak	Weak	Weak	4.95	4.27	4.20	4.25
III	.25	Med. Firm	Sl. Weak	Sl. Weak	Sl. Weak	5.25	4.30	4.20	4.30
IV	.50	Med. Firm	V. Sl. Weak	Sl. Weak	Weak	5.05	4.30	4.25	4.30
V	1.00	Med. Firm	Sl. Weak	Sl. Weak	Weak	5.32	4.34	4.30	4.35
VI	.25**	Med. Firm	Sl. Weak Gelatinous	Sl. Weak	Weak	4.90	4.48	4.70	4.40

*Standardizing Agent Dissolved in Eight Gallons of Water.
**Storage Water Changed Every Three Days.

wash water. The standardizer in the storage water seemed to cause the curd stored in alkaline water to develop a bitter, metallic, unnatural flavor which was extremely objectionable. These off-flavors

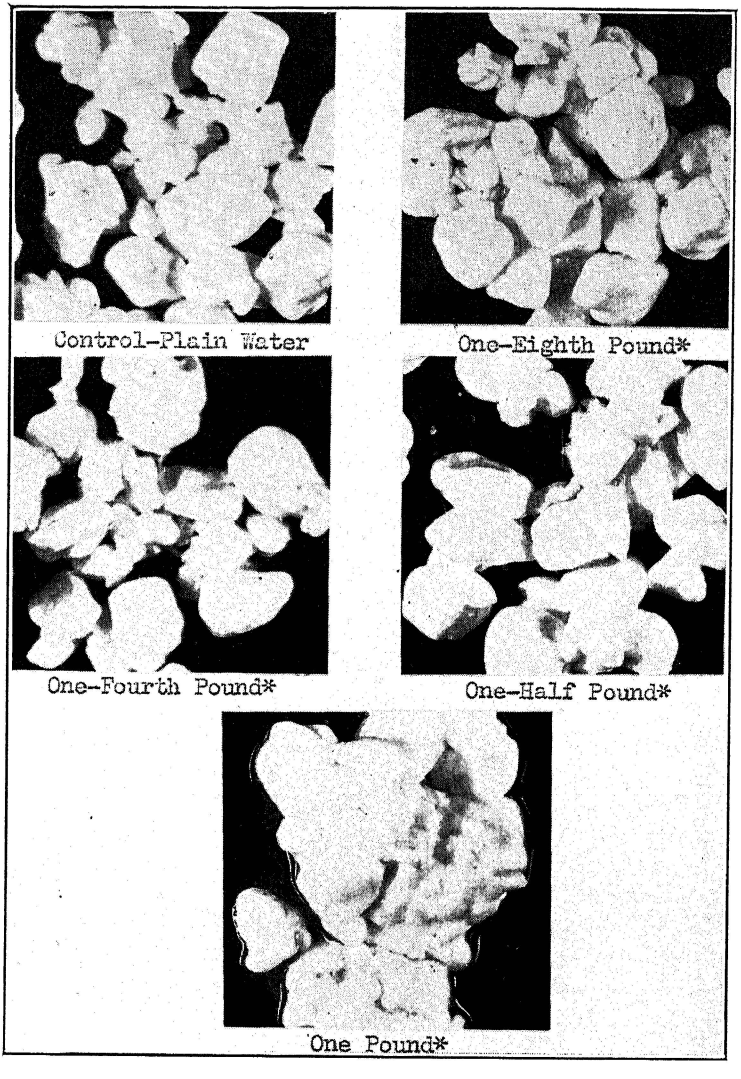

Fig. 4.—The Effect of Storage Waters Containing Variable Increments of Standardizing Agent Upon Cottage Cheese Curd Held in Storage Three Days. *Per Eight Gallons of Water.

appears to become more intense as the concentration of the standardizer in the storage water, and as the length of the time held in storage was increased.

TABLE 6.—THE EFFECT OF STANDARDIZING THE ACIDITY OF CREAM FOR CREAMING CURD UPON FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE.

