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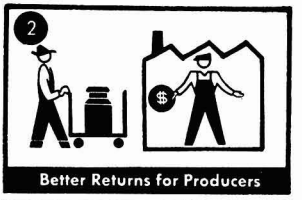

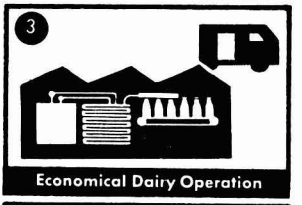

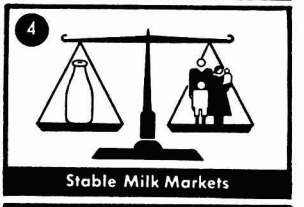

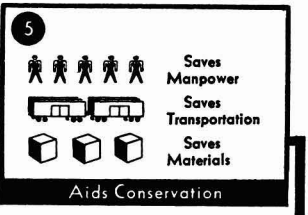

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THE EFFECT OF INCOMPLETE MILKING ON CHRONIC MASTITIS CAUSED BY STREPTOCOCCUS AGALACTIAE

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Field observations by the senior author suggested that incomplete milking of cows affected with chronic mastitis may perhaps aggravate the infection. Judging from the literature, this question has been little investigated. München, Schmidt-Hoensdorf, and Schmidt (2–4) studied the practice of stripping versus nonstripping in 50 cows artificially infected with streptococcic mastitis. According to them, the clinical symptoms became more intense in the animals not stripped after machine-milking, whereas with the cows that were stripped, the secretion soon assumed a normal appearance. Woodward, Hotis, and Graves (6), however, experimenting with 15 cows, of which 11 were infected with *Str. agalactiae*, failed to find that incomplete milking aggravated the infection. To obtain further information concerning the effect of incomplete milking on chronic mastitis, the experiments here reported were undertaken.

The University dairy herd, which provided the animals, consisted of 60 cows, milked by machine and thoroughly stripped afterwards. Data on the extent and severity of mastitis in this herd were accumulated for three years prior to this special investigation. Though the incidence of infection with *Str. agalactiae* averaged 30 per cent during this time, the infected animals rarely produced a visibly abnormal milk; for, out of a total of 419 strip-cup examinations made on the infected cows in this herd during the three-year period, visible particles were found in the foremilk in only 6.9 per cent of the tests.

METHODS

The cows selected for these special studies were harboring *Str. agalactiae* in one or more quarters, but were producing a visibly normal milk. A strip-cup test, chlorine determination, cell count, bacteriologic analysis, and palpation of the milked-out udder for indurations were made at weekly intervals on every quarter of each cow, beginning 3 weeks before incomplete milking and continuing throughout the experimental period.

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Strip-cup test. The first milk from each quarter was examined for visible particles or other abnormalities by drawing it into a shallow dish with a black bottom. A single flake was not regarded as significant; but shreds, clots, thick pus, watery milk, or 2 or more flakes were considered as evidence of a positive test.

Chlorine test. A rapid volumetric method was used to determine the percentage of chlorine. With a Babcock pipette, 17.6 cc. of milk was placed in a beaker; 2 cc. of a 10 per cent potassium chromate solution was added; and this was titrated with a twentieth-normal silver nitrate solution until the color changed from yellow to orange. The percentage of chlorine was determined directly from the number of cubic centimeters of silver nitrate solution used, since each cubic centimeter of twentieth-normal silver nitrate is equivalent to 0.01 per cent chlorine in 17.6 cc. of milk.

Bacteriologic analyses. After the strip-cup test and the drawing of milk for the chlorine test, the teats were washed with a freshly prepared solution containing about 400 ppm. of available chlorine. Milk samples from the individual quarters were collected in sterile vials and were iced or refrigerated until plated. One cubic centimeter of a 1–100 dilution in saline of each milk sample was plated with veal infusion agar containing 5 to 7 per cent fresh horse blood and was incubated at 37° C. for 48 hours. The remainder of the milk sample was incubated overnight to be used in the microscopic examination for streptococci and in the determination of the cell count. Colonies suspected of being streptococci were transferred from the blood-agar plates to serum broth; after 24 hours at 37° C., smears were made. Cultures proving to be streptococci were classified by the method described in a previous publication (3).

Cell count. To determine the number of leucocytes and epithelial cells per cubic centimeter of milk, 0.01 cc. of incubated milk was spread over 1 square centimeter of a slide. The smear, stained by the Broadhurst-Paley (1) method, was examined with a calibrated microscope. The cell count and an examination for streptococci in the milk sample were made at the same time.

Palpation for fibrosis. The milked-out quarters were palpated in the manner described by Udall (5). Scores of 1, 2, 3, and 4 were given to show the degree of tissue firmness. A score of 1 was used to indicate a soft, pliable quarter; 2, a pliable quarter having a deep but not extensive firmness in the lower cistern area. Quarters, meaty throughout or exhibiting distinct and extensive firmness of the cistern region, were scored as 3, and those with a marked firmness throughout as 4. Scores of 3 and 4 represented a distinct abnormality.

EXPERIMENTAL

The effect on chronic mastitis of leaving approximately 2 pounds of milk in the udder at each milking. Five cows, with 8 quarters infected with *Str.*

agalactiae, were selected. The time, in minutes, required for the milking machine to remove all but about 2 pounds of milk from the udder was determined for each cow. Incomplete milking was then practiced for 13 weeks, after which stripping was again carried out for 1 month with 4 of the cows before they were dried off. To check the amount of milk left in the udders, they were stripped after one morning and one evening milking each week. As the experiment progressed and production diminished, the milking-machine time was shortened correspondingly to leave about 2 pounds of milk in the udder.

Table 1 shows the history of each cow, the duration of infection with *Str. agalactiae* in each quarter, the average amount of milk left in the udder, the results of strip-cup tests during the period of incomplete milking, and the palpation score of each quarter.

The 8 quarters infected with *Str. agalactiae* on these 5 cows were producing normal-appearing milk before incomplete milking was initiated, and all developed readily-visible symptoms of mastitis when about 2 pounds of milk was left in the udders at each milking. With 2 of these *Str. agalactiae*-infected quarters, the first evidence of a positive strip-cup reaction occurred during the first week of incomplete milking; with 4 such quarters during the second week; with 1 infected quarter during the third week, and with another infected quarter during the fifth week.

Two quarters developed acute attacks of mastitis, and with 3 quarters the parenchyma became firmer during the experiment. When complete milking was resorted to again with 4 of the cows, the visible particles tended to disappear from the foremilk; but with 3 quarters the secretion was greatly diminished and remained watery. Staphylococci were being shed by 5 quarters, 4 of which showed visible particles in the foremilk on one or more occasions during the period when milk was left in the udders.

Figure 1 (graphs I, II and III) shows the mean effect of leaving about 2 pounds of milk in the udder on the chlorine content, cell count, and bacterial count of milk from normal quarters and those infected with *Str. agalactiae.* Two quarters of cow 617 and 1 quarter of cow 1026, infected with *Str. agalactiae,* were producing, before incomplete milking, a secretion that was abnormal with respect to chlorine content and cell count. These data, therefore, were not used in preparing the respective graphs, nor were the data on the 5 quarters shedding staphylococci included.

According to graph I (fig. 1), the chlorine content of the milk from the infected quarters increased significantly as soon as incomplete milking was initiated and it remained high throughout the experiment as compared with a gradual minor rise in the milk from normal quarters. Graph II (fig. 1) shows that an immediate and marked increase took place in number of cells per cc. of infected milk, whereas no change was observed in the milk from normal quarters. According to graph III (fig. 1), the mean bacterial count

TABLE 1

Strip-cup tests and palpation scores of normal and infected quarters during the period of incomplete milking

Cow	Lactation period	Month of lactation	Av. pounds milk left in udder		Quarter	Duration of infection with *Str. agalactiae* (months)	Palpation score		Strip-cup tests during incomplete milking†	
			A.M.	P.M.			Before	After	Weeks during which positive tests were obtained	Severity of strip-cup reaction‡
180	8th	2nd	2.2	1.9	RF	0	1	1	0	0
					RR	19	2	3	2–13 inclusive	+++§
					LF	0	1	1	0	0
					LR	0*	2	2	1, 3, 4, 7	++
556	5th	4th	2.0	2.1	RF	4	3	4	2–13 inclusive	+++‖
					RR	0	1	1	0	0
					LF	0	1	1	0	0
					LR	0	2	2	0	0
617	4th	3rd	1.9	1.8	RF	21	4	4	3, 4, 7, 8, 11, 12, 13	++‖
					RR	0*	2	2	3	+
					LF	8	3	3	2, 6, 7, 8, 10, 11, 13	+++‖
					LR	0	1	1	0	0
1006	4th	5th	2.0	1.6	RF	0	1	1	0	0
					RR	23	2	2	1, 3, 4, 5, 6, 9, 11	+++
					LF	23	2	3	2–13 inclusive	+++¶
					LR	23	3	3	5, 8	++
1026	2nd	6th	1.6	1.5	RF	0*	1	1	0	0
					RR	0*	1	1	8	+
					LF	23	2	2	1, 2, 3, 5, 6, 8, 11	++
					LR	0*	1	1	1, 8	+

* Shedding staphylococci.

† Strip-cut tests were negative prior to incomplete milking.

‡ Code for strip-cup test: 0 – Milk normal.
\+ – Few flakes.
++ – Many clots and shreds.
+++ – Many clots, shreds and often thick pus.

§ Acute mastitis during 8th and 9th weeks of incomplete milking.

‖ Production greatly diminished by experiment.

¶ Acute mastitis from 2nd to 4th weeks of incomplete milking.

of the milk from the infected quarters was erratic; and since half of the mean counts were less than the highest before incomplete milking, apparently the bacterial count was not much affected by leaving milk in the udder. These data, together with results of the strip-cup and palpation tests, demonstrate that the infections with *Str. agalactiae* were aggravated by leaving an average of 2 pounds of milk in the udders at every milking over a period of 13 weeks; also that a stimulating effect on the infections was apparent

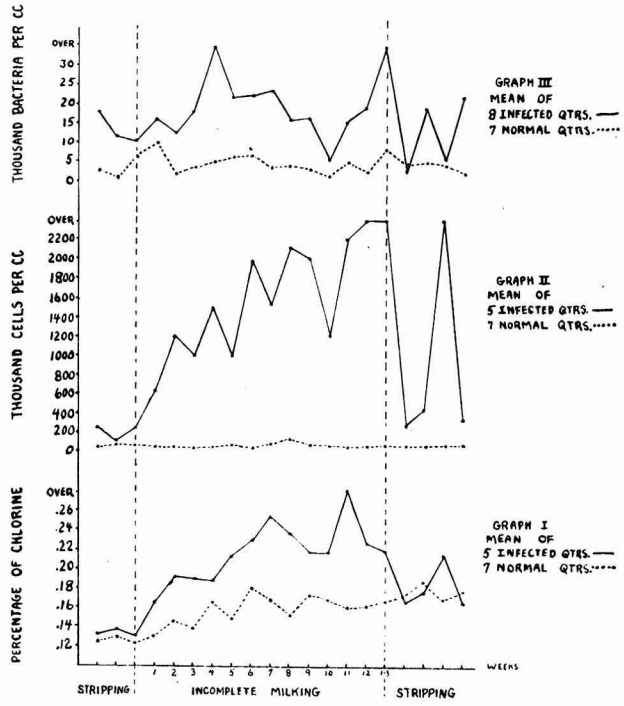

FIG. 1. The effect of leaving two pounds of milk in the udder at every milking on the chlorine content (graph I), the cell count (graph II), and the bacteria count (graph III), of milk from normal quarters and quarters infected with *Streptococcus agalactiae*.

within the first week of incomplete milking and became more pronounced as this method of milking was continued.

The effect of nonstripping after normal machine-milking on normal quarters and on quarters infected with Str. agalactiae. Leaving 2 pounds of milk in the udder at every milking is an extreme and probably uncommon procedure. Some dairymen, however, are milking by machine without stripping the cows afterwards. Tests were made, therefore, to determine the effect of nonstripping on chronic mastitis.

Four cows, having 6 quarters infected with *Str. agalactiae*, and 2 control cows free of infection, were chosen for this second experiment. Two of

the infected cows, 1006 and 1026, had been used in the first trial. They had been dried up at the termination of that experiment; and, after 6 and 7 weeks, respectively, they freshened again. They were milked in the normal manner by machine and were thoroughly stripped until being placed on nonstripping. Their milk, as well as that of the other cows in this experiment, was free of visible particles before nonstripping. They were then milked twice daily by machine in a normal manner, but were not stripped afterwards during a period of 17 weeks. For a brief interval before removing the milking machine from a cow, the operator manipulated the udder and pulled down gently on the machine cups in an attempt to remove as much more milk as possible. To check on the amount remaining in the udder, each cow was stripped by hand after two evening milkings each week. The mastitis tests employed in the first trial on incomplete milking were also made at weekly intervals on these cows. In addition throughout the period of study, the milker, at every milking, examined the foremilk of each quarter with a strip cup.

Table 2 shows the history of each cow, the duration of infection with *Str. agalactiae* in each quarter, the average amount of milk left in each quarter, the strip-cup reactions during the period of nonstripping, and the palpation score of each quarter.

Nonstripping after machine-milking resulted in leaving averages of 0.52 to 1.1 pounds of milk in the udders. The average quantity of milk retained by the individual quarters varied from 0.03 to 0.4 of a pound. Nonstripping caused no detectable changes in the structure of the quarters or in the appearance of the milk from normal udders. The quarters infected with *Str. agalactiae,* however, reacted in a variable manner to nonstripping. Surprisingly, the degree of response could not be correlated with the amount of milk left in the quarters. The right rear quarter of cow 185 retained an average of 0.4 of a pound of milk per milking, and visible particles were found in the foremilk of this quarter in only 4.6 per cent of the examinations. The parenchyma of this quarter increased in firmness, however, and the palpation score changed from 3 to 4. On the other hand, the left front quarter of cow 1006 and cow 1026 retained as little as 0.10 and 0.05 of a pound of milk per milking, respectively; yet the foremilk of each was abnormal in over 40 per cent of the strip-cup examinations. The latter quarter, which retained less milk than any other infected quarter, exhibited the most pronounced symptoms of clinical mastitis shown in this experiment. Six quarters were shedding staphylococci; and, of these, four revealed visible particles in their foremilk in 0.5 to 5.0 per cent of the examinations made.

Figure 2 (graphs IV, V and VI) shows the mean effect of nonstripping on the chlorine content, the cell count per cc., and the bacteria count per cc. of milk from normal and infected quarters. The data from the 6 quarters

TABLE 2

Effect of nonstripping, after machine-milking, on the strip-cup reaction and palpation score of normal and infected quarters

Cow	Lactation period	Month of lactation	Quarter	Average pounds of milk left in each quarter per milking	Duration of infection with *Str. agalactiae* (months)	Palpation score		Strip-cup tests during nonstripping‡		
						Before	After	Weeks during which positive tests were obtained	Percentage of daily strip-cup tests found positive	Severity of strip-cup reactions§
185	8th	3rd	RF	0.18	0	1	1	0	0	0
			RR	0.40	36	3	4	8, 9, 10, 12, 13, 17	4.6	+
			LF	0.14	0	1	1	0	0	0
			LR	0.38	0*	2	2	1, 8, 10, 17	1.7	+
722	3rd	3rd	RF	0.08	0*	2	2	0	0	0
			RR	0.30	0	1	1	0	0	0
			LF	0.07	0*	3†	3	0	0	0
			LR	0.20	13	2	2	1, 2, 3, 12, 13	1.6	+
1006	5th	1st	RF	0.20	0	1	2	0	0	0
			RR	0.24	28	2	3	5, 6, 7, 8, 9, 10, 16	11.5	++
			LF	0.10	28	3	3	4–17 inclusive	47.5	++
			LR	0.36	28	3	3	8–13 inclusive	3.6	+
1026	3rd	2nd	RF	0.13	0*	1	1	5, 7, 8, 9	2.7	+
			RR	0.24	0*	1	1	3, 7, 9, 16, 17	5.0	+
			LF	0.05	28	2	3	1, 2, 5–17 inclusive	43.5	+++
			LR	0.12	0*	1	1	9, 11, 14	0.5	+
719	3rd	2nd	RF	0.05	0	2	2	0	0	0
			RR	0.04	0	1	1	0	0	0
			LF	0.03	0	3†	3	0	0	0
			LR	0.40	0	1	1	0	0	0
1003	5th	4th	RF	0.10	0	1	1	0	0	0
			RR	0.12	0	1	1	0	0	0
			LF	0.25	0	1	1	0	0	0
			LR	0.10	0	1	1	0	0	0

* Shedding staphylococci.
† Meaty quarter.
‡ Strip-cup tests were negative prior to nonstripping.
§ Code: 0 – Milk normal.
+ – Few flakes.
++ – Many clots and shreds.
+++ – Many clots, shreds, and often thick pus.

shedding staphylococci were not used in preparing the graphs. The milk from the left front quarter of cow 1026, infected with *Str. agalactiae,* had a chlorine content above normal; and that from the left rear quarter of cow 722, also infected with *Str. agalactiae,* had a cell count above normal before nonstripping. The data relative to these tests were, therefore, not used in preparing the respective graphs.

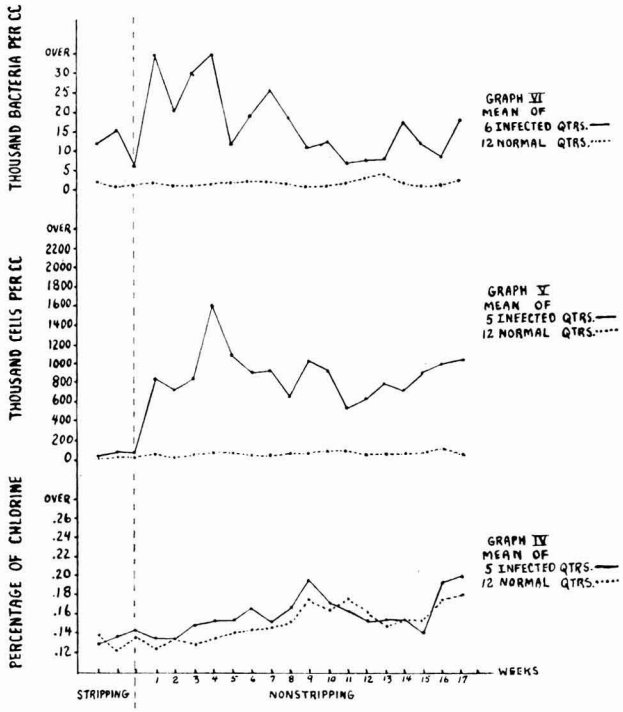

FIG. 2. The effect of nonstripping after machine milking on the chlorine content, (graph IV), the cell count, (graph V), and the bacteria count, (graph VI), of milk from normal quarters and quarters infected with *Streptococcus agalactiae.*

According to graph IV (fig. 2), the mean chlorine content of the milk from both the infected and normal quarters increased gradually during the first 9 weeks of nonstripping and then dropped gradually during the next 6 weeks; an abrupt rise followed during the last 2 weeks of the experiment. The difference between the mean chlorine content of the milk from infected and normal quarters is not great enough to be significant. As graph V (fig. 2) reveals, a considerable increase in body cells occurred in the milk of the infected quarters as soon as stripping was no longer practiced, while the mean cell count in the milk of the normal quarters was not affected. Graph VI (fig. 2) shows an erratic mean bacterial count in the milk from

the infected quarters. Since half the mean counts during the nonstripping period were less than the highest prior to incomplete milking, apparently the bacterial count of the infected milk was not altered significantly.