Lot Number	Acidity of Cream Per Cent	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	.20	Med. Full Sl. Acid	Sl. Acid	Lacking Sl. Unclean	Cheesy Old Cream	Good	Medium	Medium	Poor
II	.10	Full, Mild Sl. Sweet Creamy	Full, Mild Sl. Sweet	Med. Full Sl. Sweet Sl. Bitter	Sweet Sl. Cheesy Sl. Bitter	Good	Good	Medium	Poor
III	.05	Sweet, Full Creamy Mild	Sweet, Full Creamy Mild	V. Sl. Bitter Med. Full Sl. Unnatural	Unclean Sl. Bitter Sl. Unnatural	Good	Good	Medium	Poor
IV	.00	Too Sweet Full, Mild Mellow	Too Sweet Full, Mild Mellow	Med. Full Mild V. Sl. Bitter	Unclean Unnatural	Good	Good	Medium	Poor

Lot Number	Acidity of Cream Per Cent	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	.20	Smooth Mellow	Smooth Mellow	Smooth	Smooth	4.80	4.60	5.00	4.90
II	.10	Smooth Mellow	Smooth Mellow Sl. Soft	Smooth Mellow Sl. Soft	Smooth Sl. Soft	5.00	4.90	5.10	5.00
III	.05	Smooth Mellow V. Sl. Slick	Smooth Mellow V. Sl. Slick	Smooth V. Sl. Slick	Smooth Sl. Slick	5.10	4.90	5.10	5.00
IV	.00	Smooth Mellow Sl. Slick	Smooth Mellow Gelatinous	Smooth Mellow Gelatinous	Smooth Sl. Slick	4.90	4.90	5.10	5.10

Storage in alkaline water containing moderate amounts of the standardizer caused the curd to mat in the storage containers. Changing to fresh storage water of the same concentration further decreased its physical properties, even though the pH remained considerably higher than that of those lots in which the storage water was unchanged throughout storage.

Figure 4 indicates that storage of cottage cheese curd in water containing as much as 0.50 pound of standardizing agent per eight gallons of water produced no apparent physical defects, but storage in water containing 1 pound of standardizing per eight gallons of water produced a gelatinous curd which was subject to severe matting.

The Effect of Standardizing the Acidity of Cream for Creaming Curd Upon Flavor, Body, Keeping Quality, and pH of Cottage Cheese.—The cream used in creaming cottage cheese is an important factor in the quality of the finished product. The acidity of clean, fresh, sweet cream was increased to .20 per cent by the addition of high quality lactic acid starter. Portions of the cream were reduced to various acidities by addition of variable increments of standardizer and applied to the cottage cheese curd to determine what effect they would have upon the resulting cottage cheese. Four lots of cream were used, and the acidity of each was as follows:

Lot I—.20 per cent Lot II—.10 per cent; Lot III.—.05 per cent; Lot IV—.00 per cent.

The data in Table 6 shows that a full, mild, clean flavor was produced by using cream in which the acidity had been reduced. The control lot which had an acidity of .20 per cent possessed a slight acid flavor which became more apparent as the storage time was prolonged.

The Effect of Standardizing the Acidity in Both the Skim Milk and the Cream Used for Creaming the Curd upon the Flavor, Body, Keeping Quality, and pH of Cottage Cheese.—Since the quality of the cottage cheese was improved by acidity standardization in the original skim milk and by acidity standardization in the cream a combination of both treatments on the same lot of curd was prepared. Seven lots of curd were obtained from three batches of skim milk in which the acidity had been standardized to 0.00, 0.05, and 0.10 per cent respectively, and each lot was creamed with acidity-reduced cream as follows:

Lot Number	Acidity Standardization of Skim Milk Per Cent	Acidity Standardization Cream Per Cent
Lot I	0.00	0.20
Lot II	0.00	0.10
Lot III	0.00	0.00
Lot IV	0.05	0.20
Lot V	0.05	0.10
Lot VI	0.10	0.20
Lot VII	0.10	0.10

Table 7 shows that only Lots I, VI, and VII had good keeping quality after three days of storage. Lots I, II, and IV possessed the best body, while the other lots appeared to be weak, pasty, and gelatinous.

The unsatisfactory condition of the cheeses might be attributed to the reaction, the casein of the cheese, which is soluble in alkaline solutions, and the high concentration of the basic constituents of the standardizer ($Ca(OH)_2$ and MgO).

The reaction of the standardizer upon the casein in the cream increased its viscosity and desirable creaming properties. The high viscosity in the low testing cream gives the appearance of a rich, thick cream which may be preferred by many consumers.

The Effect of Standardizing the Acidity in Cream and Variable Increments of Standardizer in the Second Wash Water Upon the Flavor, Body, Keeping Quality, and pH of Cottage Cheese.—Eight lots of Cottage Cheese Curd were made in this series. Four lots were washed in water containing one pound of standardizer per eight gallons of water and four lots were washed in water containing one-fourth pound of standardizer per eight gallons of water. Acidity-reduced cream with acidities ranging from .20 to .00 per cent was added to the curd of each lot. Each lot was prepared and treated as follows:

Lot Number	Standardizer in Wash Water Pounds	Acidity of Cream Per Cent
Lot I	1.00	.20
Lot II	1.00	.10
Lot III	1.00	.05
Lot IV	1.00	.00
Lot V	0.25	.20
Lot VI	0.25	.10
Lot VII	0.25	.05
Lot VIII	0.25	.00

Table 8 shows that by using moderate amounts of standardizer in the cream and wash water the quality of cheese was improved

TABLE 7.—THE EFFECT OF STANDARDIZING THE ACIDITY OF BOTH SKIM MILK AND CREAM FOR CREAMING CURD UPON FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE.

Lot Number	Acidity of Skim Milk Per Cent	Acidity of Cream Per Cent	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	.00	.20	Full, Clean Pleasant	Sl. Unnatural	Sl. Acid Unnatural	Sl. Sour Yeasty	Good	Good	Poor	Poor
II	.00	.10	Clean, Full Mellow, Mild	Unnatural	Sl. Bitter Unnatural	Sl. Fruity Unnatural	Good	Medium	Medium	Poor
III	.00	.00	Clean, Sweet Mellow, Mild	V. Sl. Acid Sl. Unnatural	Sl. Acid Sl. Unclean	Sl. Fruity	Good	Medium	Medium	Poor
IV	.05	.20	Full, Clean Pleasant	Sl. Acid Sl. Unnatural	Sl. Bitter Sl. Unnatural	Unclean Sour Cream	Good	Medium	Medium	Poor
V	.05	.10	Sl. Sweet, Full Mellow, Mild	Sl. Acid	V. Sl. Bitter Sl. Unnatural	Sl. Bitter Unnatural	Good	Medium	Poor	Poor
VI	.10	.20	Full, Mellow	Full, Mellow	Unclean Sl. Bitter	Fruity Sour Cream	Good	Good	Poor	Poor
VII	.10	.10	Full, Mild	Med. Full	Sl. Unclean	Unclean Fruity	Good	Good	Poor	Poor

Lot Number	Acidity of Skim Milk Per Cent	Acidity of Cream Per Cent	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	.00	.20	Smooth Mellow Med. Firm	Smooth Mellow Med. Firm	Smooth Mellow Med. Firm	Smooth Mellow Med. Firm	5.20	4.70	4.30	4.50
II	.00	.10	V. Sl. Slick	Med. Firm	Med. Firm	Med. Firm	5.10	4.50	4.40	4.50
III	.00	.00	Soft, Slick Gelatinous	Soft, Slick Gelatinous	Sl. Weak Gelatinous	Weak Gelatinous	5.80	4.70	4.50	4.50
IV	.05	.20	Smooth Mellow	Smooth Mellow	Smooth Mellow	Smooth Mellow	4.90	4.50	4.50	4.50
V	.05	.10	Smooth Mellow	Smooth Mellow	Smooth Gelatinous	Smooth Gelatinous	5.20	4.60	4.50	4.50
VI	.10	.20	V. Sl. Weak	V. Sl. Weak	V. Sl. Weak	V. Sl. Weak	4.90	4.90	4.60	4.60
VII	.10	.10	Sl. Soft	Sl. Soft Sl. Weak	Sl. Pasty	Sl. Pasty	5.00	5.10	4.80	4.60

TABLE 8.—THE EFFECT OF STANDARDIZING THE ACIDITY IN CREAM AND VARIABLE INCREMENTS OF STANDARDIZING AGENT IN THE SECOND WASH WATER UPON FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE.