DISCUSSION AND SUMMARY

The effect of incomplete milking on chronic mastitis caused by *Str. agalactiae* was studied with infected cows that were producing a visibly normal secretion at the time they were placed on experiment.

Five cows, having 8 quarters infected with *Str. agalactiae,* 5 quarters shedding staphylococci, and 7 quarters free of any infection were selected for the first trial on incomplete milking. An attempt was made to leave about 2 pounds of milk in the udder of each cow at every milking over a 13-week period. Under this system of milking, the noninfected quarters continued to produce a normal milk, 4 of the 5 quarters shedding staphylococci infrequently showed visible particles in their foremilk, while every quarter harboring *Str. agalactiae* developed readily visible symptoms of mastitis. The strip-cup test became positive with 2 *Str. agalactiae*-infected quarters during the first week of incomplete milking, with 4 such quarters during the second week, with 1 infected quarter during the third week, and with another during the fifth week. With 7 of the 8 infected quarters, flakes, clots, shreds, and sometimes thick pus, were found in the foremilk with great regularity as long as incomplete milking was continued. Two quarters developed acute mastitis; and their parenchyma, as well as that of another quarter, increased in firmness. The chlorine content and the cell count of the *Str. agalactiae*-infected milk increased significantly as soon as the incomplete milking was started, whereas no appreciable changes were observed in the secretion of the normal quarters. The total bacterial count of both normal and infected milk was not affected to any great extent. When thorough milking was resumed, there was a definite tendency toward a return to a visibly normal secretion, although with 3 quarters production was considerably reduced and the milk was somewhat watery.

Leaving 2 pounds of milk in the udder represents an extreme procedure. Some dairymen, however, do not strip their cows after machine-milking. The effect of this form of incomplete milking on normal and infected quarters was studied on 2 cows with noninfected udders and 4 cows having a total of 6 quarters infected with *Str. agalactiae,* 6 quarters shedding staphylococci, and 4 quarters free of any infection. These animals were not stripped after normal machine-milking over a period of 17 weeks, except after 2 evening milkings each week to ascertain the quantity of milk left in the udders. The average amount of strippings per udder varied from 0.52 to 1.1 pounds per milking and the average quantity retained by the individual quarters per milking varied from 0.03 to 0.4 of a pound. The noninfected quarters continued to produce a normal secretion, 4 of the 6 quar-

ters shedding staphylococci infrequently contained visible particles in their foremilk, and the quarters harboring *Str. agalactiae* reacted in a variable manner to nonstripping. A surprising result was that, among the *Str. agalactiae*-infected quarters, the two retaining the smallest average quantity of strippings, 0.05 and 0.10 of a pound of milk per milking, developed the most pronounced clinical symptoms of mastitis, while quarters retaining from 0.2 to 0.4 of a pound of milk per milking only infrequently showed mild evidence of mastitis. In every case, however, the inflammatory process in the *Str. agalactiae* quarters was aggravated to some degree, as indicated by a significant rise in cell count when nonstripping was practiced. The chlorine content and the bacterial count of both normal and infected milks were not affected materially.

The number of cows studied was small. The results, though not conclusive, especially those of the second experiment, indicate that incomplete milking may lead to increased severity of the clinical manifestations of *Str. agalactiae* infections. Conversely, thorough milking of cows affected with chronic mastitis seemed to reduce the severity of the disease. It is hoped that the results reported here will motivate further study of this important aspect of the mastitis problem.

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THE BACTERIOLOGY OF BRICK CHEESE. IV. CONTROL OF "EARLY-GAS" DEFECT[1]

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"Early-gas" or the pin-hole defect is a major problem in the commercial manufacture of Brick cheese. Makers have succeeded in controlling the defect by the use of pasteurized milk, but pasteurizing equipment is not always available or obtainable. Therefore, this investigation was begun in an effort to find a method of preventing the early-gas defect in Brick cheese made from raw milk.

In a study of a similar defect in Swiss cheese, Frazier and co-workers (2) demonstrated that the early-gas defect was prevented when active starters were used. Hanson (4) and Langhus (5) reported that members of the coli-aerogenes group of bacteria were the cause of early-gas in Brick cheese. In addition, Langhus (5) reported that *Streptococcus lactis* and *Streptococcus thermophilus* starters were of equal value in inhibiting the growth of the coli-aerogenes bacteria.

METHODS

Brick cheese was manufactured from raw milk by the "mild wash" method described in a previous publication (1). This method followed the conventional procedure of Wilson and Price (6), with the exception that after the cutting of the curd, 25 to 28 pounds of water per 100 pounds of milk were added to the vat. Then 50 to 55 pounds of whey were removed and replaced by an equal volume of water.

The mild wash method was used because preliminary work had demonstrated that the early-gas defect was more difficult to control in Brick cheese made by the mild wash method than by the conventional method. Therefore, any method, which would control the early-gas defect in Brick cheese made by the mild wash method, should be equally successful if the conventional method was used.

The milk used in all of the experiments was from the University of Wisconsin Dairy and was delivered by one patron. This milk was of the highest quality; the methylene blue reduction time was never less than seven hours, and the total number of bacteria, determined culturally, always was less than 2,000 per milliliter.

Streptococcus lactis, Streptococcus thermophilus and *Lactobacillus bulgaricus* starters were carried in sterilized milk. When used in the experi-

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[1] Published with the permission of the Director of the Wisconsin Experiment Station.

[2] Now in the Research Laboratory, Hiram Walker and Sons, Inc., Peoria, Illinois.

[3] Now First Lieutenant, Sanitary Corps, U. S. Army. Station Hospital, Fort Dix, New Jersey.

mental studies, the starters were inoculated into skim milk, which had been steamed for two hours, and incubated at 37° C. (98° F.) for 10 to 12 hours. The strain of *Str. lactis* used was one that grew well at 37° C. and, at this temperature, gave a culture that survived the cooking temperature well and initiated growth soon in the warm curd.

A pure culture of *Aerobacter aerogenes* was used as representative of the coli-aerogenes bacteria, and was carried in sterilized milk. When used in the experimental studies, it was handled in the same manner as the starters. An inoculum of 0.0025 per cent of *A. aerogenes* resulted in a concentration of 15,000 to 18,000 aerogenes organisms per milliliter of milk, a concentration slightly larger than the highest number reported for market

TABLE 1

Changes in pH of Brick cheese manufactured from raw milk containing about 15,000 Aerobacter aerogenes organisms per milliliter, and with 0.5 per cent Streptococcus thermophilus and different amounts of Streptococcus lactis starters

	Amount of starter-per cent				
Str. lactis	0.5	1.0	1.5	2.0	3.0
Str. thermophilus	0.5	0.5	0.5	0.5	0.5
Time of sampling	Acidity	Acidity	Acidity	Acidity	Acidity
Hours	*pH*	*pH*	*pH*	*pH*	*pH*
2	5.64	5.52	5.50	5.50	5.53
4	5.40	5.33	5.28	5.30	5.31
6	5.30	5.19	5.23	5.22	5.19
8*	5.30	5.04	4.99	5.11	5.12
10	5.20	5.08	5.00	5.10	5.12
24†	5.14	5.00	5.08	5.14	5.13

* Pin holes visible in all lots.
† Lactose completely gone.

milk (3). It was believed that if methods could be devised to control the above number of aerogenes organisms in raw milk, the same methods would work satisfactorily in commercial practice, and the early-gas defect would be prevented.

The measurement of pH was by the quinhydrone method.

Residual lactose was estimated, as described in a previous publication (1), by exposing thin slivers of cheese to 104° C. for three to four hours and noting the degree of caramelization that occurred. The darker the color, the greater was the concentration of lactose in the cheese; when the lactose had been fermented completely, the slivers remained white.

RESULTS

Inhibition of growth of Aerobacter aerogenes in Brick cheese by means of different kinds and amounts of starters. In the first series of experiments, five lots of cheese were compared wherein the milk was inoculated with 0.0025 per cent *A. aerogenes* and 0.5 per cent of *Str. thermophilus.*

In addition, the first lot of milk was inoculated with 0.5 per cent *Str. lactis* starter, the second with 1.0 per cent, the third with 1.5 per cent, the fourth with 2.0 per cent and the fifth with 3.0 per cent. The cheese was made by the mild wash method and was cooked to 106° F.

Table 1 demonstrates the rapid decrease in pH that occurred when large amounts of starter were added to the milk. It was hoped that the rapid increase in acidity would inhibit the growth of *A. aerogenes*. However, the results indicate that, regardless of the acidity, the aerogenes organisms developed and caused the formation of pin holes when residual lactose remained in the cheese. It will be noted that increase in the amount of *Str. lactis* starter beyond one per cent had little effect on the changes in the pH of the cheese; if anything the additional amounts of starter seemed to slow up

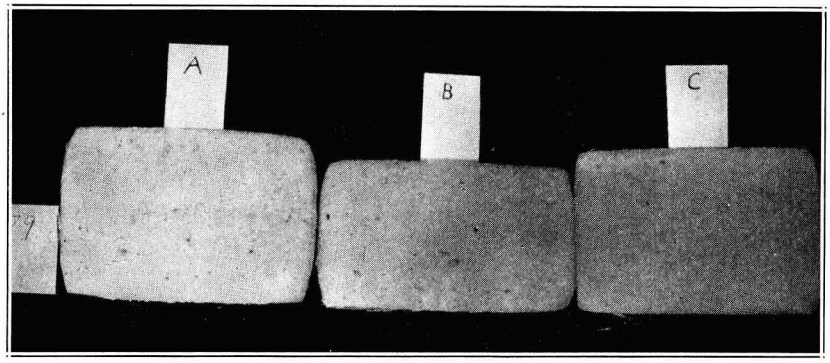

FIG. 1. Brick cheese manufactured from raw milk containing about 15,000 *Aerobacter aerogenes* organisms per milliliter, and with 0.5 per cent *Streptococcus thermophilus* and 1.0, 2.0 and 3.0 per cent of *Streptococcus lactis* starters, respectively. (Age of cheese —3 weeks.)

	Aerobacter aerogenes (*per cent*)	*Streptococcus lactis* (*per cent*)	*Streptococcus thermophilus* (*per cent*)	*Method of manufacture*
A	0.0025	1.0	0.5	Mild washing
B	0.0025	2.0	0.5	Mild washing
C	0.0025	3.0	0.5	Mild washing

slightly the development of acidity. The texture of the cheese, as shown in figure 1, was very open. Many pin holes were present even when 3.5 per cent of starter was used.

Inhibition of the growth of Aerobacter aerogenes in Brick cheese by means of different cooking temperatures. Four lots of milk were inoculated with 0.0025 per cent of *A. aerogenes* and 1.5 per cent of *Str. thermophilus* starter. In addition, the fourth lot of milk received 1.5 per cent of *Str. lactis* starter. All four lots of milk were made into Brick cheese by

the mild wash method. The first lot was cooked to 106° F., the second to 112° F., the third to 120° F., and the fourth to 112° F.

Figure 2 shows that large amounts of *Str. thermophilus* were not effective in inhibiting the growth of the aerogenes organisms; but when the cooking temperature was raised to 120° F., the "blowing" was less extensive. This fact was very apparent during the early hours. The cheese cooked to 106° F. showed pin holes at the sixth hour after dipping; that cooked to 112° F., at the twelfth hour; that cooked to 120° F., not until one day and then only a few. The above results indicated that a cooking temperature of 112° or 120° F. heat shocked the aerogenes organisms, thereby prolonging their lag phase for several hours.

The fourth lot of cheese contained 1.5 per cent of *Str. lactis* starter in addition to 0.0025 per cent of *A. aerogenes* and 1.5 per cent of *Str. ther-*

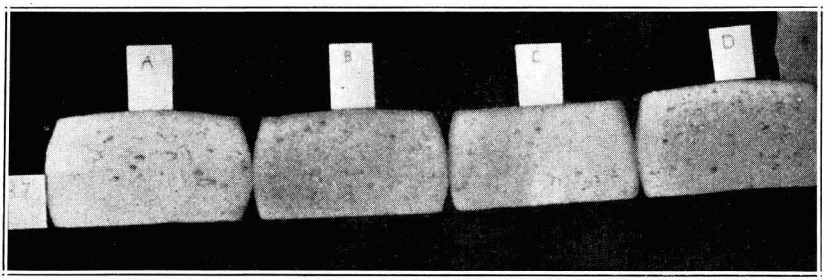

FIG. 2. Brick cheese manufactured by the mild washing method containing about 15,000 *Aerobacter aerogenes* organisms per milliliter, and with different amounts of *Streptococcus thermophilus* and *Streptococcus lactis* starters, and different cooking temperatures. (Age of cheese—3 weeks.)

	Aerobacter aerogenes (*per cent*)	*Streptococcus thermophilus* (*per cent*)	*Streptococcus lactis* (*per cent*)	*Method of manufacture*	*Cooking temperature* (°F.)
A	0.0025	1.5	.....	Mild washing	106
B	0.0025	1.5	.....	Mild washing	112
C	0.0025	1.5	.....	Mild washing	120
D	0.0025	1.5	1.5	Mild washing	112

mophilus starter, and was cooked to 112° F. In this experiment, it was hoped that the *Str. lactis* organisms would not be harmed by the 112° F. cooking temperature as much as the *A. aerogenes*, and that the lactis organisms would be able to gain the upper hand and inhibit the aerogenes bacteria. The results in figure 2 show that the *A. aerogenes* organisms were scarcely retarded in their development, for the cheese had a very open texture.

Inhibition of the growth of Aerobacter aerogenes in Brick cheese by means of different cooking temperatures and thermophilic starters. Three lots of milk were inoculated each with 0.0025 per cent of *A. aerogenes*, 0.5

TABLE 2

The development of acidity in Brick cheese manufactured by the mild wash method wherein the curd was cooked to 106°, 112°, and 120° F., and 0.0025 per cent of Aerobacter aerogenes and 0.5 per cent each of Streptococcus thermophilus and Lactobacillus bulgaricus were added to the milk

Time of sampling	Cooking temperature		
	106° F.	112° F.	120° F.
	Acidity	Acidity	Acidity
Hours	*pH*	*pH*	*pH*
2	5.35	5.33	5.47
4	5.22	5.22	5.35
8	5.22*	5.21	5.29
12	5.18	5.19	5.20
24†	5.15	5.15	5.11
72	5.10	5.20	5.08
72 (per cent moisture)	44.2	42.5	43.7

* First signs of pin holes in this cheese.
† No lactose left.

per cent of *Str. thermophilus* and 0.5 per cent of *L. bulgaricus*. The inoculated milk was made into Brick cheese by the mild wash method. One lot was cooked to 106° F., the second to 112° F., and the third to 120° F. Table 2 demonstrates the very rapid decrease in pH that occurred in the cheese. The raising of the cooking temperature from 106° to 112° F. did not affect

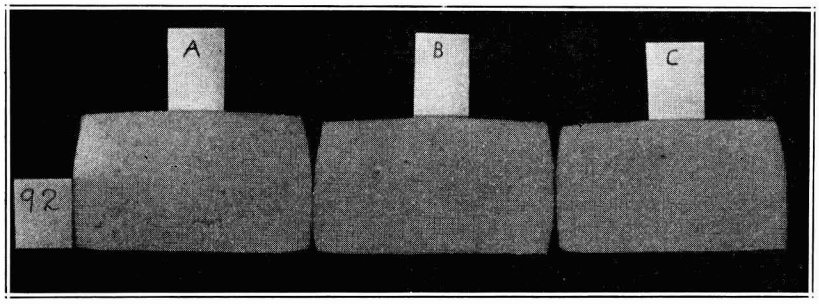

FIG. 3. Brick cheese manufactured by the mild wash method from raw milk containing about 15,000 *Aerobacter aerogenes* organisms per milliliter, and with 0.5 per cent each of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* starters, and with cooking temperatures of 106°, 112°, and 120° F., respectively. (Age of cheese—3 weeks.)

	Aerobacter aerogenes (per cent)	*Streptococcus thermophilus (per cent)*	*Lactobacillus bulgaricus (per cent)*	*Cooking temperature (°F.)*	*Method of manufacture*
A	0.0025	0.5	0.5	106	Mild washing
B	0.0025	0.5	0.5	112	Mild washing
C	0.0025	0.5	0.5	120	Mild washing

the rate of decrease in the pH of the cheese, but when the cooking temperature was raised to 120° F., the rate of decrease in pH was slowest. However, by the twelfth hour after dipping there was little difference in the pH of any of the lots of cheese.

Figure 3 shows that the cheese cooked to 112° and 120° F. had a good texture, but that cooked to 106° F. was very open.

The quality of the cheese cooked to 112° and 120° F. was very good after five weeks. The flavor was clean and mild, and the texture was close. After five weeks, the cheese cooked to 106° F. showed a bitter flavor and the presence of many pin holes, and was of poor quality.

DISCUSSION

In the first series of experiments, wherein large amounts of *Str. lactis* and *Str. thermophilus* and a cooking temperature of 106° F. were used, the growth and activity of *A. aerogenes* were inhibited only slightly. The results of the above experiments indicated that, regardless of the acidity, the growth of the aerogenes bacteria continued until all the lactose in the cheese was fermented. When the cooking temperature was raised above 106° F., the lag phase of growth of *A. aerogenes* was prolonged several hours. However, the growth of *Str. lactis* was affected in a similar manner at the higher cooking temperatures. Therefore, it was necessary to use a starter mixture which would not be harmed at a cooking temperature of 112° or 120° F., and which would ferment all the lactose in the cheese before the aerogenes organisms recovered from the "heat shock" effect. The combination of *Str. thermophilus* and *L. bulgaricus* fulfilled the above requirements and in the cheese made with a combination of the thermophilic starters, and a cooking temperature of 112° or 120° F., the growth and activity of *A. aerogenes* was inhibited, thereby preventing the early-gas defect. It should be noted that any appreciable amount of growth of *A. aerogenes* in milk previous to its use for cheese is likely to cause flavor defects.

SUMMARY

When Brick cheese was made by the mild wash method from raw milk which was inoculated with 0.0025 per cent of *A. aerogenes:*

1. A combination of *Str. lactis* and *Str. thermophilus* starters and a cooking temperature of 106° or 112° F. did not prevent early-gas defect.

2. When a combination of *L. bulgaricus* and *Str. thermophilus* starters and a cooking temperature of 112° or 120° F. were used, the early-gas defect was prevented and the quality of the cheese was as good as that of the control cheese when examined after five weeks. With the above combination of thermophilic starters and a cooking temperature of only 106° F., the "blowing" was not prevented.

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REESTABLISHMENT OF THE ARTERIAL SUPPLY TO THE UDDER*

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The right external pudic artery was ligated on a month-old heifer calf. An inch of the artery was removed just below the inguinal canal after which she was allowed to develop in a normal fashion (as far as the udder was concerned). On freshing, this cow milked equally well from both halves of the udder. No appreciable differences (0.2 lb. per milking) could be found in the amount of milk secreted by either half of the udder, in the physical characteristic of the two halves, or in the manner of secretion.

After two normal lactations, this cow was destroyed and the left mammary artery injected with lead oxide paste. When the arterial vessels were exposed it was found that the arterial supply to the right half of the udder came exclusively from the caudal branch of the left mammary artery. The blood supply from the right external pudic artery was not reestablished. However, due to an anastomoses with the arterial vessels from the left half of the udder, the vessels which naturally supply the right half of the udder developed in the usual manner.

Despite the failure in the above case of the ligated external pudic artery to reestablish itself in the mammary gland, there is evidence that a supplementary blood supply can be readily established in some instances. For example, the udder of another month-old heifer calf was completely cut away from its attachment, with the exception of the two external pudic arteries. The udder was then reversed and reattached to the body. In spite of the crossing of the arteries the udder grew fast and healed in a very few days leaving only minor scars. Incisions were then made and both external pudics ligated. After the ligation of all the arterial vessels the udder continued to develop normally. Unfortunately the heifer was lost when 9 months of age while we were conducting some trials on the etiology of ketosis.

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A QUANTITATIVE STUDY OF THE HEAT LABILE SULFIDES OF MILK. II. GENERAL ORIGIN OF SULFIDES AND RELATION TO TOTAL SULFUR, TOTAL NITROGEN AND ALBUMIN NITROGEN[1,2]

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As indicated in the previous paper of the series (31), the liberation of sulfides from milk at temperatures of 76–95° C. is well established, but information of a quantitative nature relative to the origin of these sulfides is scarce. In addition, no data are available showing the relation of heat volatile sulfides to the total sulfur, total nitrogen, and albumin nitrogen content. This paper is presented, therefore, with the view of contributing information on these particular points.

In 1902, Rettger (22), using a qualitative method involving lead acetate, observed skimmilk to liberate more and cream less hydrogen sulfide than normal milk. In more recent studies of quantitative nature, Diemair, Strohecker, and Keller (5) arrived at similar conclusions. These findings are somewhat in contrast to the observations of Gould and Sommer (8) who found the following critical temperatures for a 3-minute holding period: Milk, 74–76° C.; skimmilk, 76–78° C.; 35 per cent cream, 66–68° C.; 20 per cent cream 70–72° C. On the basis of the formation of sulfhydryl groups, Josephson and Doan (15) also report cream to have a lower critical temperature than milk.

The lower critical temperature for sulfide liberation in cream may indicate that the proteins associated with the fat globules play an important role in this connection (7, 8). Gould and Sommer (8) found critical temperatures of 35 per cent cream and its buttermilk to be approximately 8° C. lower than for normal milk. Furthermore, cream prepared from skimmilk and butteroil gave practically identical critical temperatures as the skimmilk itself. In addition, Gould (7) showed that the sulfide-contributing material of cream was not easily removed by washing. Three-times washed cream had a critical temperature practically identical to normal cream.

Somewhat different results were secured by Josephson and Doan (15). These investigators were able to remove the sulfhydryl producing materials by washing cream several times and believe that the adsorbed layer around the fat globules is a relatively unimportant source of heat-produced, sulfhydryl groups. However, they state that this evidence is not entirely con-

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[1] A portion of the thesis by the senior author submitted to the Graduate Faculty, Michigan State College, in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

[2] Journal Article No. 622, new series, Michigan Agricultural Experiment Station.

vincing since cream has a lower critical temperature than milk, and has a more sulfide odor and flavor than milk or skimmilk.

From available information, casein per se contributes few if any of the sulfides liberated from milk at temperatures of 75–95° C. (7, 8, 15). However, the sulfur-containing materials of whey are principal contributors of the heat volatile sulfides in milk and skimmilk. Albumin, the major whey protein, is the most likely source of sulfides inasmuch as it undergoes denaturation and coagulation at temperatures above 60° C. (9, 14, 17, 19, 23, 24, 25, 26), temperatures similar to those at which –SH groups and sulfide liberation occurs; since it contains a comparatively high sulfur content (3, 16), and since approximately 50–60 per cent of this sulfur is supplied by the heat labile amino acid, cystine (3, 16). Mirsky and Anson (20) and Hopkins (12) have demonstrated that –SH groups appear upon denaturation and coagulation of albumin. Josephson and Doan (15) concluded lactalbumin to be the principal origin of sulfhydryl compounds in heated milk.

Other sulfur containing materials have been reported as being present in whey and perhaps they too contain heat labile sulfur. Ansbacher, Flanigan, and Supplee (1) isolated the foam producing material from whey and found it to display sulfur migration when subjected to ultraviolet light, heat, or agitation. This material contained no cystine but 0.6 per cent sulfur. The adsorbed membrane surrounding the fat globules has been reported to contain the following percentages of sulfur: 0.74 per cent by Titus, Sommer, and Hart (30), 0.94 to 0.96 per cent by Palmer and Wiese (21) and 2.58 per cent by Hattori (10). Vitamin B_1 contains approximately 12 per cent sulfur (32) and when milk is subjected to temperatures from pasteurization to sterilization, there may be as much as 10 to 50 per cent of this vitamin destroyed (4, 6, 11, 13, 18).

In addition to Vitamin B_1, other sources of non-protein sulfur may exist in milk. Tillsman and Sutthoff (29) found that 15.1 per cent of the sulfur of milk was in the form of non-protein organic sulfur. These investigators present the following percentages showing the sulfur distribution of milk containing 92.1 mg. of SO_3 per liter: protein sulfur, 84.9; other organic sulfur, 4.9; sulfuric acid already formed 10.4, and ash 1.23. Sure and O'Kelly (28) studied the sulfur distribution of the filtrate obtained from milk after precipitating the casein with acid and precipitating the albumin and globulin by heating the acid whey. They report that the dry residue of protein-free milk contains 0.11–0.14 per cent sulfur, and that 65.9 to 76.4 per cent of this sulfur is in the organic form.

EXPERIMENTAL PROCEDURE

The procedures were, in general, the same as those described in the first paper of this series. Cream and skimmilk were secured by centrifugal separation of fresh milk; buttermilk by churning the fresh cream; whey and

buttermilk by rennin coagulation of the casein in the skimmilk or buttermilk.

Total sulfur was determined on a 25-gram sample according to the official magnesium nitrate method (2). This method was selected following satisfactory preliminary trials on cystine samples of sufficient size to give barium sulfate precipitates equal to those generally obtained for normal milk. Total and albumin nitrogen determinations were conducted on a 5-gram sample by the official method (2).

EXPERIMENTAL RESULTS

Milk, skimmilk, whey. To study quantitatively the critical temperatures of milk, skimmilk, and whey, samples of each were heated momentarily to temperatures ranging from 72° C. to 90° C. The sulfides evolved during heating and for a 30-minute aspiration period thereafter are shown in figure 1.

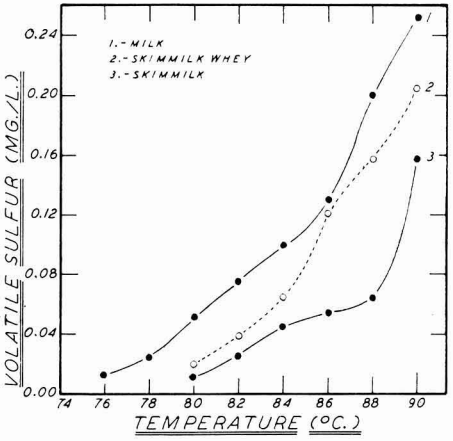

FIG. 1. Relationship between temperature of heating and quantity of sulfides evolved in milk, skimmilk, and skimmilk whey. (Sulfides evolved during momentary heating to various temperatures and a 30-minute aspiration period thereafter.)

These results agree with the qualitative studies reported previously (8). The critical temperature for milk is 76–78° C. and for skimmilk and whey 80–82° C. Milk not only exhibits a lower critical temperature than skimmilk or whey but also shows more sulfide liberation throughout the temperature range. Respective sulfide liberation in milligrams per liter of the three products at 80, 86, and 90° C. are: milk 0.053, 0.130, 0.240; skimmilk 0.012, 0.054, 0.158; whey 0.020, 0.124, 0.205.

Figure 1 shows also that whey liberates more sulfide than skimmilk. On the basis of these results, it would appear that casein not only does not contribute to the heat labile sulfides at the temperatures involved but actually slightly inhibits sulfide evolution.

TABLE 1

Volatile sulfides recovered from milk and its corresponding cream, buttermilk and buttermilk whey momentarily heated at different temperatures

Temperature	Milk	Cream (20%)	Buttermilk	Buttermilk whey	Cream (30%)	Buttermilk	Buttermilk whey
°C.	mg./l.	mg./l.	mg./l.	mg./l.	mg./l.	mg./l.	mg./l.
62	.....	0.000	0.000	0.000	0.000	0.000	0.000
64	.....	0.000	0.000	0.000	0.000	0.000	0.012
66	0.000	0.000	0.000	0.006	0.000	0.006	0.026
68	0.000	0.000	0.012	0.022	0.006	0.012	0.049
70	0.000	0.006	0.028	0.036	0.010	0.036	0.071
72	0.000	0.012	0.040	0.057	0.019	0.067	0.106
74	0.000	0.028	0.060	0.082	0.045	0.114	0.151
76	0.012	0.033	0.082	0.106	0.067	0.135	0.192
78	0.031	0.095	0.098	0.127	0.151	0.176	0.245
80	0.052	0.151	0.158	0.167	0.252	0.275	0.305
82	0.065	0.196	0.192	0.200	0.345	0.350	0.360
84	0.090	0.237	0.237	0.252	0.400	0.405	0.412
86	0.124	0.260	0.282	0.290	0.430	0.435	0.445
88	0.196	0.275	0.305	0.337	0.462	0.487	0.525
90	0.243	0.296	0.330	0.375	0.480	0.512	0.575

Milk, cream, buttermilk, buttermilk-whey. The slightly higher volatile sulfide liberation from milk in contrast to skimmilk indicates that the proteins associated with the fat globules may be involved. This is further demonstrated in the data presented in table 1. From the standpoint of volatile sulfides, these products rate in the following order: buttermilk-whey, buttermilk, cream, and milk. The differences between the whey, buttermilk, and cream are relatively slight, whereas the difference between these products and milk is appreciable.

Relationship of sulfides to total sulfur and total nitrogen. In order to ascertain more about the origin of heat labile sulfides and, also, to study the nature of the constituents involved, various milk products were secured as

TABLE 2

Relationship of the volatile sulfides obtained by heating milk momentarily to 90° C. to the total sulfur and total nitrogen

Product	Sulfur recovered as volatile sulfides	Total sulfur	Total nitrogen	Ratio	
				Volatile sulfur to total sulfur	Total sulfur to total nitrogen
	mg./l.	mg./l.	gms./l.		
Milk	0.227	291	5.62	1: 1074	1: 19
Skimmilk	0.175	304	5.89	1: 1737	1: 19
Whey	0.192	189	1.76	1: 984	1: 9
Cream*	0.476	235	3.73	1: 494	1: 16
Buttermilk	0.523	303	5.66	1: 579	1: 19
Buttermilk whey	0.521	220	2.12	1: 422	1: 10

* Cream contained 30–35 per cent fat.

in the previous section and the volatile sulfides, total sulfur, and total nitrogen determined. The volatile sulfiles were obtained by aspirating the sample while heating momentarily to 90° C. and for 30 minutes thereafter. The results are presented in table 2.

Data on the volatile sulfide determinations compare favorably with those presented in the previous sections. Total sulfur and total nitrogen values differ appreciably for the various products, but, in general, exhibit a direct relationship to each other. Low total sulfur values occurred in those samples having low total nitrogen values, but the ratio between the two values is by no means constant. For example, the ratio of total sulfur to total nitrogen in milk, skimmilk, and buttermilk is approximately 1 : 19 whereas in skimmilk whey and buttermilk whey the ratio is about 1 : 9.

TABLE 3

Influence of washing cream on the volatile sulfides, total sulfur, total nitrogen, and albumin nitrogen of the cream and its buttermilk

Product	Sulfur recovered as volatile sulfides*	Total sulfur	Total nitrogen	Albumin nitrogen	Ratio	
					Total sulfur to total nitrogen	Volatile sulfur to albumin nitrogen
	mg./l.	*mg./l.*	*gms./l.*	*gms./l.*		
Cream	0.450	212	4.610	0.602	1 : 22	1 : 1337
Buttermilk	0.489	290	5.680	0.650	1 : 20	1 : 1329
Washed cream	0.368	95	0.640	0.072	1 : 7	1 : 196
Washed cream buttermilk	0.470	104	0.805	0.083	1 : 8	1 : 177

* Samples heated momentarily to 90° C. Sulfides represent those liberated during heating and during a subsequent 30-minute aspiration period.

No relationship is apparent between the volatile sulfides and the total sulfur and total nitrogen. Skimmilk is high in total sulfur and nitrogen but liberates less volatile sulfur than any of the other products. Conversely, whey is considerably lower in total sulfur and total nitrogen than skimmilk yet liberates slightly more sulfides. Cream and buttermilk whey are low in total sulfur in comparison to milk and skimmilk but are high in heat volatile sulfides.

Washing of cream. Trials were also conducted to determine the influence of washing cream upon the volatile sulfur, total sulfur, total nitrogen, and albumin nitrogen. In this study, cream of approximately 30 per cent fat was washed three successive times with equal portions of distilled water at 37° C. After each washing and separation, the cream was adjusted to the original volume and fat content with the liquid obtained by the corresponding separation. The results are presented in table 3.

These data reveal that the washed cream has only a slightly lower volatile sulfur content than the original cream, although having values for total

sulfur, total nitrogen and albumin nitrogen considerably lower. The washed cream buttermilk is also shown to be high in heat labile sulfur but low in total sulfur, total nitrogen and albumin nitrogen. Furthermore, the ratios of total sulfur to total nitrogen and volatile sulfur to albumin nitrogen are approximately the same for the cream samples and their respective buttermilks, but differ greatly between the normal and washed products.

Separation temperature. Since the results in the previous section indicated that considerable heat labile sulfur is derived from certain materials associated with the fat globules, and furthermore, since Sharp (27) has pointed out that the fat globule membrane apparently contains an adhesive material that remains with the cream when milk is separated at low temperatures, but passes into the skimmilk when the separation is at high temperatures; a study was conducted to ascertain the influence of separation of different temperatures on the sulfides liberated from the cream and skimmilk. In this experiment milk was separated at 15.5° C., 35° C., and 57.2° C. The results are shown in table 4.

TABLE 4

Influence of separation temperature on the volatile sulfur and total sulfur of the resulting cream and skimmilk

Separation temperature	Cream (25%)		Skimmilk	
	Volatile* sulfur	Total sulfur	Volatile* sulfur	Total sulfur
°C.	mg./l.	mg./l.	mg./l.	mg./l.
15.5	0.428	245.5	0.156	324.1
35.0	0.397	263.2	0.156	318.6
57.2	0.388	254.0	0.172	318.1

* Sulfides liberated during momentary heating to 90° C. and for 30 minutes thereafter.

Although these average results indicate the volatile sulfides to decrease slightly in the cream and increase slightly in the skimmilk with increasing separation temperatures, the differences do not appear significant. Furthermore, the total sulfur values show some variations, but no definite trend is apparent. On the basis of these results, the conclusion may be drawn that separation of milk under the conditions of this experiment, does not affect the heat labile sulfide or total sulfur content of the resulting cream and skimmilk.

DISCUSSION

Previous workers have indicated milk and skimmilk to liberate more hydrogen sulfide than cream. Such results appear logical inasmuch as the extent of sulfide liberation may be expected to correspond with the total protein and serum protein content. Results herein presented, however, reveal that such a relationship does not necessarily exist in the case of heat labile sulfides.

The findings in this study indicate a considerable difference in the heat stabilities of the constituents contributing heat labile sulfides. This difference may be illustrated by comparing the volatile sulfur and total sulfur ratios: cream, buttermilk, and buttermilk whey have a ratio of approximately 1:500, whereas milk, skimmilk and whey have a ratio of 1:1000 or more. These results emphasize the importance of sulfur containing compounds associated with the fat as a source of heat labile sulfur. Furthermore, the ratio of total sulfur to total nitrogen indicate that the sulfide contributing fraction associated with the fat is not especially high in sulfur, but is relatively unstable toward heat.

CONCLUSIONS

Quantitative studies are reported on the heat labile sulfides of milk, skimmilk, skimmilk whey, cream, buttermilk, and buttermilk whey. The total amount of sulfides liberated per liter from these products when they are heated momentarily to 90° C. and aspirated for 30 minutes thereafter are approximately as follows: Milk, 0.24 mg.; skimmilk, 0.158 mg.; skimmilk whey, 0.205 mg.; cream (30 per cent) 0.480 mg.; buttermilk (from 30 per cent cream) 0.512 mg.; and buttermilk-whey (from 30 per cent cream) 0.575 mg.

Heat labile sulfides of milk and milk products originate from two sources: (a) the milk serum, and (b) the material associated with, and firmly attached to, the fat globules. Whey proteins are the chief sources of heat labile sulfides in products low in fat whereas the fat-associated constituent (or constituents) is responsible for an important share of the sulfides in products high in fat or those secured from high-fat products by churning.

There is not necessarily a direct relationship between the sulfide liberation of milk and milk products and the total sulfur and total nitrogen content. The heat instability of the fat-associated material appears to be responsible for the fact that cream, buttermilk, and buttermilk-whey exhibit lower critical temperatures and greater sulfide liberation than milk, skimmilk, and skimmilk-whey.

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A QUANTITATIVE STUDY OF THE HEAT LABILE SULFIDES OF MILK. III. INFLUENCE OF PH, ADDED COMPOUNDS, HOMOGENIZATION AND SUNLIGHT[1,2]

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In connection with the work reported upon in the first two papers of this series (30, 31), studies were conducted to ascertain the influence of the following on the sulfide liberation from milk: (a) hydrogen-ion concentration, (b) addition of organic and inorganic compounds, (c) exposure to sunlight, and (d) homogenization. The results of these studies constitute the basis of this paper.

Hydrogen-ion concentration is generally known to influence the stability of proteins and limited qualitative studies on milk have indicated this factor to influence hydrogen sulfide liberation by heat. Rettger (28) concluded from his early observations that the liberation of hydrogen sulfide from milk was enhanced by slight alkalinity and retarded by slight acidity. According to Jackson, Howat and Hoar (19), sodium bicarbonate, disodium phosphate, or sodium citrate, added to canned cream at the rate of 5 grams per gallon, favored sulfide liberation during sterilization, and decreased the temperature and period of heat exposure necessary to give a positive nitroprusside test. The work of Gould and Sommer (12) indirectly indicated that the pH of the milk may influence the lability of the sulfur since they observed the critical temperature for the cooked flavor to be lowered by adjusting the pH to 7.6, and increased by adjusting the pH to 5.8–6.0.

Small amounts of copper have been shown in qualitative studies to retard and in some cases entirely prevent the liberation of heat volatile sulfides or the formation of sulfhydryl groups (11, 12, 20). Ferrous iron, however, was found to have only a slightly retarding influence on sulfide liberation (11). Copper added to milk after the heat treatment is apparently more effective for inhibiting sulfide liberation than when added previous to heating (11, 12). Approximately 0.25 ppm. of copper prevented further sulfide liberation when added to milk previously heated to 90° C. (11).

In a previous paper (31) it was pointed out that sulfide liberation in milk occurred at approximately those temperatures at which denaturation and coagulation of the whey proteins occur. On this basis, then, factors

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which influence this denaturation or coagulation may also definitely affect the formation of sulfhydryl compounds.