Lot Number	Standardizer in Wash Water	Acidity of Cream Per Cent	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	One Pound Per Eight Gallons	.20	Med. Full Creamy	Sl. Acid Unnatural	Sl. Acid Unnatural	Sl. Unclean Old Cream	Good	Medium	Medium	Poor
II		.10	Sl. Sweet Full, Mild	Med. Full Unnatural	Med. Full V. Sl. Bitter	Unclean Unnatural	Good	Medium	Medium	Poor
III		.05	Sl. Sweet Full, Mild	Med. Full Unnatural	Med. Full Unnatural	Sweet, Fruity Unclean	Good	Medium	Medium	Medium
IV		.00	Full, Mild Unnatural	Med. Full Unnatural	Sl. Metallic Unnatural	Fruity Unnatural	Good	Medium	Poor	Poor
V	One-Fourth Pound Per Eight Gallons	.20	Med. Full Creamy	Unnatural Sl. Acid	Med. Full Sl. Acid	Old Cream Sl. Unclean	Good	Medium	Medium	Poor
VI		.10	Sl. Sweet Full, Mild	Med. Full Unnatural	Sl. Flat Unnatural	Sl. Acid Unclean	Good	Medium	Medium	Medium
VII		.05	Sl. Sweet Full, Mild	Med. Full Sl. Acid	Med. Full V. Sl. Bitter	Cheesy V. Sl. Bitter	Good	Good	Good	Medium
VIII		.00	Sweet, Mild	Med. Full Unnatural	Med. Full V. Sl. Bitter	Sl. Bitter Unnatural	Good	Medium	Medium	Medium

Lot Number	Standardizer in Wash Water	Acidity of Cream Per Cent	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	One Pound Per Eight Gallons	.20	Smooth Med. Firm	Smooth Med. Firm	Smooth Med. Firm	Smooth Med. Firm	4.80	4.90	5.00	5.00
II		.10	Smooth	Sl. Weak	Weak, Pasty	Weak, Pasty	5.10	5.10	5.20	5.10
III		.05	Smooth	Soft, Pasty	Soft, Pasty	Soft, Pasty	5.10	5.10	5.20	5.10
IV		.00	Smooth Sl. Weak	Sl. Soft Sl. Weak	Soft Weak	Weak Pasty	5.00	5.20	5.20	5.10
V	One-Fourth Pound Per Eight Gallons	.20	Smooth Mellow	Med. Firm	Med. Firm	Med. Firm	5.10	4.80	5.00	4.90
VI		.10	Smooth Mellow	Smooth Med. Firm	Med. Firm	Med. Firm	5.10	4.90	5.00	4.90
VII		.05	Smooth Mellow	Smooth Mellow	Smooth V. Sl. Weak	Smooth V. Sl. Weak	5.10	4.90	5.00	5.10
VIII		.00	Smooth Sl. Slick	Smooth Sl. Slick	Smooth Sl. Weak	Smooth Sl. Weak	4.90	5.00	5.10	5.10

and as the concentration of the standardizer in the wash water was increased or the acidity of the cream was standardized to less than .05 per cent, the desirable properties of the cottage cheese were somewhat impaired.

Lot VII was the most desirable lot in the series. A better flavor was obtained, the body of the cheese was unchanged, and the keeping quality was considerably better than when larger amounts of standardizer were used. The use of excessive amounts of the standardizer in the cream and wash water impaired the body and caused unnatural flavors to become apparent.

The Effect of the Addition of Standardizer to Cream and Wash Waters Upon Flavor, Body, Keeping Quality, and pH of Cottage Cheese.—This series was the same as series 8, except that the standardizing agent was used in both wash waters. The data, Table 9, indicate that the effect of the standardizing agent in this series was very similar to that obtained in the previous series in which standardizing agent was used only in the second wash water.