Protein stabilizing action of sugars has been demonstrated by several investigators. That sucrose may exert some influence upon the amount of the soluble proteins coagulated during the heating of milk is indicated by Leighton and Mudge (24) who found the maximum heat stability of milk secured by heating to 95° C. to be delayed by the presence of 20 per cent sugar. Beilinsson (2), Duddles (5), Fay (6) and Hardt (13) have demonstrated that sugars tend to inhibit the heat coagulation of egg albumin at approximately 70° C. Duddles (5) determined the coagulation of egg albumin at pH 4.6 when held at 70° C. for 10 minutes and found glucose and fructose to exert progressive protective action against coagulation with increased concentration of the sugars. Sucrose and mannose exerted some protective action, but were less effective than glucose and fructose. Hardt (13) found denaturation of egg albumin by heat was inhibited by the presence of d-glucose, d-fructose, d-mannose, l-arabinose and d-xylose. This denaturation was measured by the determination of sulfhydryl groups both by the iodoacetic acid method and less satisfactorily by the use of 2,6 dichlorobenzenoneindophenol.

Evidence is available indicating that formaldehyde also influences the coagulation properties of serum proteins. Early studies by Blum (3) revealed that a few drops of formaldehyde prevented the heat coagulation of albumin. Fischer (7, 8) found 0.0045 to 0.0022 per cent of formaldehyde would delay or inhibit the denaturation of serum globulin at 70° C. This treatment was more effective when the formaldehyde was added soon after denaturation started and had no effect if added 5 or 6 minutes later. However, Freeman (10) demonstrated that serum proteins are 25 to 70 per cent denatured by treatment with 0.5 per cent formaldehyde and holding at 37° C. for 10 days. Ramsey, Tracy and Ruehe (27) found browning of milk to be prevented with a small amount of formaldehyde, whereas Webb (33) observed small amounts to increase and larger quantities to inhibit discoloration.

Although ethyl alcohol is used in the precipitation of certain proteins, only limited attention has been given to its influence upon the heat coagulation of these proteins. Henkel (15) was one of the first to show that an equal volume of 70 per cent alcohol does not always completely coagulate fresh mixed-herd milk, and expressed the belief that the coagulating action was due to dehydration of proteins. However, Vasil'ev (32) measured the coagulating action of various alcohols on albumin and casein and found that coagulation begins at such low concentration of alcohol that the action is not one of dehydration but is a surface energy change resulting from the adsorption of alcohol on the protein micelle.

Klobusitsky (23) and Teorell (29) have shown that even small amounts of alcohol lower the temperature of protein coagulation. Klobusitsky (23)

found that pseudoglobulin manifests its great turbidity below the boiling temperature with 18 per cent alcohol and Teorell (29) observed that protein coagulum formed in such concentrations of alcohol tend to dissolve when heated to boiling, but reprecipitate on cooling.

Extraction of kidney and liver globulins with boiling 95 per cent alcohol was conducted by Harris and Mattill (14). This treatment caused no decrease of nitrogen in these proteins but did produce a loss of cystine and hydrogen sulfide. Hopkins (16) states that precipitation of protein from solution with alcohol causes the appearance of –SH groups.

Exposure of milk to ultra-violet rays for prolonged periods of time may create changes resulting in the formation of sulfhydryl compounds. Flake, Jackson and Weckel (9) found ultra-violet rays to produce sulfhydryl compounds in milk and associated these compounds with the activated flavor. These investigators also observed that prolonged irradiation of milk caused heat labile sulfur formation at a temperature approximately 10° C. below normal. By distillation at 77–79° C. they recovered 0.0131 mg. of sulfur from 350 ml. of milk exposed to ultra-violet rays for 90 minutes, whereas only 0.0036 mg. were recovered from normal milk. In earlier work, Weckel and Jackson (34) produced an activated flavor in casein and albumin by irradiation, and Mancovitz (25) observed that exposure of milk to irradiation for 45 seconds produced disagreeable sulfur flavors. Also, Ansbacher, Flanigan and Supplee (1) concluded that ultra-violet rays alter the sulfur compounds of the foam producing material of milk.

Doan and Meyers (4) present results of a thorough study showing that sunlight produced the activated flavor in milk products, but made no attempt to correlate their findings with the formation of sulfhydryl compounds. However, Young (35) in 1922 demonstrated that sunlight has a destructive effect upon albumin.

The possible influence of homogenization on sulfhydryl formation has not been definitely established. Jackson, Howat and Hoar (18) found homogenization to have no influence on sulfide liberation in sterilized canned cream and Gould and Sommer (12) observed that homogenization had only a negligible influence on the critical temperature for the cooked flavor.

EXPERIMENTAL PROCEDURE

Experimental methods used were, in general, identical with those described in the previous papers of this series (30, 31). Qualitative studies on sulfide liberation were conducted by the lead acetate paper method of Gould and Sommer (12).

Studies on pH were made on the rennet whey from skimmilk in order to eliminate casein precipitation which would occur at the lower pH levels in the case of milk. The adjustment of the whey was accomplished by using hydrochloric acid and ammonium hydroxide and the pH was determined by Type G Beckman pH meter and Type E glass electrode.

The various compounds added to milk to ascertain their effect upon the heat labile sulfides are, for convenience, classified into two groups: (a) organic and (b) inorganic. Organic substances used consisted of sugars, alcohol, cystine, cysteine, and formaldehyde, whereas inorganic substances included sodium chloride, hydrogen peroxide, sodium sulfite, sodium cyanide, copper, iron, silver, mercury and iodine. Qualitative tests were also made using salts of nickel, tin, aluminum, and manganese.

In trials involving homogenization, the milk was forewarmed to 55° C. and processed through a new style, stainless steel viscolizer. Sunshine

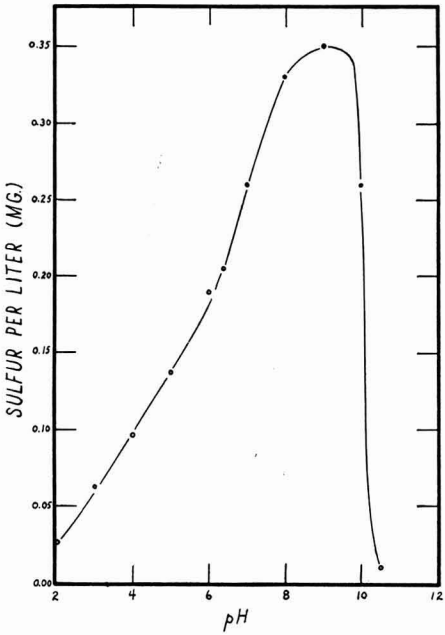

FIG. 1. Influence of pH on the heat labile sulfides of skimmilk whey momentarily heated to 90° C.

treatment of the milk was accomplished by exposing a 2-liter sample of milk in a 5-liter round bottom flask to direct sunlight; agitating the sample with a motor driven glass stirring rod constantly during the exposure.

The sulfide values were secured as in the previous portions of this study. Values secured represent liberation of sulfides during the heating and for a 30-minute aspiration period thereafter.

EXPERIMENTAL RESULTS

pH: To show the influence of pH upon volatile sulfide liberation, skimmilk whey was adjusted to pH values ranging from 2 to 10.5. The sulfides

evolved during the heating of the milk to 90° C. momentarily, and for an aspiration period of 30 minutes thereafter were measured. The results are illustrated in figure 1.

This figure reveals that as the pH of the sample is lowered below the normal pH of 6.5, the quantity of sulfides evolved is decreased. In contrast, an increase in pH above normal to about pH 9 was accompanied by an increase in the amount of heat volatile sulfides. However, further increases in the pH above pH 9 (pH 10 and 10.5), resulted in a marked decrease in the sulfides with only a trace being volatilized from the sample having a pH of 10.5. The normal whey at pH 6.5 evolved 0.202 mg. of sulfur per liter, whereas at pH 4 and pH 9 the whey liberated 0.097 and 0.350 mg. of sulfur per liter respectively.

Organic Compounds:

Sugars: Five per cent of sucrose, dextrose, and lactose were added to milk and the quantitative determinations of the heat labile sulfides determined. As previously stated, the sulfides determined were those liberated upon heating the milk momentarily to 90° C. and during a 30 minute period thereafter. The results are presented in table 1.

TABLE 1

Influence of five per cent of sucrose, dextrose, and lactose on the volatile sulfides liberated from milk momentarily heated to 90° C.

Trial No.	Control	Sucrose	Dextrose	Lactose
	mg./l.	*mg./l.*	*mg./l.*	*mg./l.*
1	0.215	0.192	0.142	0.122
2	0.222	0.191	0.151	0.136
3	0.236	0.200	0.176	0.151
Average	0.224	0.194	0.156	0.136
% decrease	.....	13.39	30.35	39.30

These results indicate a definite retarding influence upon the volatile sulfides by all of these sugars. However, those sugars with active reducing groups, *i.e.*, dextrose and lactose, exhibited greater sulfide inhibiting ability, with the lactose producing the greatest reduction.

Additional trials were conducted in which 20 per cent of sucrose were added to milk and the volatile sulfides determined at temperatures ranging from 74 to 90° C. These results are illustrated by figure 2 and reveal that this particular concentration of sucrose greatly reduces the quantity of sulfides throughout the temperature range, with the greatest difference occurring at the higher temperatures. At 90° C. the control sample evolved 0.222 mg. of sulfur per liter as contrasted to 0.090 mg. evolved from the sample containing the 20 per cent of added sucrose.

Alcohol: Ethyl alcohol (95%) was added to milk at the rate of 12.5, 25, and 50 per cent by volume and the volatile sulfides determined at 82° C. and 90° C. The results are presented in table 2.

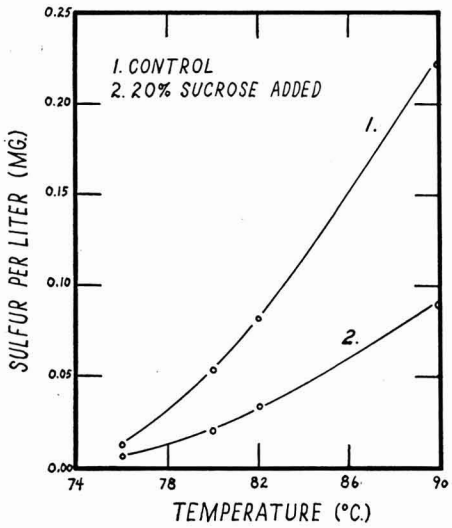

FIG. 2. Influence of the presence of 20 per cent sucrose on the heat labile sulfides of milk momentarily heated to various temperatures.

These results reveal alcohol to increase the amount of volatile sulfides liberated. The control sample liberated 0.075 mg. of sulfur per liter at 82° C. and 0.210 mg. at 90° C., whereas the liberation of sulfides in those samples containing 12.5 per cent alcohol amounted to 0.230 mg. and 0.290 mg. at these respective temperatures.

Difficulty was encountered in heating samples containing 25 per cent or more of alcohol. When 25 per cent of alcohol was used, some alcohol was driven over at 82° C. and 90° C., but was generally withheld from the receivers by the foam trap. However, when the milk was diluted with 50 per cent of alcohol, the heating period required to reach 82° C. was prolonged abnormally and considerable amounts of the alcohol evaporated over and con-

TABLE 2

Influence of ethyl alcohol upon the volatile sulfides of milk heated momentarily to 82° C. and 90° C.

Ethyl alcohol	Sulfur recovered as volatile sulfides	
	82° C.	90° C.
%	*mg./l.*	*mg./l.*
0	0.075	0.210
12.5	0.230	0.290
25.0	0.300	0.310*
50.0	0.260*	.....

* Considerable alcohol was driven off and some difficulty was encountered in reaching this temperature; therefore these results are of questionable value.

densed in the foam trap. Consequently, attempts to conduct the volatile sulfide determinations upon the 50 per cent alcohol-milk mixture were unsuccessful.

Cystine and cysteine: Trials were conducted to determine the influence of adding cystine (Pfanstiehl) and cysteine-hydrochloride (Eastman) upon the volatile sulfides liberated from milk momentarily heated to 76° C. to 90° C. Results of trials in which these compounds were added at the rate of 0.25 and 0.5 gm. per liter are presented in table 3.

These results show that either 0.25 or 0.5 gm. of cystine per liter of milk almost entirely prevents sulfide evolution, whereas the addition of the same quantity of cysteine-HCl greatly increases the quantity of heat labile sulfides. It may be observed that there is practically no difference in the amount of sulfides secured when either 0.25 or 0.5 gm. of cystine were used,

TABLE 3

Influence of cystine and cysteine upon the liberation of volatile sulfides from milk momentarily heated to different temperatures

Temperature	Sulfur liberated as volatile sulfides				
	Control	Cystine per liter		Cysteine-HCl per liter	
		0.25 gm.	0.5 gm.	0.25 gm.	0.5 gm.
°C.	mg./l.	mg./l.	mg./l.	mg./l.	mg./l.
76	0.012	0.000	0.000	0.020	0.025
80	0.053	0.006	0.006	0.051	0.082
82	0.092	0.009	0.008	0.106	0.158
90	0.222	0.026	0.023	0.282	0.370

but only about 10 per cent of the normal sulfide liberation was secured. However, 0.25 gm. of cysteine-HCl increased the sulfide production approximately 27 per cent and 0.5 gm. resulted in an approximate increase of 67 per cent over normal when the samples were heated to 90° C.

The higher sulfide values secured when the cysteine-HCl was utilized do not appear to be the result of heat degradation of the cysteine-HCl itself. To demonstrate this, 0.25 and 0.5 gm. samples of cystine and cysteine-HCl were heated in a liter of distilled water to 90° C. and to boiling for 15 minutes. The sulfides evolved were collected and measured in the regular manner. Under these conditions, the cystine exhibited no sulfide liberation and neither did the sample containing the 0.25 gm. cysteine-HCl per liter. However, a trace of sulfides was detected at 90° C. (0.006 mg./l.) and after boiling for 15 minutes (0.013 mg./l.) when the concentration of cysteine was 0.5 gm. per liter.

Formaldehyde: The influence of formaldehyde upon the heat labile sulfides was determined by adding formalin (40 per cent solution of formaldehyde) to milk at the rate of 0.5 ml. per liter. The milk was then heated to 90° C. and the sulfides which were evolved were measured. For compari-

son the heat labile sulfides were determined in the same milk which contained no formalin. Average results of three trials gave the following results: Control—0.223 mg. sulfur per liter; milk with formalin—0.055 mg. sulfur per liter. These results reveal that this quantity of formalin reduced the sulfides liberated by heating to 90° C. by approximately 75 per cent.

Inorganic Compounds:

Sodium chloride: Sodium chloride was added to milk at rates of 5, 10, 15, and 25 per cent. The sulfides liberated when the milk was heated momentarily to 90° C. were measured. Results are illustrated by figure 3 which reveals this salt to have marked ability to reduce the quantity of heat labile sulfides. Five per cent of NaCl decreased the sulfides approximately

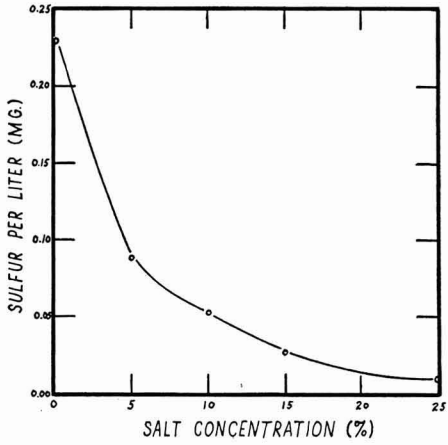

FIG. 3. Influence of sodium chloride on the heat labile sulfides of milk momentarily heated to 90° C.

60 per cent in comparison to the control sample, and 15 per cent salt lowered the liberated sulfides to approximately 10 per cent of their normal value.

Sodium cyanide and sodium sulfite: Milk was treated with 0.25 gm. per liter of sodium cyanide and sodium sulfite. The milk was then heated to 90° C. with the liberated sulfides being determined in the usual manner. Average of the results were as follows: Control—0.218 mg. of sulfur per liter; sodium sulfite (0.25 gm./l.)–0.395 mg. of sulfur per liter; sodium cyanide (0.25 gm./l.)–0.345 mg. of sulfur per liter.

This experiment demonstrates the ability of these two compounds to increase sulfide liberation from milk, the increase over the control value amounting roughly to 58 per cent for the sodium cyanide and 81 per cent for the sodium sulfite. Again, as in the case with the cysteine-HCl, neither the cyanide nor the sulfite contributed appreciable quantities of volatile reducing materials when they were heated in distilled water to 90° C.

Hydrogen peroxide: A 30 per cent solution of this oxidizing agent was added to milk before and after the milk was heated to 90° C. The sulfides were collected and measured by aspirating the samples for a 30-minute period at approximately 37° C. immediately following the heat treatment. The results are presented in table 4.

Hydrogen peroxide, even in small quantities, greatly decreases sulfide liberation; the decreasing effect is greater when the peroxide is added following the heat treatment. Approximately 60 per cent reduction in sulfide liberation occurs when only 0.25 ml. of hydrogen peroxide is added to the milk prior to the heat treatment and approximately 80 per cent reduction occurs when the same quantity of the peroxide is added subsequent to heating.

Milk used for these hydrogen peroxide trials was also examined for the cooked flavor and for sulfhydryl groups as detected by the nitroprusside

TABLE 4

Influence upon the liberation of volatile sulfides of adding hydrogen peroxide before or after heating milk momentarily to 90° C.

Hydrogen peroxide (30% soln.)	Sulfur liberated as volatile sulfides	
	Peroxide added before heating	Peroxide added after heating
ml./l.	*mg./l.*	*mg./l.*
Control	0.236	0.236
0.25	0.089	0.047
0.50	0.064	0.023

test. The nitroprusside test was positive in all cases with the exception of those samples to which 0.5 ml. per liter of peroxide was added following heating; in these samples the test was either slightly positive or negative. Also, the cooked flavor of milk was affected by the addition of the hydrogen peroxide after heating: the flavor was not typically "cooked" but possessed an obnoxious flavor characterized as "smoky."

Further trials involving the use of hydrogen peroxide were conducted in which qualitative determinations were made to ascertain the amount of peroxide necessary to completely prevent sulfide liberation. The results secured indicate that approximately 2.5 ml. of 30 per cent hydrogen peroxide per liter added to milk before heating will prevent sulfide liberation whereas approximately 0.75 ml. added following the heat treatment will produce the same effect.

Metals: Since qualitative experiments have been reported in which copper and ferrous iron were found to exhibit a retarding effect upon sulfide liberation, it appeared desirable to study quantitatively the influence of these and other metallic salts. Consequently, trials were conducted in which various metals were added to milk prior to heating the milk to 90° C. The heat labile sulfides were measured and the results are presented in table 5.

These results reveal copper, mercury (mercuric) and silver to be equally effective in preventing sulfide liberation from milk, with one ppm. being sufficient in each case to reduce the normal quantity of heat labile sulfides by more than 95 per cent. Ferric and ferrous iron exhibited much less ability to decrease sulfide liberation, although the ferric compound was more effective than the ferrous salt in this connection. In fact, these data indicate that the ferric iron is approximately five times as effective since the use of one ppm. of ferric chloride resulted in approximately the same value as five ppm. of ferrous chloride.

TABLE 5

Influence of different metals upon the liberation of volatile sulfides from milk momentarily heated to 90° C.

Metallic salt added	Amount of metal	Sulful liberated as volatile sulfides
	ppm.	*mg./l.*
Control	0.00	0.236
Copper sulfate	0.50	0.032
" "	0.75	0.028
" "	1.00	0.019
Silver nitrate	0.50	0.032
" "	0.75	0.027
" "	1.00	0.019
Mercuric acetate	0.50	0.036
" "	0.75	0.028
" "	1.00	0.019
Ferric chloride	0.50	0.135
" "	0.75	0.090
" "	1.00	0.045
Ferrous chloride	0.50	0.225
" "	1.00	0.174
" "	3.00	0.155
" "	5.00	0.053
Mercurous chloride	0.5 gm./l.	0.011

Another interesting result presented in this table concerns the mercurous chloride. The concentration of this salt was comparatively high but because of the low solubility of the salt only an extremely small amount may be expected to be in solution. However, the compound has marked ability to prevent sulfide liberation, with only a negligible quantity of sulfides being evolved when the milk was heated to 90° C. It is likely that the concentration of the mercurous chloride is sufficiently high to exert an influence directly upon the sulfide contributing substances in milk.

To secure additional data concerning the ability of copper to retard sulfide liberation at various temperatures, an experiment was conducted in which 0.5 ppm. of copper was added to milk and the milk then heated to temperatures from 74° C. to 90° C. The results are portrayed by figure 4, and show that this quantity of copper practically prevents sulfide liberation

until the milk reaches a temperature of 86° C. or higher. The amount of sulfides liberated from the milk heated to 90° C. is somewhat higher than was secured in the trials presented in table 5, but even then it is only approximately 20 per cent of the value of the control sample under similar conditions.

In connection with the copper studies, attention was directed toward the possible influence of the negative ion on the ability of the copper salt to prevent sulfide liberation. With this in mind, qualitative trials were conducted in which a number of copper salts were added to milk in increasing quantities prior to heating the milk to 90° C. The sulfides liberated were

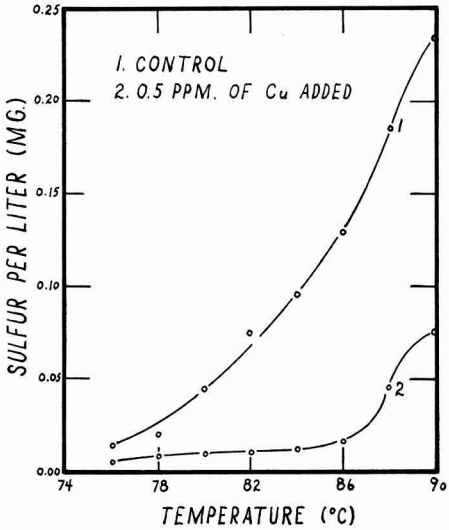

FIG. 4. Influence of copper (0.5 ppm.) on the heat labile sulfides of milk momentarily heated to various temperatures.

collected on lead acetate paper and comparison between the various samples made. Copper salts studied included the nitrate, acetate, chloride, and sulfate. The qualitative results indicated no appreciable difference between these salts in retarding sulfide volatilization.

In addition to qualitative studies on these copper salts, similar trials were conducted in which 5 ppm. of nickel acetate, stannous chloride, aluminum chloride, and manganese chloride were added to milk. The milk was heated to 90° C. and the intensity of the sulfide deposit on lead acetate paper noted. Organoleptic and nitroprusside tests were also made on these samples. The results secured indicate that these four compounds were without material effect upon sulfide liberation, sulfhydryl formation and the cooked flavor.

Iodine: Milk with and without iodine (0.5 ppm.) was heated to 90° C. The average results secured were as follows: Control: 0.223 mg. sulfur per

liter; milk with iodine: 0.084 mg. sulfur per liter. On the basis of these results, it appears that 0.5 ppm. iodine reduces the sulfide liberation of milk approximately 60 per cent.

Homogenization: Milk was homogenized at 2500 pounds pressure and then the sulfides were liberated by heating the milk to 70–90° C. momentarily. The control sample was unhomogenized. Results are presented in table 6.

These data reveal that homogenization of milk has no significant affect upon the critical temperature nor upon the amount of heat labile sulfur evolved at the various temperatures.

Sunlight: Raw milk was exposed to bright sunlight for periods of one and three hours. The quantity of sulfides liberated when this milk was

TABLE 6

Influence of homogenization upon the liberation of volatile sulfides when milk is momentarily heated to various temperatures

Temperature	Sulfur liberated as volatile sulfides	
	Homogenized	Non-homogenized
° *C.*	*mg./l.*	*mg./l.*
70	0.000	0.000
75	0.010	0.015
80	0.043	0.052
85	0.129	0.129
90	0.235	0.237

heated momentarily to 90° C. was determined. The results for these samples and for the same milk not exposed to sunlight indicate no definite influence of the sunlight upon the heat volatile sulfides. The average results secured for three trials were as follows: Control, 0.223 mg. sulfur per liter; milk exposed one hour, 0.227 mg. sulfur per liter; milk exposed three hours, 0.226 mg. sulfur per liter. The flavor of the milk, also, was not influenced by the sunlight which may account for the results secured.

DISCUSSION

The results pertaining to the influence of pH upon the heat labile sulfides are interesting inasmuch as they reveal that both acidity and extremely high alkalinity reduce the quantity of sulfides evolved. Doubtless, these reactions produce a change in the sulfide-contributing constituents which retards or prevents sulfide liberation, but it is not necessarily the case that the change produced is identical in the acid and alkaline systems. The increase in sulfide liberation when the alkalinity was increased within the range of pH 6.5 to pH 9.0 may be predicted in view of the well known instability of cystine in the presence of alkalies. The failure to obtain sulfides at higher pH values may be due either to the fact that they were not formed or were held in solution as alkaline sulfides.

In general, it appears that there is a relationship between heat denaturation and coagulation of the serum proteins and the liberation of sulfides. For example, sugars and formaldehyde have been reported to delay heat coagulation of proteins and, in the studies herein presented, these compounds retard and decrease sulfide evolution. NaCl apparently exhibits the same properties (21, 22). In contrast, alcohol favors protein denaturation and coagulation and it also increases the quantity of heat labile sulfides.

The comparative efficiencies of the different sugars in preventing coagulation of serum proteins and retarding the formation of sulfhydryl groups may be due, at least partially, to the presence of potential aldehyde or ketone groups. Lactose and dextrose possess these oxidizing groups and exhibit considerably more sulfide-decreasing ability than does sucrose.

The results secured with cysteine, cystine, sodium cyanide, sodium sulfite, and hydrogen peroxide demonstrate that reducing substances enhance and oxidizing agents retard sulfide liberation. Undoubtedly, the enhancing action of reducing agents is due to the greater tendency toward the formation of sulfhydryl groups. For example, sodium sulfite and cysteine are capable of reducing protein S–S groups to –SH groups (26) and sodium cyanide will act upon milk proteins to form sulfhydryl compounds (12, 17). These compounds also favor sulfide liberation. In contrast, cystine and hydrogen peroxide oxidize sulfhydryl groups (26) and, as shown in this study, they interfere with sulfide liberation. Iodine also may react with –SH groups as indicated by the work of Mirsky and Anson with iodoacetate (26). It appears logical, therefore, to assume that the formation of sulfhydryl groups is the first step in sulfide liberation.

The ability of certain metals to reduce the quantity of heat labile sulfides is likely due to their sulfide combining ability. Copper, silver, mercury, and iron all exhibit this property and, with the exception of ferrous iron, show marked ability to decrease the liberation of volatile sulfides from milk.

Although, as shown in the previous paper in this series, the materials associated with the fat globules may be appreciable contributors of heat labile sulfides, the creation of new surfaces by homogenization apparently does not influence the quantity of sulfides liberated. Furthermore, under the conditions of this experiment, sunlight was found without effect upon sulfide liberation. However, if the casein had been removed by precipitation and the whey exposed to sunlight, then the effect upon the serum protins may have been greater thus resulting in increased sulfide liberation. Also, the fact that no sunshine flavor developed in the milk may indicate that the action of the sunlight was insufficient to produce detectable sulfhydryl compounds.

SUMMARY

Sulfide liberation from milk is decreased either by low pH values or pH values above 9; by sugars, formaldehyde, cystine, sodium chloride, hydro-

gen peroxide, iodine, and the following metals: copper, silver, mercury, and iron.

An increase in the heat labile sulfides results by increasing pH values between 6.5 and 9, and by the addition of ethyl alcohol, sodium sulfite and cysteine-HCl.

Those factors which apparently have no effect upon the formation of sulfhydryl compounds in milk are homogenization, sunlight, and the addition of salts of nickel, tin, aluminum, and manganese.

Sulfide liberation from milk may be decreased by (a) treating milk so that the denaturation and coagulation of serum proteins are retarded or prevented, (b) oxidizing or blocking out the sulfhydryl groups as they are formed, or (c) by adding materials that will combine with the liberated sulfides. Enhancement of sulfide liberation may be produced by (a) treating milk so that denaturation and coagulation of serum proteins are favored, or (b) by creating a reduced system through the addition of suitable reducing agents.

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THE OXIDATION OF VITAMIN A AND CAROTENE IN MILK FAT

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While the literature indicates that the problem concerning oxidation of milk fat received considerable attention in past years, the mechanism involved and particularly the role which vitamin A and carotene play in this phenomenon are not yet well understood. Our studies on the effects of ordinary temperatures, however (5°–60° C.), and the time of holding upon the keeping quality (as judged organoleptically) of the fat from the milk in which lipolysis was checked by pasteurization immediately after withdrawal from the mammary gland have shown that the development of oily-tallowy and finally dominantly tallowy flavors in the samples was accompanied by corresponding losses in their vitamin A and carotene contents. Furthermore, it was observed that, although the bitter flavor and unpleasant odor of the milk in which lipolysis was produced by temperature changes (7) were not inherited by the fat, nevertheless, the keeping quality of the latter was considerably lowered. Our data (9) concerning the distribution of lipase-liberated fatty acids between the fat and the plasma of the milk have indicated that the oleic acid was largely retained by the fat, while all of the butyric and most of the caproic and caprylic acids were retained by the plasma.

The early studies of Greenbank and Holm (2) on autoxidation of milk fat at 95° C. revealed further that the loss of color and appearance of tallowy odor were apparent in the sample at the moment when the absorption of oxygen was rapid. They found that the resistance of milk fat to autoxidation was decreased in the presence of added oleic acid. More recently Davies (1) observed that the progressive increase in the acidity of lipolytically-active butter, held at room temperature, was accompanied by fat-peroxide formation in amounts varying directly with the acidity. This he attributed to the presence of free oleic acid. He concluded that this acid in the free state is more susceptible to oxidation than when bound to the fat molecules.

Since the oleic acid oxidation is mainly responsible for the development of intense tallowy odor (5), the above studies together with our own observations suggested a possibility that the oxidation of vitamin A and carotene in the milk fat is brought about by oxidation of double bonds of unsaturated fats, and consequently that this reaction proceeds at a much faster rate in the presence of free oleic acid.

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The observations reported in this paper deal with comparative rates of destruction of vitamin A and carotene in the fat from "1-milk," in which lipolysis was accelerated by temperature changes (7) and "2-milk" in which lipolysis was checked immediately by pasteurization after withdrawal from the mammary gland. The rates of destruction were studied at different temperatures of storage and upon exposure to ultra-violet light.

Preparation of milk fat. The fresh mixed milk obtained in the afternoon was divided into two parts. One part of it was immediately pasteurized, while the other part was made rancid by the activation method described in a previous paper (7) and then pasteurized. These milk samples were separated after pasteurization to yield cream containing 30 per cent of fat.

The milk fat was prepared by churning the cream, transferring the butter to a centrifuge bottle, and centrifuging to secure a clear layer of fat. After filtration the fats were placed under a vacuum for a short period of time. Twelve grams of each sample having 0.30 and 3.30 acid degrees respectively were weighed separately into 18 mm. clean dry test tubes. Subsequently one-half of the tubes were sealed under a vacuum[1] and the remaining samples were left open to the air. These samples were then quickly cooled in an ice-water bath and stored at 5° C. in the dark for future use.

STORAGE TEMPERATURE AND COMPARATIVE RATES OF DESTRUCTION OF VITAMIN A AND CAROTENE

In order to study the comparative rates of destruction of vitamin A and carotene in milk fats having natural and developed free fat acidity contents, several samples of each in the liquid state exposed to the air but protected from light, were placed in incubators at temperatures approximating 5°, 10°, 20°, 30°, 40°, 50°, 60° C. Their vitamin A and carotene concentrations were determined periodically by the procedure of Koehn and Sherman (6) and at the same time were scored for flavor. In two instances the fats were analyzed for peroxides by the iodine liberation method (3). Finally, the changes, if any, in the acid degrees of these fats were determined by the method described in a previous paper (4).

The results are presented in figures 1 and 2. It is of interest to note that the extent of oxidative deterioration of milk fat at different temperatures of storage could be approximately estimated by the presence of oily, oily-tallowy, dominantly tallowy, and bitter flavors, because of a definite relationship between their intensities and order of appearance on one hand, and the magnitude of observed chemical changes on the other. It appeared that the oily flavor resulted from the by-products of oxidative destruction of vitamin A and carotene, while the tallowy flavor resulted from the oxida-

[1] 5 mm. Hg.

tion of unsaturated fats and acids. This was evident from the fact that oily flavor appeared in the sample at the point when the concentration of vitamin A and carotene began to decrease, which, in turn, was reflected in the score assigned to the fat. This flavor continued to increase in its intensity up to the point when the formation of peroxides was detectable by the iodine liberation method, and at which the presence of tallowy flavor was also apparent, although of lower intensity. Subsequently, both flavors

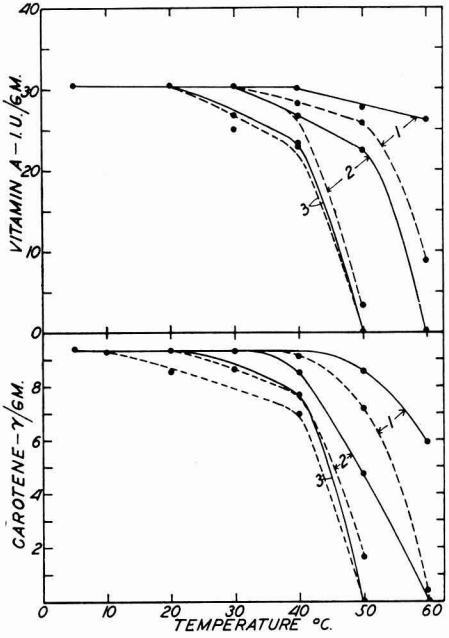

FIG. 1. The relation between the temperature of storage and the rates of destruction of vitamin A and carotene in the fat from (1) milk (solid line) in which lipolysis was checked by pasteurization immediately after excretion by mammary gland, and (2) milk (dotted line) in which lipolysis was accelerated. The fat was exposed to the air but protected from the light. (Numbers 1, 2 and 3 on the graphs indicate months of storage.)

blended, producing a very repellent taste simulating that of castor oil. This junction appeared to be a turning point in the ability of the milk fat to resist oxidation, since from then on the reaction proceeded at a gradually increasing rate directly related to the temperature of holding. It should be noted, however, that at the end of the second month of storage the abrupt drop in the flavor score of the fat prepared from rancid milk was caused by the presence of an additional flavor identified by the judge as cheesy. This defect was not necessarily accompanied by oxidative destruction of vitamin A and carotene.

Furthermore, the absence of a cheesy flavor in reconstituted milk prepared by reemulsification of the "cheesy" fat in a fresh, pasteurized skim-milk was rather striking. Such milk was judged as "old" but showed a fairly good keeping quality in comparison with the one containing fat in which the destruction of vitamin A and carotene had just begun. The latter milk developed tallowy and bitter flavors within a few minutes after preparation. This "reconstitution test" was found to be extremely useful in recognizing not only the flavor defects of the milk fat, but also in estimating the extent of oxidative deterioration. It appears, therefore, that in the above case the cheesy flavor alone could not be considered as indicative of

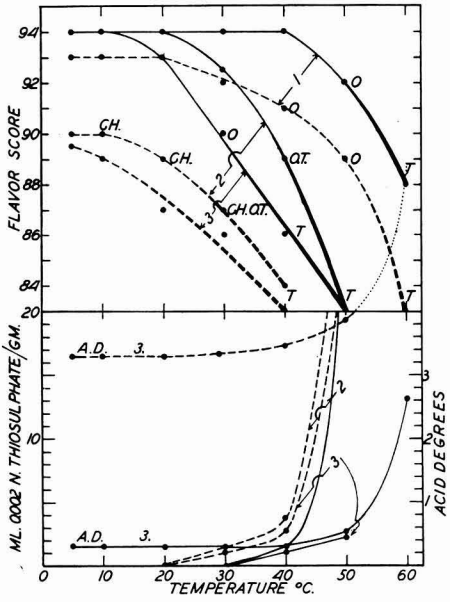

FIG. 2. The acid degree (A.D.), peroxide values and judges' scores of the milk fat exposed to the air but protected from the light after 1, 2 and 3 months in storage at indicated temperatures. (Symbols on the graphs indicate: O—oily; O.T.—oily and tallowy; T—tallowy and CH.—cheesy flavors.) 93 and 94 flavor scores indicate no criticism and excellent flavors respectively. (See Fig. 1.)

the extent of oxidation. However, it is not possible at the present time to explain its origin.

As the accumulation of a large amount of peroxides in these samples was apparent only at the point when the oxidation of vitamin A and carotene was nearly complete, it is possible to assume that their part in this reaction was that of an oxygen acceptor, thus helping to break down the peroxides formed, while the increase in acid degrees indicates that the oxidation was not limited to the above stage only, but continued to the point where glycerides were broken down.

Finally, it should be noted that the appearance of a bitter flavor in fat coincided with a slight increase in the acid degrees of the samples. It resembled closely the bitter flavor produced by lipolytic action in milk, and could be easily extracted from the fat by reemulsification in the skimmilk. This observation, together with the one pointed out earlier, namely, that the bitter flavor of rancid milk was not inherited by its fat, suggests the possibility that the by-products of oxidative and enzymatic reactions responsible for bitter flavor are of the same nature and result from the breakdown of glycerides.

THE EFFECT OF LIGHT UPON VITAMIN A ACTIVITY IN MILK FAT

The preceding experiments indicate that the thermo-induction period of milk fat protected from light but exposed to air varies with the tempera-

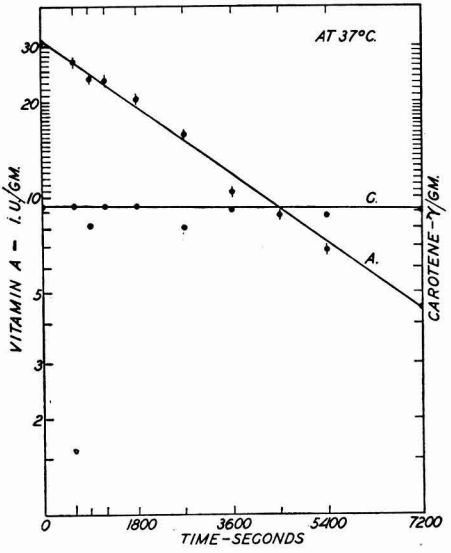

FIG. 3. The effect of irradiation upon vitamin A of the milk fat. (Symbols on the graph indicate: C—carotene; A—vitamin A.)

ture of storage, and that the active period manifests itself by simultaneous progressive destruction of vitamin A and carotene. It was thought worth while to pursue the matter further in order to obtain some idea concerning the destruction of vitamin A and carotene in fat exposed to light.