The Effect of Standardizing Agent in the Second Wash Water and Variable Increments of Standardizing Agent in the Storage Water Upon Flavor, Body, Keeping Quality, and pH of Cottage Cheese Curd.—To determine what effect a combination of alkaline wash water and alkaline storage water would have upon cottage cheese curd, five lots of curd, washed in water containing one-fourth pound of standardizer per eight gallons of water were stored in storage water containing 0, .125, .25, .50 and 1 pound of standardizer respectively, in eight gallons of water and held at 40 degrees F. for 12 days. The lots used and treatments given each lot are as follows:

Lot Number	Standardizer in Wash Water Pounds	Standardizer in Storage Water Pounds
Lot I	0.25	0.00
Lot II	0.25	0.125
Lot III	0.25	0.25
Lot IV	0.25	0.50
Lot V	0.25	1.00

The combination of alkaline wash water and alkaline storage water was quite unsatisfactory as indicated by the data in Table 10. Lot I, which was treated only with alkaline wash water and then stored in plain water had the most satisfactory body and keeping quality. The desirability of the other four lots decreased uniformly as the concentration of standardizer in the storage water increased, the principal defects being an unnatural flavor, a soft,

TABLE 9.—THE EFFECT OF STANDARDIZING THE ACIDITY IN CREAM AND VARIABLE INCREMENTS OF STANDARDIZING AGENT IN BOTH WASH WATERS UPON FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE.

Lot Number	Standardizer in Wash Water	Acidity of Cream Per Cent	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	One Pound Per Eight Gallons	.20	Full Mellow	Med. Full Unnatural	Sl. Bitter	Cheesy, Yeasty Unclean	Good	Medium	Medium	Poor
II		.10	Full, Mild Sweet	Sweet Med. Full	Sweet Med. Full	Sweet, Unclean Sl. Bitter	Good	Good	Medium	Poor
III		.05	Mild, Full Mellow	Mild, Full Mellow	Med. Full Unnatural	Too Sweet Unclean	Good	Good	Medium	Poor
IV		.00	Too Sweet Med. Full Flat	Too Sweet Med. Full Unnatural	Med. Full Too Sweet Unnatural	Too Sweet Unclean	Good	Good	Poor	Poor
V	One-Fourth Pound Per Eight Gallons	.20	Med. Full Mellow	Med. Full Sl. Acid	V. Sl. Bitter Unnatural	Old Cream Sl. Bitter	Good	Medium	Medium	Medium
VI		.10	Full, Mild Creamy	Med. Full Sl. Acid	Sl. Bitter Sl. Acid Unnatural	Acid, Bitter Unnatural	Good	Medium	Medium	Poor
VII		.05	Mild, Full Mellow	Mild, Full	Med. Full Unnatural	Bitter Unclean	Good	Good	Medium	Poor
VIII		.00	Sl. Sweet Full, Mild	Sl. Sweet Sl. Flat	Med. Full V. Sl. Bitter	Sl. Bitter Unclean	Good	Medium	Medium	Medium

Lot Number	Standardizer in Wash Water	Acidity of Cream Per Cent	Body Observations Days Stored 0	3	6	9	pH Observations Days Stored 0	3	6	9
I	One Pound Per Eight Gallons	.20	Smooth	Med. Firm	Med. Firm	Med. Firm	5.00	4.90	5.00	4.90
II		.10	Smooth Sl. Slick	Sl. Soft Sl. Pasty	Sl. Weak	Sl. Weak	5.00	4.90	5.10	4.90
III		.05	Smooth Sl. Slick	Smooth Sl. Soft	Sl. Soft Sl. Pasty	Soft Pasty	5.10	4.90	5.10	4.90
IV		.00	Smooth Sl. Slick	Sl. Slick Sl. Soft	Sl. Soft	Soft	5.00	5.10	5.10	5.00
V	One-Fourth Pound Per Eight Gallons	.20	Smooth Mellow	Med. Firm	Med. Firm	Med. Firm	4.80	4.80	4.90	4.90
VI		.10	Smooth Mellow	Smooth Mellow	Med. Firm	Med. Firm	4.90	5.00	5.00	4.90
VII		.05	Smooth Mellow	Smooth Mellow	Smooth V. Sl. Weak	Smooth Sl. Weak	4.80	4.90	5.00	5.00
VIII		.00	Smooth Sl. Slick	Smooth Sl. Weak	Smooth Sl. Weak	Smooth Weak	4.70	5.00	5.10	5.00

TABLE 10.—THE EFFECT OF STANDARDIZING AGENT IN THE SECOND WASH WATER* AND VARIABLE INCREMENTS OF STANDARDIZING AGENT IN THE STORAGE WATER UPON FLAVOR, BODY, KEEPING QUALITY AND pH OF COTTAGE CHEESE CURD.