In order to eliminate the combined effects of temperature and time upon the rates of destruction of vitamin A and carotene it was found necessary to carry out the experiment in the shortest possible time. This was accomplished by placing 18-mm. Pyrex tubes containing aliquot amounts of fat inside of and next to the wall of a cylinder made of aluminum tubing

through which cold water was circulating, and by irradiation of these samples with ultraviolet light of a constant intensity from the center of the cylinder. Throughout the duration of this experiment the temperature of the fat was maintained at 37° C. and the intensity of the mercury vapor lamp at 1400 foot-candles.[2] Portions of two samples of milk fat having 0.30 and 3.30 acid degrees, respectively, were irradiated in open tubes and in vacuum-sealed tubes for different periods of time up to 7200 seconds. At the end of each period they were immediately analyzed for vitamin A and carotene. The data are presented in figure 3.

Although experimental errors are apparent in some values, nevertheless the straightness of the line shows clearly that there is a relationship between vitamin A content of the fat and the time of exposure. The data indicate also that while the vitamin A content falls, the concentration of its precursor remains practically constant through the duration of the experiment and that the rate of destruction of vitamin A was not affected by the presence of free fatty acids or the availability of atmospheric oxygen. Furthermore, some points on the line show a fairly good constancy in K (velocity constant): K_{600}—0.000237, K_{1200}—0.000228, K_{1800}—0.000228, K_{2700}—0.000248 and K_{7200}—0.000265. It seems justified, therefore, to assume that the above reaction is unimolecular.

Since, under the experimental conditions just described, no destruction of carotene occurred, it seemed desirable to increase the intensity of ultraviolet light radiated by the mercury vapor lamp from 1400 up to 1900 foot candles, as measured by a Weston light meter, in order to learn whether or not the atmospheric oxygen plays a role in the photochemical destruction of carotene. Consequently, samples of fat open to the air and under vacuum were irradiated for four hours. Through the duration of exposure the temperature was maintained at 57° C. At the end of this period the concentration of carotene in the presence of oxygen was reduced to 50 per cent of its original value, while that in vacuo remained unchanged. Since a considerable accumulation of peroxides was observed in the sample exposed to the air, it seemed probable that their formation was an important factor governing the rate of destruction of carotene.

In this connection, it is of interest to note that recently Sumner and Sumner (8) in their studies of carotene oxidase showed that this enzyme bleached carotene with extreme slowness unless a small amount of unsaturated fat was present. They concluded that the bleaching action by the enzyme is probably a coupled reaction.

Although the above observations are not sufficient to determine the order of the reaction or to warrant definite conclusions, it appears that the oxidation of carotene in the milk fat is accompanied by the oxidation of double bonds of unsaturated fats.

[2] G.E. H3, 85 watts, with Weston M. 603 light meter.

Finally, in order to ascertain whether or not the atmospheric oxygen bears a relationship to the disappearance of vitamin A in milk fat in the absence of light, samples of fat exposed to the air and under vacuum were stored at 60° C. Their vitamin A and carotene contents were determined initially and, at the time of a complete decolorization of the fat, exposed to the air. It was found that while vitamin A and carotene of the decolorized samples were completely destroyed, they remained intact in the ones kept in vacuo. It was apparent, therefore, that the disappearance of vitamin A and carotene from the milk fat in the absence of light was due to their oxidation.

SUMMARY AND CONCLUSIONS

The effects of light, atmospheric oxygen and temperature of storage upon the rates of destruction of vitamin A and carotene in the milk fat were investigated.

The observations indicate that a relationship exists between the intensities and order of appearance of oily, tallowy and bitter flavors on one hand and the magnitude of observed chemical changes on the other.

The data show that the destruction of carotene in the milk fat either in the absence or presence of light was accompanied by the oxidation of the double bonds of unsaturated fats. While in the case of the vitamin A, an additional photochemical reaction caused its rapid destruction. Apparently this reaction is unimolecular.

The data suggest that the efficiency of utilization of vitamin A and carotene from the milk fat by a human might be influenced by the ability of the milk fat to resist oxidation during its passage through the stomach and intestinal tract.

ACKNOWLEDGMENT

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THE RELATION OF THE KIND OF PASTURE CROP TO THE WEED CONTENT OF THE FORAGE

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Weed infestation constitutes a serious problem in dairy cattle pastures. Heavy weed growths apparently decrease yields of grasses and legumes, render forage unpalatable and in some cases the consumption of weeds produces undesirable flavors in milk.

EXPERIMENTAL METHODS

The weed content of the forage of several pastures was determined over an eight-year period (1935–1942 inclusive). Yields of forage and of weeds were determined from samples of the forage harvested at approximately monthly intervals. The first sample was taken during the last week of April or first week of May (just prior to turning the cattle to pasture) and the last sample of the season was taken close to the time pasturing ended, which usually was about October 1.

Only one area at each sampling location was harvested on the first sampling date. During the taking of the first samples, two reinforced wire cages, each about $4' \times 4'$ in size, were placed at each sampling location. One of these was placed over an area just harvested. The forage taken from this area the following month comprised only the forage produced by one month's growth. This was designated the "A" sample.

On each sampling date a cage was also placed over a representative portion of the open pasture. The forage harvested from this protected area the following month formed the "B" sample. It comprised not only forage produced during one month's growth, but also the forage on the area at the time the protecting cage was put in place. The "C" samples consisted of harvests of forage from the open, or unprotected, portion of each plot on each harvest date.

In most cases there were two sampling locations in each field. Hence, a single sample, as referred to in this report, usually consisted of the total forage harvested from two areas. The samples were harvested by placing a metal frame $44'' \times 44''$ in size and $1\frac{1}{2}''$ high carefully around the designated area, and clipping the forage with grass shears. The forage was collected in cloth sacks and taken to the laboratory where it was at once separated by careful hand sorting into weed and grass portions. Each portion was resacked in tared cloth sacks, weighed, and dried in a constant-temperature electrically-heated oven at 95°–100° C. In case the samples were too large, subsamples of 1 to 2 pounds were taken for drying.

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During 1935 and 1936, the pastures were grazed by milk cows; in subsequent years, by yearling heifers. The pastures were located on highly-productive tillable land. Most of the pastures were treated with heavy applications of barnyard manure one or more times annually.

Five pasture crops were studied. These were alfalfa (*Medicago sativa*), Kentucky bluegrass (*Poa pratensis*), brome grass (*Bromus inermis*), winter rye (*Secale cereale*), and a mixture of Sudan grass (*Andropogon sorghum sudanesis*), and soybeans (*Soja max*).

EXPERIMENTAL RESULTS

The proportions which weeds formed of the total forage dry-matter yields of the pasture crops are shown in table 1. It is apparent that both the

TABLE 1

Weed content of pasture forage

(Expressed in percentage of the total-forage dry-matter yield formed by the dry-matter yield of weeds)

Kind of pasture	Sample	No. of samples	Apr.	May	June	July	Aug.	Sept.	Ave. all samples
Alfalfa	A	28	.....	12	32	27	50	19	28
Alfalfa	B	30	.....	10	9	15	37	32	26
Alfalfa	C	21	1	.....	2	26	49	31	22
Alfalfa	All	79	1	11	9	23	45	26	26
Bluegrass	A	121	.....	17	19	29	21	23	22
Bluegrass	B	134	.....	20	12	14	13	13	14
Bluegrass	C	155	26	14	7	7	7	9	10
Bluegrass	All	410	26	16	13	16	14	15	15
Brome grass[a]	All	32	48	26	5	0	2	5	12
Brome grass[b]	All	55	0	0[c]	1	0	0	0	0[c]
Winter rye	All	31	0	0	.....	.....	.....	.....	0
Sudan grass-soybeans	All	41	.....	.....	0	3	1	4	2

[a] First year after seeding.
[b] Second year after seeding.
[c] Less than 0.5 per cent.

alfalfa and bluegrass pastures had a relatively high weed content, while the brome grass and Sudan grass-soybean pastures had a relatively small proportion of weeds. The winter rye was practically free from weeds.

Analyses showed that alfalfa pastures had a relatively smaller weed content in April, May, and June than during the remainder of the pasture season. The A samples were the highest and the C samples lowest in weed content, although these differences were not large. It was observed that the weed infestation of alfalfa pastures was light during the first pasture season (next year after seeding) and increased greatly toward the end of the third year of pasturing when many of the alfalfa plants died because of bacterial wilt. This thinning of the alfalfa stand permitted a heavy growth of common annual weeds such as foxtail, pigweed, common ragweed, smartweed, and crab grass.

The weed content of the bluegrass pastures was higher during the first part of the pasture season than later. This is accounted for mainly by the heavy infestation of dandelions which made up the bulk of the weed portion. The dandelions became largely dormant after July 1, except in seasons of above-normal fainfall, and except in the areas harvested as A samples. Close cutting and protection of these areas seemed to retard the growth of the grass and to permit the dandelions to form a larger proportion of the forage than in the case of the B and C areas. The heifers ate both dandelions and grass, and usually after July 1, both grass and weeds were closely grazed. No supplementary feed was given to the heifers. On the other hand, it was observed that milk cows receiving supplementary feed tended to avoid the dandelions.

Other weeds present in small amounts in the bluegrass pastures were foxtail, lamb's quarters, common ragweed, and field sorrel.

Brome grass was seeded in August, 1940, and pastured first on May 17, 1941. The first samples of the pasture forage consisted of 25 to 50 per cent weeds, mostly some of the annual kinds mentioned above. As the season progressed, the stand of brome grass became more dense and percentage of weeds decreased. By the end of the second year of pasturing, the forage was practically free of weeds.

The winter rye usually was pastured only during April and May and was plowed under May 20 to 31, to be followed by a mixture of Sudan grass and soybeans. Rarely were weeds present in the rye pasture forage, and when present usually constituted less than 0.5 per cent of the dry matter. The rye was seeded in fall after plowing the land (occasionally after discing if crop residues were small). Plowing or thorough cultivation of these fields twice yearly and the heavy growth of the crops seemed to be the main factors which kept the weed content of the forage at a low level.

The Sudan-grass and soybean pasture also benefited from the twice-yearly seedbed preparation. Weeds remained at a relatively low level. However, one of the weeds most troublesome in these pastures was velvet weed (*Abutilon Theophrasti* Medic.). It was controlled by hand pulling, removal from the field, and burning.

Curled dock (*Rumex crispus* L.) was prevalent in the alfalfa, bluegrass and brome grass pastures and its incidence seemed to bear little or no relation to the kind of pasture crop. It was removed nearly every year by hand digging.

Large quantities of hay and straw were purchased for the feeding and bedding of the cattle kept on the farm. It is assumed that the barnyard manure spread on the pastures contributed considerable quantities of curled dock and other weed seeds to the fields. Even with these recurring additions of weed seeds to the fields, the amounts of weeds in some pastures were relatively large and in others relatively small, thus showing a distinct relation of the kind of pasture crop to the weed content of the forage.

TABLE 2

Weed content of samples of bluegrass pasture forage taken from open pasture (C samples)

(Expressed in percentage of the total-forage dry-matter yield formed by the dry-matter yield of weeds)

Year	Apr.	May	June	July	Aug.	Sept.
1935	.....	.....	.....	.....	4	3
1936	.....	6	4	0	4	0[a]
1937	.....	10	2	6	7	2
1938	19	5	11	9	13	12
1939	.....	24	4	9	2	8
1940	.....	9	8	5	2	47[b]
1941	19	24	15	9	7	11
1942	40	21	15	15	14	26

[a] Less than 0.5 per cent.

[b] Season of low rainfall; September samples of two plots showed only 356 lbs. total forage per acre; other two plots bare, no sample.

There seemed to be no reduction in the weed content of the bluegrass pasture forage over the eight-year period embraced in the study. In fact, the percentage of weeds appeared to be somewhat higher in 1941 and 1942 than in the earlier years (table 2). This increase occurred in spite of the employment of good management methods such as heavy manuring, removal of dock and a few other large weeds by hand digging, and careful adjustment of the pasture period by keeping the cattle from pasture until the grass had made a good growth in spring and by removing them in fall in time to permit the grass to replenish its food reserves. At all times there was a heavy sod in the bluegrass pastures, although it was well filled with dandelions. A possible explanation of the greater weed growth in 1941 and 1942 is heavier stocking of the pastures in those years, particularly in spring.

A question arises as to whether or not weeds increase the total forage yield. This question is not fully answered by the data at hand, but the figures given in table 3 show that one of the most heavily weed-infested pas-

TABLE 3

Pasture forage yields

(Expressed in pounds of dry matter in total forage per acre[a])

Crop	Year					
	1937	1938	1939	1940	1941	1942
Alfalfa	5900	5950	.....	.....	6600	6700
Bluegrass	2750	4250	2700	2800	3550	4150
Brome grass	.....	.....	.....	.....	7150	5550
Winter rye	2050	3650	4150	4100	2700	3100
Sudan grass-soybeans	4600	4850	5100	5900	8800	6500

[a] Since the Sudan grass-soybeans followed the winter rye crop on the same field in the same pasture season, yields of the two crops should be taken together to obtain the yield per acre for the year.

ture crops, bluegrass, was lowest in yield. Alfalfa, though also showing a high proportion of weeds, was much higher in yield than the bluegrass. The low weed content of the brome grass, winter rye, and Sudan grass-soybean mixture, together with their high yields, are factors which help to make these crops outstanding as valuable pasture crops for dairy cattle.

A study of the dry-matter levels in the grass and weed portions of the pasture samples (table 4) shows differences in this factor between the pasture crops. Only a limited number of samples are available for this study because many samples contained no weeds, or had too small an amount of weeds to give a reliable determination of dry-matter content.

Only 133 of the bluegrass samples harvested from 1939–1942, inclusive, meet these requirements. It was found that the grass portion of every one of these samples was higher in percentage of dry matter at the time of har-

TABLE 4

Dry-matter levels in grass and weed portions of pasture samples at time of harvest

Pasture crop	No. of samples	Dry matter in	
		Grass portion	Weed portion
		per cent	*per cent*
Alfalfa	53	28	24
Bluegrass	133	37	20
Brome grass	21	23	25

vest than the corresponding weed portion. The mean values for the 133 samples were 37 per cent dry matter in the grass portion and 20 per cent dry matter in the weed portion. This appears to be a significant difference of unusual magnitude.

On the other hand, the differences in dry matter content of the grass and weed portions of the alfalfa and brome grass samples were much smaller. Of the 53 alfalfa samples, 11 showed a higher percentage of dry matter in the weed portion than in the grass (alfalfa) portion, while in the case of brome grass, the weed portions of 15 out of 21 samples were higher in dry matter than the corresponding grass portions.

SUMMARY AND CONCLUSIONS

Pasture forage samples harvested over the eight-year period 1935–1942 and comprising 79 samples of alfalfa, 410 samples of bluegrass, 87 samples of brome grass, 31 samples of winter rye, and 41 samples of Sudan grass-soybeans, were analyzed for their weed and dry-matter contents.

It was found that alfalfa and bluegrass pasture forages had a high weed content, while brome grass (second year's growth), winter rye, and Sudan grass-soybean pasture forages were nearly free from weeds. Alfalfa forage in spring had a smaller weed content than later in the season, while with

bluegrass the situation tended to be reversed. The weed content (chiefly dandelions) of bluegrass pastures did not decrease from year to year in spite of the use of good management methods, including heavy manuring.

Samples taken in alfalfa and bluegrass pastures under three different procedures showed that the weed growth in areas harvested (closely clipped) a month before was greater than in unclipped areas. This indicates that close grazing of these crops is likely to increase weed growth.

Two features of brome grass, winter rye, and Sudan grass-soybean pastures which commend them as desirable for dairy cattle are their low weed content and high yields.

This study shows a distinct relation between the kind of pasture crop and the weed content of the forage.

A STUDY OF THE ETHER EXTRACT OF THE MATERIALS ESTIMATED AS FAT IN THE BABCOCK TEST OF MILK

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A previous paper (5) has emphasized the importance of density and coefficient of expansion of milk fat and of the materials estimated as fat by the Babcock method. This paper evaluates the impurities in these fatty materials as determined by ether extraction.

Bailey (2) removed from each of 15 test bottles, 1 to 1.5 grams of fatty materials and subjected them to ether extraction by the Roese-Gottleib method without ammonium hydroxide. His results showed impurities ranging from 0.36 to 1.23 with an average of 0.78 per cent. He determined by ether extraction the fat that remained in the acid hydrolysate after the necks containing the fatty materials had been removed and 38 determinations varied from 0.066 to 0.233, averaging 0.132 per cent. Fahl, Lucas and Baten (3) made similar analyses on bottles that had been centrifuged at three temperature ranges. An average of 0.1801 per cent fat was obtained from the acid hydrolysate when the centrifuge was operated at 1.6–7.2° C., 0.1194 per cent at 21° C. and 0.0881 per cent at 57.2–65.5° C. They stated that the individual determinations in each temperature range varied so widely from the mean that a comparison of averages lost some significance. Bailey (2) reported that the loss of fatty materials by hydrolysis and by volatilization of fatty acids is not significant in the Babcock test for milk.

METHODS

The methods for collecting samples and conducting the tests at the Vermont Station have been described in previous papers (4, 5). The impurities in the fatty materials were determined by ether extraction with the Mojonnier apparatus, reagents and procedure (6) except that ammonium hydroxide was omitted. Two different methods were used for removing the fatty materials from the neck of the bottle for extraction.

Method I: For each determination, the fatty materials from three Babcock test columns were aspirated to the bottom of a tared Mojonnier extraction flask through a glass tube. The flask was weighed immediately and the contents subjected to ether extraction.

Method II: The Babcock test bottle neck was plugged with a rubber stopper, nicked, and broken off just below the column of fat. The contents

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[2] Published with the approval of the Director.

were rinsed into an extraction flask with the Mojonnier reagents and extracted. Since the fatty materials could not be weighed directly in this procedure, their weight was calculated by formula (2).

Acid numbers were determined in duplicate according to official methods (1) except that 1- to 2-gram samples were used and the titrations were made with a micro-burette. Fresh neutral butter fat for the acid number determinations described in table 2 was prepared by mechanically separating the milk at 32.3–38° C., churning the raw cream after 16 to 20 hours, melting the butter in a steam bath, filtering the butter fat, and drying it in the Mojonnier vacuum oven.

RESULTS

To ascertain the accuracy of the ether extraction method, milk fat was purified according to the method described by Jenness *et al.* (5). One to

TABLE 1

The efficiency of recovering purified milk fat by ether extraction

Sample	Ether extract	Sample	Ether extract
	per cent		*per cent*
1	99.6321	17	99.8305
2	100.1240	18	99.8925
3	99.6394	19	99.5299
4	99.6632	20	99.7911
5	100.0000	21	98.4833
6	99.2625	22	98.9888
7	99.6226	23	99.6369
8	99.5629	24	98.9614
9	99.2027	25	99.1518
10	99.1922	26	100.2123
11	99.1933	27	100.0100
12	99.2123	28	98.8588
13	99.3918	29	99.6203
14	100.0656	30	99.7393
15	99.9604	31	99.2023
16	98.9822	32	99.8421
Average	.....	.....	99.5143

two grams of this purified milk fat plus 5–6 ml. of water were subjected to ether extraction. The results from 32 determinations shown in table 1 indicate an average recovery of 99.5143 per cent. Fahl *et al.* (3) reported a recovery of 98.5 per cent; their experiment was similar to this one, except that they used smaller amounts of milk fat.