Lot Number	Standardizer** Pounds	Flavor Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	0	V. Sl. Acid	V. Sl. Acid	Sl. Bitter Sl. Acid	Unclean Bitter	Good	Good	Medium	Poor
II	.125	V. Sl. Acid	V. Sl. Acid	Sl. Acid Unclean—Bitter	Bitter Unclean	Good	Medium	Medium	Poor
III	.25	Sl. Unnatural	Sl. Acid	Sl. Bitter	Bitter Metallic	Good	Medium	Medium	Poor
IV	.50	Mild Unnatural	Sl. Flat	Unclean	Bitter	Good	Medium	Medium	Poor
V	1.00	Med. Full Unnatural	V. Sl. Acid	Sl. Bitter Unclean	Sl. Metallic Unclean Very Bitter	Good	Medium	Poor	Poor

Lot Number	Standardizer** Pounds	Body Observations Days Stored 0	3	6	9	Keeping Quality Days Stored 0	3	6	9
I	0	Med. Firm	Med. Firm	V. Sl. Weak	Sl. Weak	5.15	4.29	4.20	4.25
II	.125	Med. Firm	V. Sl. Weak	Sl. Weak	Weak	5.05	5.25	4.25	4.25
III	.25	Med. Firm	Sl. Weak	Weak	Soft	5.10	5.25	4.20	4.30
IV	.50	Med. Firm	Sl. Weak	Weak	Weak	5.30	4.30	4.25	4.35
V	1.00	Sl. Weak	Sl. Weak	Weak	Weak	5.10	4.33	4.30	4.35

*One-Fourth Pound of Standardizing Agent to Eight Gallons of Wash Water.
**Dissolved in Eight Gallons of Storage Water.

weak body and poor keeping properties. No difference in the keeping quality was noted in Lots II, III, and IV, in which .125, .25 and .50 pounds of standardizer respectively was used in the storage water, but in Lot V in which a higher concentration of standardizer was used the poorest quality with respect to flavor, body and keeping quality was observed.

Cultured Buttermilk

Eight lots of cultured buttermilk were prepared in the conduct of this investigation as follows:

EXPERIMENTAL SERIES

Control lot:
Lot I—Control
Acidity adjustment in milk:
Lot II—Acidity of the milk adjusted to 0.00 per cent.
Lot III—Acidity of the milk adjusted to 0.05 per cent.
Lot IV—Acidity of the milk adjusted to 0.10 per cent.
Lot V—Acidity of the milk adjusted to 0.05 per cent after adding starter.
Lot VI—Acidity of the milk adjusted to 0.05 per cent, 5 per cent starter added and set at a temperature of 90 degrees Fahrenheit.
Acidity standardization in buttermilk:
Lot VII—Acidity of buttermilk reduced from 1.0 per cent to .75 per cent.
Lot VIII—Acidity of buttermilk reduced from 1.0 per cent to .50 per cent.

Table 11 shows the manufacturing data of each lots of buttermilk. It will be observed that all lots are identical with respect to amount of milk used, per cent of fat in milk, acidity of milk, pH of milk, temperature and time of pasteurization, acidity of starter and cooling temperature.

Lot VI shows that after the acidity of the milk was reduced to 0.05 per cent the addition of 5 per cent starter and a setting temperature of 90 degrees Fahrenheit produced a good quality of buttermilk in 5 hours. It seems that standardization of the acidity of the milk produced an excellent medium for bacterial growth and the high percentage of starter introduced a large number of bacteria into the milk. The high setting temperature was also favorable to the rapid multiplication of bacteria, which produced lactic acid at a rapid rate, resulting in a rapid coagulation in a comparatively short time.

Lots VII and VIII had the longest incubation period because it was desirable to have a high acidity as a means of determining the effect of acidity standardization after incubation.