The efficiency with which the fatty materials from the Babcock test are extracted with ether would not be expected to be the same as that with which purified milk fat is extracted, because sulfuric acid liberates some fatty acids that are soluble in ether and because some dilute sulfuric acid remains in the fatty materials. In order to obtain some indication of the composition of the ether soluble fatty materials estimated as fat, acid numbers were determined on the butter fat prepared as described above, on the ether

TABLE 2

The acid number of butter fat, of the ether extract of the materials estimated as fat, and of the materials estimated as fat in the Babcock method

Trial	Acid number as KOH/gm.		
	Butter fat	Ether extract fat	Babcock test fat
	mgms.	*mgms.*	*mgms.*
1	0.59	4.72	7.69
2	0.55	4.34	7.82
3	0.53	4.42	7.90
Average	0.55	4.49	7.80

extract of the materials estimated as fat, and on the materials estimated as fat by the Babcock test from the same milks, 15 ml. of sulfuric acid being used. The fatty materials were aspirated from the test bottle neck (method I) in these experiments. The acid values are expressed as milligrams of potassium hydroxide required (1) to neutralize the acidity of one gram of fat or fatty material.

The results in table 2 of three experiments on different milks indicate that more than half of the acid impurities in the fatty materials are soluble in ether and probably consist of free fatty acids. These results were confirmed in another set of three experiments.

TABLE 3

Ether extractable contents of the fatty materials aspirated from the neck of the bottle in Babcock fat tests of whole milk

Source	Month	No. trials	Fatty materials	
			Milk test	Ether extract
			per cent	*per cent*
Jersey	Oct.	5	5.1850	98.4902
	Nov.	4	5.1729	98.0794
	Dec.	3	4.9084	98.6908
	Jan.	2	5.2750	98.7820
		Mean	5.1353	98.4575
Holstein	Oct.	5	3.7217	98.2274
	Nov.	4	3.1188	98.3555
	Dec.	3	3.0417	98.8333
	Jan.	2	3.4042	98.3570
		Mean	3.3583	98.4123
University composite*	Oct.	5	4.3917	98.5557
	Nov.	4	4.2125	98.0412
	Dec.	2	3.9125	98.6492
	Jan.	2	4.2375	98.6096
		Mean	4.2391	98.4201
Milk plant composite†	Oct.	5	4.1417	98.6330
	Nov.	3	4.1972	98.6885
	Dec.	2	4.0667	98.3631
	Jan.	1	4.0167	99.2548
		Mean	4.1318	98.6556

* Four breeds.
† Forty-five patrons.

Results of determinations of ether extract of the fatty materials removed by method I from Babcock tests on milks from four sources are recorded in table 3. These results are uniform with a true average of 98.4779 per cent ether extract.

It is impossible to aspirate all the fatty materials from the test bottle neck because some adheres to the glass and some is necessarily left at the bottom of the column. To evaluate the effect of this condition, ten trials, each consisting of 32 Babcock fat estimations from the same milk, were conducted. The milk was weighed into the bottles. The finished Babcock tests in each trial were utilized as follows: The fatty materials were removed from the neck of each of eight bottles by method II and extracted; eight fat estimations were made by the regular Babcock method; eight were made using a red mineral oil, glymol, to eliminate the meniscus; and eight were used to obtain the temperature of the fatty materials in the bottles with a copper-constantan thermocouple and a Leeds and Northrup potentiometer. The density, weight, and ether extractable contents of the materials expressed as fat were calculated by formulae (1), (2), and (3) respectively.

(1) $$D = \frac{0.9171 \times 0.99318}{1 + (t - 37.5)\ (75.58 \times 10^{-5})}$$

where: D = Density of fatty materials at t° C. in gms./ml.
0.9171 = Specific gravity of fatty materials at 37.5/37.5° C[3]
0.99318 = Density of water at 37.5° C. in gms./ml.
75.58×10^{-5} = Coefficient of expansion of fatty materials (5) in ml./ml./°C.

(2) $$G = 0.2\ B \times D$$

where: G = Weight of fatty materials in grams.
0.2 = Volume in ml. for each per cent graduation of bottle neck.
D = Density calculated by formula (1) in gms./ml.
B = Babcock test with glymol in per cent.

(3) $$E = 100(W/G)$$

where: E = Ether extractable contents of the fatty materials in per cent.
W = Weight of ether extract of fatty materials in grams.
G = Weight of fatty materials calculated by formula (2) in grams.

An average of 97.8605 per cent ether extract was obtained by this method as shown in table 4. With this technic, it is evident that all the materials estimated as fat are rinsed into the extraction flask. Eight more trials were made using this technic. In each of these the milk was tested in duplicate; the fatty materials were removed by method II and subjected to ether extraction. A mean of 98.0351 ± 0.49 per cent ether extract was obtained.

[3] The average of weekly determinations of specific gravity of fatty materials from Babcock tests of milk from four sources during 1939.

The amount of sulfuric acid specified by official methods is 17.5 ml. of specific gravity 1.82–1.83 at 20° C. In the laboratory of the Vermont Agricultural Experiment Station, the clearest fat columns have been obtained with 15 ml. of sulfuric acid of specific gravity 1.82–1.83 at 20° C. added to the milk at 20–21° C. while 17.5 ml. of acid has resulted in darker fat columns containing variable amounts of charred material. To ascertain the effect of varying amounts of sulfuric acid on the ether extract of the materials estimated as fat, 16 samples of milk were tested using 15 and 17.5 ml. of acid. The fatty materials were removed by method I for ether extraction. The results of this study, recorded in table 5, show slightly lower values for the

TABLE 4

*Ether extractable contents of the fatty materials obtained by removing the neck of test bottles in Babcock tests of whole milk**

Trial	Babcock test with glymol	Materials estimated as fat				
		Temperature	Density	Calculated weight	Ether extract	
	per cent	*°C.*	*gms./ml.*	*gms.*	*gms.*	*per cent*
1	5.5438	50.2	0.9021	1.0000	0.9854	98.5400
2	3.6250	47.4	0.9040	0.6554	0.6373	97.2383
3	3.0812	44.9	0.9057	0.5581	0.5427	97.2406
4	4.6000	46.2	0.9048	0.8324	0.8191	98.4022
5	3.8875	49.4	0.9026	0.7018	0.6902	98.3471
6	7.0562	46.8	0.9044	1.2763	1.2523	98.1196
7	2.0438	44.9	0.9057	0.3702	0.3633	98.1361
8	2.4000	45.9	0.9050	0.4344	0.4195	96.5700
9	4.4750	48.4	0.9033	0.8084	0.7854	97.1549
10	3.5812	48.0	0.9036	0.6472	0.6398	98.8566
Average	4.0294	47.2	0.9041	0.7284	0.7135	97.8605

* All figures in columns 2, 3, and 6 represent averages of 8 replicates.

percentage of fatty materials determined with 15 ml. as compared with 17.5 ml. of acid in the Babcock test, but they also indicate that the percentage of ether extract in these materials was slightly higher when 15 ml. were used.

It was observed, when 17.5 ml. of acid were used, that some of the charred material in the fat column adhered to the neck of the test bottle and thus was not aspirated into the extraction flask. To measure the influence of this factor and to repeat the comparison between 15 and 17.5 ml. of acid, the ten experiments recorded in table 6 were conducted in each of which the fatty materials were removed by method II for extraction. Glymol was used to eliminate the meniscus in replicate tests on the same milks. It was found that after the test bottles had remained in a water bath at 60° C. for 5 minutes, the center of the fat column at a point midway from top to bottom had attained an average temperature of 58.6° C. The density of the fatty materials at this temperature is 0.8965 gms./ml. by formula (1). The weight and ether extractable contents of the fatty materials were calculated by formulae (2) and (3) respectively.

TABLE 5

Effect of 15 and 17.5 ml. of sulfuric acid on the ether extract of the fatty materials aspirated from the neck of the test bottle

Sample	15 ml. H_2SO_4		17.5 ml. H_2SO_4	
	Babcock test	Ether extract	Babcock test	Ether extract
	per cent	*per cent*	*per cent*	*per cent*
1	3.50	99.3903	3.52	97.8900
2	3.52	99.0440	3.62	97.8445
3	3.58	96.4616	3.52	98.9735
4	3.50	98.3977	3.57	97.1091
5	3.50	99.2953	3.55	99.1551
6	3.52	98.8471	3.53	97.9967
7	3.53	99.3478	3.57	98.5507
8	3.50	97.9248	3.52	98.5834
9	4.93	98.3981	4.98	97.9990
10	4.93	98.7365	4.93	96.3855
11	3.22	98.9155	3.22	98.2192
12	3.20	98.7066	3.23	98.2849
13	3.80	95.9216	3.85	98.3796
14	3.82	98.5230	3.87	98.4483
15	3.92	98.1106	3.98	98.2076
16	3.95	98.7684	4.00	96.3876
Average	3.74	98.4243	3.78	98.0259

The results in table 6 verify those in table 5 and show that the ether extract of the fatty materials average lower with 17.5 than with 15 ml. of sulfuric acid. Again slightly lower values for fatty materials were obtained with 15 ml. of acid. Another set of 48 samples of milk was tested in the

TABLE 6

*Effect of 15 and 17.5 ml. of sulfuric acid on the ether extract of the fatty materials that were obtained by removing the test bottle necks**

Trial	Fatty materials							
	Babcock test with glymol		Calculated weight		Ether extract			
					Weight		Per cent	
	A 15.0 ml. H_2SO_4	B 17.5 ml. H_2SO_4	A	B	A	B	A	B
	per cent	*per cent*	*grams*	*grams*	*grams*	*grams*	*per cent*	*per cent*
1	3.575	3.600	0.6410	0.6455	0.6318	0.6257	98.5647	96.9326
2	3.750	3.775	0.6724	0.6769	0.6618	0.6596	98.4236	97.4442
3	3.750	3.750	0.6724	0.6724	0.6589	0.6499	97.9923	96.6538
4	3.700	3.725	0.6634	0.6679	0.6543	0.6458	98.6283	96.6911
5	4.000	4.125	0.7172	0.7396	0.7084	0.7189	98.7730	96.5251
6	3.750	3.725	0.6724	0.6679	0.6564	0.6423	97.6205	96.1671
7	3.575	3.650	0.6410	0.6544	0.6315	0.6276	98.5179	95.9046
8	3.675	3.750	0.6589	0.6724	0.6504	0.6489	98.7100	96.5051
9	3.725	3.775	0.6679	0.6769	0.6555	0.6647	98.1434	98.1977
10	3.750	3.850	0.6724	0.6903	0.6641	0.6676	98.7656	96.7116
Average	3.725	3.772	0.6679	0.6764	0.6573	0.6546	98.4139	96.7733

* All figures in columns 2, 3, 6 and 7 represent averages of duplicates.

TABLE 7

The effect of 15 and 17.5 ml. of sulfuric acid on the acid number of the materials estimated as fat in the Babcock test

Sample	Acid number as KOH/gm.	
	15 ml. H_2SO_4	17.5 ml. H_2SO_4
	mgms.	*mgms.*
1	6.44	8.89
2	7.05	8.45
3	5.83	7.52
4	6.22	8.07
5	6.31	8.31
6	6.92	9.22
7	7.02	8.87
8	6.61	8.61
9	6.70	7.76
10	6.93	8.78
Average	6.60	8.45

same manner and those with 17.5 ml. of acid averaged 0.04 per cent higher; 36 reading higher, 3 the same and 9 lower. The milks tested with 17.5 ml. of acid had darker fat columns which, in some instances, contained charred material. The acid numbers were determined on the fatty materials from individual replicate samples of this series within four hours after they were estimated for fat. The results in table 7 show higher values when 17.5 ml. of acid were used.

TABLE 8

A comparison of the ether extract from the materials estimated as fat by the Babcock method with the ether extract estimated as fat in the Mojonnier method

Trial	Weight sample*	Materials estimated as fat				
		By Babcock method			By Mojonnier method†	Mojonnier minus ether soluble Babcock
		With glymol*	Ether extractable matter*			
	grams	*per cent*	*grams*	*per cent*	*per cent*	*per cent*
1	17.9124	5.5438	0.9854	5.5012	5.6530	0.1518
2	17.9120	3.6250	0.6373	3.5579	3.7764	0.2185
3	17.9048	3.0812	0.5427	3.0310	3.1678	0.1368
4	17.9316	4.6000	0.8191	4.5679	4.6942	0.1263
5	17.9241	3.8875	0.6902	3.8507	3.9698	0.1191
6	17.8624	7.0562	1.2523	7.0108	7.1536	0.1428
7	17.9679	2.0438	0.3633	2.0219	2.1396	0.1177
8	17.9284	2.4000	0.4195	2.3399	2.4962	0.1563
9	17.8651	4.4750	0.7854	4.3963	4.5736	0.1773
10	17.8988	3.5812	0.6398	3.5745	3.7286	0.1541
Average	17.9108	4.0294	0.7135	3.9852	4.1353	0.1501

* Average of eight replicate determinations in each trial.
† Average of duplicate determinations in each trial.

A comparison was made of the ether extract from the materials estimated as fat by the Babcock method with the ether extract designated as fat in the Mojonnier method. This was done by assembling the data from the experiments recorded in table 4 and making comparisons with the Mojonnier estimations for fat on the same samples of milk. The results are recorded in table 8. When the ether extract from the fatty materials estimated by the Babcock test is subtracted from the Mojonnier ether extract, there is an average difference of 0.1501 per cent. This closely approximates the values given by Bailey (2) and by Fahl *et al.* (3) for fatty material left in the bulb of the Babcock test bottle.

It is evident (column 2, table 8) that milk pipettes calibrated to contain 17.6 ml. of water at 20° C. deliver only an average of 17.9108 grams of milk at this temperature. This would result in an underreading of 0.0223 per cent on these samples because the test bottle is calibrated for an 18 gram charge. Bailey (2) found that pipettes calibrated to deliver 17.6 ml. of water at 20° C. in 5–8 seconds, delivered only 17,924 grams of milk at 21.1° C. when they were allowed to drain for two to three seconds after the flow of milk ceased.

DISCUSSION

When 15 ml. of sulfuric acid were used in the Babcock method, the ether extracts of the materials estimated as fat from the four sources showed quantitative uniformity (table 3). It is evident that 17.5 ml. of acid of specific gravity 1.82–1.83 yields higher fat estimations but lower percentages of ether extract, due to the inclusion of more acid and charred impurities, as compared with 15.0 ml.

The method of obtaining the fatty materials affected the amount of ether extract. When 15.0 ml. of acid were used, aspiration of the fatty materials into the extraction flasks in 68 trials resulted in an averaged recovery of 98.4653 per cent ether extract while removal by breaking off the bottle neck in 28 trials resulted in an averaged recovery of 98.1080 per cent. Similarly, when 17.5 ml. of acid were used, the recovery of ether extract was 98.0259 per cent in 16 trials by aspiration and 96.7733 per cent in 10 trials by the method of breaking off the bottle neck. A difference is to be expected, because by removal of the neck, impurities associated with the fat column that adhere to the glass are included, but these impurities are not included by aspiration of the fatty materials into the extraction flask. Furthermore, the bottom of the fat column is curved when estimated, but the calculations made by formula (2) assume that it is horizontal.

SUMMARY

1. In Babcock tests in which 15.0 ml. of sulfuric acid of specific gravity 1.82–1.83 were used the ether extract of the fatty materials aspirated from the bottle neck averaged 98.4653 per cent as compared with 98.1080 per cent when these materials were removed with the bottle necks.

2. Higher estimations for fat by the Babcock method, but lower percentages of ether extract from the materials so estimated, were obtained with 17.5 ml. than with 15.0 ml. of sulfuric acid of specific gravity 1.82–1.83.

3. Approximately 57 per cent of the acid impurities in the fatty materials in the Babcock "fat" column, were soluble in ether, as judged by the acid number of this material and that of its ether extract in comparison with the acid number of butter fat. Use of 17.5 ml. of sulfuric acid yielded larger amounts of acid impurities in the "fat" column than use of 15.0 ml.

4. A reconciliation between the Babcock and Mojonnier methods on an ether extract basis yielded a difference of 0.1501 per cent in favor of the Mojonnier method.

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ABSTRACTS OF LITERATURE

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Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEW

351. Ultra-Violet Light and Its Applications. H. C. DAKE AND JACK DEMENT. Chemical Publishing Co., Brooklyn, N. Y. 209 pp., including short glossary, list of sources of supplies, bibliography, and index. $3.25.

The subject material is divided into 8 chapters, which include applications to: Criminology and Police Science; Military Applications; Advertising; Medical Sciences; Microscopy; Chemistry; Spectroscopy; Petroleum and Mining. It is presented for the greater part in condensed form, wherein the possible applications of ultra-violet radiation and fluorescence are cited without inclusion of sufficient of the details of procedure by which the applications may be made. An exception to this is in the section on Chemistry wherein quantitative procedures are given for identification of a large number of both organic and inorganic substances. The physico-chemico process by which fluorescence occurs is not presented. The probable use of this text to those engaged in dairy technology lies principally in the suggestions that may be gleaned from the large number of applications cited, since the present use of ultra-violet radiation in the dairy field is limited principally to milk irradiation and a few analyses. K.G.W.

BACTERIOLOGY

352. Two-Stain Method for Direct Bacteria Count. P. H. H. GRAY, Dept. of Bact., Macdonald Col., McGill Univ., Quebec, Canada. Jour. Milk Technol., *6*, No. 2: 76. Mar.–Apr., 1943.

A new two-stain solution has been developed with special reference to differentiating capsules on bacteria. It has also been found to be applicable to staining milk films, but it has not been tested in routine bacterial milk counts. It does have an apparent advantage over the Breed and Newman-Lampert stain in that there is no eyestrain in picking out the cells. The bacteria and other cells are stained blue against a pink background. It is easier to prepare than the Broadhurst-Paley stain. Preparation is as follows:

Solution A.	1.0% aqueous methylene blue	50 parts
	Methyl hydrate (methyl alcohol)	50 parts
Solution B.	1.0% aqueous basic fuchsin	25 parts
	Methyl hydrate	25 parts

Mix solution A and B. L.H.B.

353. Loss of Lactose Fermentative Power by Coliform Bacteria. LEONARD I. KATZIN, MARY E. STRONG, MARY MACQUIBBEN AND MARILYN ITZKOWITZ, U. S. Pub. Health Serv., Bethesda, Md., and N. Y. A., Norfolk, Va. Jour. Milk Technol., *6*, No. 1: 17. Jan.–Feb., 1943.

Heat treatment (pasteurization temperature) and use of 0.85% saline solution for diluting a culture for counting may have a significant effect upon the ability of coliform bacteria to ferment lactose.

Experiments are cited showing this to be the case. After treatments above mentioned heavy growths were sometimes noted in inoculated lactose fermentation tubes without any gas formation. Further investigation proved these growths to be Gram-negative rods, and some of them upon cultivation again fermented lactose. L.H.B.

354. A Comparison of Various Methods for Detecting Thermoduric Bacteria in Milk. J. B. FISCHER AND C. K. JOHNS, Dept. of Agr., Ottawa, Canada. Jour. Milk Technol., *5*, No. 5: 269. Sept.–Oct., 1942.

Comparisons were made of the following methods using the standard agar plate count as a yardstick:

1. Meyers and Pence tube method.
2. Hileman and Leber microscopic method.
3. Mallman, Bryan and Fox microscopic method.
4. Wainess resazurin method.

The authors concluded that the Meyers and Pence tube method gave results closer in agreement with the standard plate count than did either of the other methods studied. Also, it appears to be more convenient than either the standard plate or the microscopic method, and has an advantage over the plate count in time, media, glassware, and incubator space saved.