The Effect of Acidity Adjustment Upon the Flavor, Body, Keeping Quality, and pH of Cultured Buttermilk.—The data, Table 12, show that Lot IV in which the acidity of the skim milk was adjusted to

TABLE 11.—MANUFACTURING DATA OF THE EXPERIMENTAL LOTS OF CULTURED BUTTERMILK.

Lot Number	I	II	III	IV	V	VI	VII	VIII
Pounds of Milk	50	50	50	50	50	50	50	50
Per Cent Fat in Milk	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Acidity of Milk (Per Cent)	.175	.175	.175	.175	.175	.175	.175	.175
pH of Milk	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Pasteurization Temperature (Deg. F.)	180	180	180	180	180	180	180	180
Pasteurization Time (Minutes)	45	45	45	45	45	45	45	45
Ounces of Standardizer in Milk	...	8.4	5.7	3.3	...	6.4	...	...
Acidity after Standardizing (Per Cent)	...	.00	.05	.10	...	.05	...	...
pH After Standardizing	...	7.70	7.30	7.10	...	7.30	...	...
Amount of Starter Added (Ounces)	8	8	8	8	8	40	8	8
Per Cent Starter	1.0	1.0	1.0	1.0	1.0	5.0	1.0	1.0
Acidity of Starter (Per Cent)	.90	.90	.90	.90	.90	.90	.90	.90
Ozs. of Standardizer after Adding Starter	...	...	...	...	6.5	...	...	...
Setting Temperature (Deg. F.)	70	70	70	70	70	90	70	70
Time of Incubation (Hours)	12	12	12	11.75	11.75	5.0	15	15
Acidity After Incubation (Per Cent)	.75	.76	.79	.785	.78	.80	1.00	1.00
Ozs. of Standardizer After Incubation	...	...	...	...	...	...	5.7	11.5
Acidity After Adding Standardizer (Per Cent)	...	...	...	...	...	...	.75	.50
Cooling Temperature (Deg. F.)	40	40	40	40	40	40	40	40
Viscosity	27.9	24.0	23.0	24.0	21.5	29.00	24.0	20.0

TABLE 12.—THE EFFECT OF ACIDITY ADJUSTMENT UPON THE FLAVOR, BODY, KEEPING QUALITY AND pH OF CULTURED BUTTERMILK.

Lot Number	Flavor Observations, Days Stored 0	3	5	7	Keeping Quality, Days Stored 0	3	5	7
I	Full, Creamy	Clean, Creamy Full, Pleasant	Rich, Full Acid, Creamy	Med. Full V. Sl. Unclean	Good	Good	Good	Medium
II	Clean, Creamy Full, Pleasant	Creamy, Med. Full Sl. Unnatural	Sl. Sweet Sl. Unnatural	Unnatural High Acid	Good	Good	Medium	Medium
III	Mild, Sl. Flat V. Sl. Unnatural Lacks Flavor	Mild, Sl. Flat Mellow Full, Creamy	Sl. Flat V. Sl. Unclean	Acid, Flat Unclean	Good	Good	Medium	Medium
IV	Full, Creamy Mellow, Mild	Rich, Mellow	Sharp Acid Clean, Med. Full	Clean, Acid Med. Full	Good	Good	Good	Good
V	Smooth, Creamy Mild, Sl. Sweet	V. Sl. Too Sweet	V. Sl. Unclean Flat, Sweet	Acid, Flat Sl. Unclean	Good	Good	Medium	Medium
VI	Sl. Sweet Clean, Acid	Clean, Full Mellow, Acid	V. Sl. Unnatural Sharp Acid	Full V. Sl. Unnatural	Good	Good	Good	Good
VII	Sweet, Mild Sl. Flat	Unnatural Sl. Sweet	Sl. Sweet Unnatural	Med. Full Sl. Oxidized	Medium	Medium	Poor	Poor
VIII	Too Sweet Unnatural	Too Sweet Unnatural	Too Sweet Unnatural	Too Sweet Unnatural	Medium	Poor	Poor	Poor

Lot Number	Body Observations, Days Stored 0	3	5	7	pH Observations, Days Stored 0	3	5	7
I	Smooth, Mellow Desirable	Smooth, Mellow Desirable	Smooth, Mellow Desirable	V. Sl. Weak V. Sl. Watery	4.40	4.50	4.40	4.40
II	Smooth Desirable	Smooth Sl. Weak	Smooth Sl. Weak	Smooth Sl. Watery	4.50	4.50	4.60	4.60
III	Smooth, Mellow Desirable	Smooth, Mellow Desirable	Smooth Desirable	Smooth Desirable	4.50	4.50	4.50	4.50
IV	Smooth, Mellow	Smooth, Mellow	Smooth, Mellow Desirable	Smooth, Mellow Desirable	4.50	4.50	4.50	4.50
V	Smooth, Mellow	Smooth, Mellow	Smooth, Mellow	Smooth V. Sl. Watery	4.50	4.50	4.60	4.60
VI	Sl. Coarse Lumpy	Sl. Coarse Lumpy	Sl. Coarse Lumpy	Sl. Coarse Lumpy	4.60	4.60	4.50	4.50
VII	Smooth, Mellow	Smooth, Mellow	Smooth, Mellow	Smooth, Mellow	4.60	4.60	4.50	4.50
VIII	Smooth, Mellow Desirable	Smooth, Mellow Desirable	Smooth, Mellow Desirable	Smooth, Mellow Desirable	4.90	4.70	4.60	4.60

.10 per cent had the most desirable flavor. Lots II and III in which the acidity of the milk was reduced to 0.00 per cent and 0.05 per cent respectively, had a flat, unnatural flavor due to the excess standardizer required to obtain the desired acidity in the skim milk. Lots VII and VIII had a pronounced standardizer flavor and an excessive sweetness caused by standardizing the acidity after incubation. Lot I, was of good quality, but was not quite as desirable as Lot IV.

The body of the different lots showed only slight differences. Lot II had a slight weak, watery condition due to the use of excess standardizer in the skim milk. Lot VI was slightly coarse and lumpy which might be due to the addition of a large amount of starter and the rapid development of lactic acid.

With the exception of Lots VII and VIII, the keeping quality of the different lots of cultured buttermilk was satisfactory. Lots IV and VI had the best keeping quality and were only slightly superior to the keeping quality of Lot I. The poor keeping quality of Lots VII and VIII was attributed to the unnatural flavors which might have been produced by the standardizing agent.

Table 12 shows that acidity adjustment has very little effect upon the pH of cultured buttermilk. The addition of standardizing agent after incubation had a tendency to result in a slightly higher pH in Lots VII and VIII at the beginning of the storage period, as compared to the control lot, but this difference was almost negligible on the third day of storage. There appeared to be close correlation between the pH and the keeping quality of cultured buttermilk.

SUMMARY AND CONCLUSIONS

1. Improvement in the methods usually practiced in the manufacture of cottage cheese resulted in a reduction of the time required for completion of the process and an increase in the yield obtained.

2. An improved flavor of the cottage cheese resulted from the use of a moderate amount of standardizer in the skim milk, while an excess produced an unnatural flavor and impaired the keeping quality.

3. A clean, mild, full-flavored cottage cheese was obtained by washing the curd in water to which a small amount of standardizing agent was added, but an excess of standardizing agent in the wash water had a tendency to produce a slick, gelatinous curd with an unnatural flavor, a weak body and impaired keeping quality.

4. Medium high acid cream in which the acidity was reduced

improved the flavor, but impaired the keeping quality of the cottage cheese curd to which it was added.

5. The use of a standardizing agent at more than one step in the manufacturing process had a somewhat detrimental effect upon the body and keeping quality of the resulting cottage cheese.

6. It was observed that the keeping quality of cottage cheese can be closely correlated with its pH. As the pH decreased the quality became less desirable.

7. Storage of cottage cheese in alkaline water for too long a period of time, usually six days, resulted in development of unnatural flavors, a weak body with a tendency toward matting, and impaired keeping quality.

8. Acidity standardization of the original milk, an increase in the amount of starter, and a higher setting temperature resulted in the production of a good quality of cultured buttermilk in 5 hours.

9. A slight improvement in flavor and keeping quality was obtained by standardizing the acidity in the original milk, but somewhat of an unnatural, sweet flavor became apparent by reducing the acidity in the buttermilk after incubation.

10. There was a close correlation between the pH and the keeping quality of the cultured buttermilk.

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