They obtained poor results with both of the microscopic methods, and failed to find any correlation between the resazurin test and the plate count for detecting the presence of thermoduric organisms. L.H.B.

BREEDING

355. Valuation of Dairy Animals. A. A. HARTMAN, C.P.A., Assoc. with Everts and Esenoff, Certified Public Accountants, San Diego, Cal. Jour. Milk Technol., *5*, No. 6: 336. Nov.–Dec., 1942.

A method for determining the cost of dairy animals is given so that the cost of an animal at the time it goes into the milking herd may be obtained. Calf and heifer costs are determined separately. Such costs are of value for income-tax purposes. L.H.B.

356. Maintaining Herd Replacements. J. W. BARTLETT, N. J. Agr. Expt. Sta., New Brunswick. Cert. Milk, *18,* No. 205: 5. May, 1943.

This article is a timely discussion of factors which have a bearing on keeping down costs of herd replacements, which is now more difficult than ever before. The factors discussed are: (1) herd health, (2) artificial insemination, (3) housing methods and costs of maintaining young heifers, and (4) the present shortage of protein feeds. W.S.M.

BUTTER

357. Surface Taint Bacteria in Ontario Butter. A. H. WHITE, Dept. of Agr., Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *22,* No. 4: 27. 1943.

P. putrefaciens was isolated from Ontario print butter with flavor defects that were described as "unclean" as well as from a sample having the typical surface taint flavor. The same organism was found in a drain in the floor of a creamery and in well-water of apparently good quality. The surface taint organism was also isolated from print butter showing extensive discoloration caused by *P. nigrifaciens,* which suggests a close association of the two organisms. O.F.G.

358. Fibre Butter Boxes. R. W. BROWN AND T. L. FORESTER, Univ. of Manitoba, Winnipeg, Manitoba. Canad. Dairy and Ice Cream Jour., *22,* No. 4: 21. 1943.

Experimental trials showed that there were no pronounced differences in the flavor of butter packed in fibre boxes and standard spruce boxes. Shipping tests showed that the fibre boxes stood up well if the butter was firmed previous to shipping. The fibre box possesses the advantage of economy and conservation of scarce materials and shipping space and costs approximately 12 to 15 cents less than the spruce box. O.F.G.

359. Early Experiences in Buttermaking in the West. L. R. SUTHERLAND. Canad. Dairy and Ice Cream Jour., *22,* No. 3: 54. 1943.

This article is a brief historical account of the development of the butter industry in western Canada, mainly in the Province of Manitoba, written by a practical dairyman. It describes the gradual improvement which has taken place since the early 1900's when the equipment consisted of a small twin vat for holding cream, a small cheese vat, a box churn with a trunk lid, a Mason worker and a Babcock tester. O.F.G.

360. Wooden Churn Barrels. H. R. THORNTON, D. H. MCCALLUM AND F. W. WOOD, Univ. of Alberta, Edmonton, Alberta. Canad. Dairy and Ice Cream Jour., *22,* No. 3: 25. 1943.

This article summarizes certain information on the sanitation and de-

terioration of wooden churn barrels. On churn sanitation it has been shown that:

1. Maximum keeping quality of butter can be expected to follow only maximum churn sanitation.
2. Heat treatment is superior to chemical treatment.
3. The maximum heat treatment feasible in practice leaves much to be desired in the sanitary condition of the churn.
4. The maximum practical heat treatment is the daily application of sufficient water at or near the boiling point to half-fill the churn. The churn should be revolved with the rollers in gear for 15 to 30 minutes.

If the churn barrel deterioration is in any way caused by high temperatures of water, which is not yet proved, the operator will have to choose between a loss in butter quality or a loss in churn service. O.F.G.

361. The Cause and Control of Surface Taint Butter. Part I. Cause (Continued). H. WOLOCHOW, H. R. THORNTON AND E. G. HOOD, Dept. of Agr., Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 11: 46. 1942.

The evidence seems clear that the butter defect known in Canada as surface taint may be caused by either *P. putrefaciens* or *F. maloloris* and that the former organism is the more important causal agent. The following conditions seem to be necessary for the appearance of the defect in butter of normal composition and texture:

1. Use of churning cream of fairly low acid and high heat treatment.
2. Presence of surface taint bacteria in sufficient numbers.
3. If diacetyl is present, it must be in concentrations below the point of inhibition in relation to the number of bacteria.
4. Provision of opportunity for certain unknown chemical reactions at the surface or within the surface layers of the butter. O.F.G.

362. The Cause and Control of Surface Taint Butter. Part II. Control. D. H. MCCALLUM, E. G. HOOD, H. R. THORNTON AND H. WOLOCHOW, Dept. of Agr., Edmonton, Ontario, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 11: 58. 1942.

Since the surface taint bacteria are soil-and-water-borne, they will be carried into the creamery by (1) dust, soil and other dirt, (2) raw cream, and (3) water supplies. Rigorous plant sanitation, efficient pasteurization, prevention of recontamination of cream, treatment of water supplies and sterilization of printing equipment and wrapping material are essential for the control of the defect. O.F.G.

363. The Cause and Control of Surface Taint Butter. Part I. Cause. H. WOLOCHOW, H. R. THORNTON AND E. G. HOOD, Dept. of Agr.,

Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 10: 21. 1942.

That "surface taint" of butter and "sweaty feet" odor of heated milk are likely identical arises from the following considerations:

1. Odor produced by *P. putrefaciens* in high-temperature pasteurized milk, cream or butter serum is the "sweaty feet" odor.
2. Odor invariably produced by the same organism in high-temperature pasteurized-cream butter is the surface taint odor.
3. There is considerable organoleptic similarity between the two odors.
4. The relation of odor production to heat-treatment is the same for milk, cream and butter.
5. Lipolysis by this organism has not been demonstrated.

The cause of surface taint in butter seems to be some substance produced by *P. putrefaciens, P. florescens* or *F. maloloris,* the former being most prevalent. *P. putrefaciens* has been isolated from soil, water, milk, cream, butter, floors and sewers. Contrary to popular belief, surface taint is not due to "over-neutralization" since considerable acidity acompanies the development of the off-flavor. Experimentally it was found that *P. putrefaciens* has a high salt tolerance, does not produce the "sweaty feet" odor in litmus milk previous to reduction of litmus and grows over a wide range of temperature. O.F.G.

CHEESE

364. It Takes a Well-Made Cheese to Meet Export Requirements. J. C. MARQUARDT, N. Y. Agr. Expt. Sta., Geneva, N. Y. Food Indus., *17,* No. 6: 63. June, 1943.

This article presents some of the essentials in the production of export cheese. A history of our export trade is given. There is also included material which explains texture and moisture variations which have resulted with changes in our export trade.

Exact details for making quality, low moisture export type are presented.

It is stated that 1.5 to 1.7 is a desired salt percentage. Export cheese with 1.2% of salt is undesirable.

Two tables are given which give the weight losses of cheese before and after paraffining. These give a liberal range and are typical for one set of conditions. They offer a guide to reducing slightly high moisture cheese by delaying the paraffining process. Most important, however, is the fact that the article states that these losses must be individually determined for factories and storages.

Although the standards allow 39% moisture, a 37% moisture is recommended. From a quality standpoint, moisture percentages below 35 have little or no value. With subsidy payments there may be an advantage in having moistures below 37. J.C.M.

365. The Manufacture of Cultured Buttermilk and Cottage Cheese. E. L. FOUTS AND L. E. MULL. Fla. Agr. Expt. Sta. Bul. 382. Jan., 1943.

Standard procedures for the manufacture of cultured and churned buttermilk and cottage cheese are given. The equipment needed and suggested time schedules for the manufacture of each of these products is also listed. P.H.T.

366. The Methylene Blue Test. E. G. HOOD, C. A. GIBSON AND I. HLYNKA, Dept. of Agr., Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *22*, No. 2: 30. 1943.

This article reports studies on the relation of milk quality as judged by the methylene blue test to the grade of Cheddar cheese. As the methylene blue test does not differentiate between relatively harmless or beneficial bacteria and those which adversely affect the quality of the cheese, no value as a practical test for assessing the bacteriological quality of cheese milk was found as a result of the investigation. The methylene blue test, therefore, should not be used for grading milk to be used in cheese manufacture. O.F.G.

367. The Importance of Cheese in the Food Economy. W. H. SPROULE, Ontario Agr. Col., Guelph, Ontario. Canad. Dairy and Ice Cream Jour., *22*, No. 2: 27. 1943.

Experimental investigation shows that cheese is a food of high nutritional value. It is an excellent source of highly digestible protein and is high in energy value because of its high fat content. Most of the sugar of the original milk is lost and this is also true of vitamin B_1. Results presented show that Canadian Cheddar retains approximately 60% of the calcium, 50% of the phosphorus and 20% of the riboflavin originally present in the milk. O.F.G.

368. What Constitutes Quality in Milk for Cheddar Cheese. I. HLYNKA AND E. G. HOOD, Dept. of Agr., Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *21*, No. 9: 19. 1942.

Milk for the manufacture of Cheddar cheese should have its own criteria of quality. Cheese milk need not have the same high quality as market fluid milk. It may be desirable to have a moderately high population of lactic acid bacteria. The relation between the initial milk flora and that of the added starter should be considered. Types as well as numbers of organisms should be known in order to control the quality of the cheese. Eleven tests which have been advocated for assessing the bacteriological quality of milk cheese are discussed and it is suggested that their suitability as practical tests should be more firmly established. Oxidized flavor is not of serious

concern in the manufacture of cheese since the large number of organisms keep the oxidation-reduction potential low. The measurement of titratable acidity is not entirely satisfactory since it does not differentiate between lactic acid and apparent acidity due to certain natural milk components. A definition of high quality cheese milk cannot be propounded until further study has been conducted and better methods of testing have been devised. O.F.G.

369. Granular Type Cheese Saves Time, Labor and Equipment. J. C. MARQUARDT, Geneva, N. Y. *Food Indus., 15, No. 5. May, 1943.*

This article describes the method for making Granular type cheese. The procedure is much like that in making Cheddar cheese. Normally consumers cannot distinguish between the two types.

During the emergency under certain conditions it is desirable to make Granular type cheese. It saves time, labor and equipment.

The cheese should contain 61.0% of solids or more. The fat content should range from 31.5 to 33.0. These values are for the cheese when fresh.

The article gives methods for making tests to indicate the proper firmness of the curd.

Laboratory and factory trials have indicated that this cheese is at its best when made from milk testing 3.7 to 3.9% of fat.

The article gives the important points in stirring and salting this type of cheese.

This article also contains a brief account of the development of Granular and Cheddar type cheese in our country. J.C.M.

CHEMISTRY

370. A Simple Method for the Approximate Estimation of the Isoelectric Point of Soluble Proteins. WERNER G. JOFFE, Dept. of Chem., Biochem. Inst., Caracas-Los Rosales, Venezuela. Jour. Biol. Chem., *148,* No. 1: 185. 1943.

"A series of buffers is prepared at intervals of 0.2 on the pH scale. To 2 cc. of each buffer solution there are added 5 drops of a 0.1% solution of a suitable cationic wetting agent, such as a mixture of higher alkyl di methyl benzylammonium chlorides (Zephiral, marketed by Alba Pharmaceutical Co., Inc.), and enough of an aqueous solution of the protein to be tested to give a final protein concentration of about 10 mg. per cc. The pH of the most acid mixture to yield a precipitate is the indicated isoelectric point. Any change in pH produced by the addition of detergent and protein solutions may be neglected unless the protein had been dissolved in acid or alkali in which case the pH of the final mixture should be verified potentiometrically." The buffers used in the above procedure were phosphate-citrate mixtures. K.G.W.

371. **The Unsaturated Fatty Acids of Hydrogenated Shortening and Other Edible Fats.** J. T. R. ANDREWS AND A. S. RICHARDSON, Chem. Div., Procter and Gamble Co., Cincinnati, O. Oil and Soap, *20,* No. 5: 90. 1943.

Two hundred and twenty-seven samples of edible fats, including lard, butter, margarine and other available cooking and shortening fats were obtained from seven geographically dispersed cities in the United States. These were analyzed for iodine and thiocyanogen values, percentage of linoleic, oleic and saturated fatty acids. The average percentage of glyceride derived from linoleic acid in these products increases in the order: butterfat, margarine, lard, hydrogenated shortening, and blended shortening containing some hydrogenated fat or animal fat as stiffening agent, as shown in the following table:

	Lard	Butter	Margarine	Hydrogenated (100%)	Hydrogenated (<100%)	Mixed animal & vegetable
No. of samples	27	41	57	60	31	11
High	13.7	4.8	23.4	22.4	38.2	26.2
Low	6.5	1.4	1.3	2.9	4.7	10.4
Median	11.8	3.3	9.9	12.8	21.5	23.2
Average	11.7	3.3	10.9	12.6	22.0	20.6

K.G.W.

DISEASE

372. **An Epidemic of Food Poisoning Due to Pasteurized Milk.** FRED W. CANDILL, M.D., M.P.H., Dir., Div. of Communicable Disease, State Dept. of Health of Ky., and MELVIN A. MEYER, State Sanit., Bur. of Foods. Jour. Milk Technol., *6,* No. 2: 73. Mar.–Apr., 1943.

This outbreak occurred in May, 1942, in a central Kentucky town of 8,000 population. All affected had nausea, vomiting, varying degrees of prostration, and a few had diarrhea. Those chiefly affected were children. All cases obtained milk from one dairy. This dairy received its milk from four herds of 102 cows; 42 of the cows showed the presence of non-hemolytic staphylococci in their milk. The organisms from two of three specimens, which gave abundant growth, were found to be toxin producers. Sanitary conditions in the barns and pasteurizing plant were poor. Milk both before and after pasteurization was inadequately cooled. The afternoon milk was held overnight in the raw state at a temperature ranging as high as 76° F. Pasteurization of the milk the next morning apparently killed the bacteria, as none were found in the pasteurized milk on the day most of the illness occurred, but the temperature of pasteurization apparently did not destroy the toxin.

The attack rate among individuals obtaining milk from this dairy was 28.6 per 100. L.H.B.

373. **Staphylococcic Food-Poisoning and Dairy Products.** RAYMOND V. STONE, SR., Dir. of Laboratories, Los Angeles Co. Health Dept., Los Angeles, Cal. Jour. Milk Technol., *6*, No. 1: 7. Jan.–Feb., 1943.

Reference is made to 23 outbreaks of food poisoning from 1914–1942 in which dairy products were involved, and in which staphylococci were the probable etiological agent. The total mentioned cases reported were 1332; these are the minimum number of cases involved in 19 of the 23 outbreaks.

Ice cream has been found to be involved in a number of cases of staphylococci food poisoning, but it has been observed that when ice cream has been involved, it has been due to either the custard-containing French vanilla type or else it was institution- or home-produced.

Cheese may be concerned in such outbreaks, but in Los Angeles County they have had little experience with cheese. One case is cited, however, involving Jack cheese, which it was found could have been contaminated and incubated in the consumers' kitchen. It has been reported, however, that the staphylococcus toxin could remain active in cheese made from contaminated milk.

In practically every instance where butter was involved it was due to some modification of butter, such as Hollandaise sauce, where there was plenty of opportunity for contamination and subsequent incubation.

Raw milk was involved seven times and it was found that there was mastitis and shedding of staphylococci by the cows in the herds involved. Failure to cool the milk to 50° F. or lower and hold at that temperature from time of production until consumed offered opportunity for incubation in most cases.

One outbreak due to pasteurized milk was reported, but investigation showed that the milk was probably contaminated after pasteurization by individuals employed in the plant who were found to be harboring similar organisms in their respiratory tract.

Two cases of heat-processed milk were also reported as being involved. One was an instance of gallon cans of evaporated milk which apparently had not been properly processed. "The canner acknowledged difficulty in recent conversion of plant equipment to handle the larger gallon receptacle." The other case was of dried milk; this milk was exposed in an open barrel which undoubtedly was the cause for its contamination.

The author concludes that, "The majority of dairy-product-involved outbreaks of staphylococci food-poisonings were due to failures in either promptly obtaining and maintaining adequate cooling or the lack of protection to the food or its ingredients from possible contamination and incubation." L.H.B.

374. A Milk-Borne Epidemic of Brucellosis. J. R. JENNINGS, Iowa State Dept. of Health, Des Moines, Ia. Jour. Milk Technol., *5*, No. 5: 339. Nov.–Dec., 1942.

In the fall of 1941, Marcus, Iowa, a town of 1200, had an outbreak of brucellosis. The town is supplied by four dairies, none of which pasteurized their milk. The health department records show 77 cases, all substantiated by agglutination and skim test. All cases regularly or intermittently used milk from one dairy. This dairy supplied about 40% of the milk, and theoretically 480 persons were exposed. On this basis about 21% of those exposed were infected.

All four herds were tested for Bang's disease. Three were free of the disease, while the fourth herd, the one suspected, had three reactors out of a herd of 41 cows. A survey of the farm showed that hogs had access to the cow yard and that most of them harbored the infection.

Organisms of the porcine strain were isolated by the State Department of Epidemiology from milk, from the blood of the persons affected and from the animals. L.H.B.

375. Relation of the Number of Leucocytes in Milk to Streptococcus Infections of the Bovine Udder. G. J. HUCKER, N. Y. Agr. Expt. Sta., Geneva, N. Y. Jour. Milk Technol., *5*, No. 6: 323. Nov.–Dec., 1942.

In a study of 30,331 leucocyte counts made on milk from 8,000 cows, it was found that about 68% of the counts were less than 100,000 per cubic centimeter, 20% were over 500,000, and 10% over 1,000,000 per cubic centimeter.

"It should be indicated that the 68% of all the samples which contained less than 100,000 cells per cubic centimeter were secured from udders which were as near normal as could be encountered among dairy cattle. When abnormalities appeared, the leucocyte count immediately increased."

As the cell count increased, the possibility of finding streptococci increased.

In one group of 104 cows examined weekly over a period of two to four lactation periods by taking samples of foremilk and examining while fresh, it was found that 98% of the individuals in which 500,000 leucocytes per cubic centimeter were present in the samples discharged streptococci at some time during the lactation period. A relationship between the number of leucocytes and a reaction to brom thymol blue was noted.

It was observed that a larger percentage of cows that were machine milked had high leucocyte counts and more of the samples showed the presence of streptococci than did comparable samples from cows milked by hand. L.H.B.

FEEDS AND FEEDING

376. Cow Cafeteria Aids Plant Breeder in Evaluating New Grasses. G. W. BURTON AND B. L. SOUTHWELL, Bur. Plant Indus., U. S. Dept. Agr., and Ga. Expt. Sta., Tifton, Ga. Cert. Milk, *18*, No. 202: 5. Feb., 1943.

Forage research workers recognize the importance of palatability in their search for better pasture plants, particularly for dairy cows, where the maximum food consumption is desired. The cow cafeteria was developed as an economical test for determining the palatability of a large number of plants. This cafeteria usually consists of one or more plots of each pasture species planted at random and enclosed together within one fence. Palatability information is obtained by allowing animals to graze at will and the amount of forage removed from each plot may be used as an index of the relative palatability of each species. The distribution of the animals on each plot may also be recorded at regular intervals and used as an index for relative palatability.

By the cafeteria method it was demonstrated that cows have a distinct preference for woolly finger grass when compared with Bermuda grass. Pearl or Cattail millet was found to be less palatable than Sudan grass. In testing various strains of Pearl millet, it was found that the finest stemmed strain was the least palatable; a result quite contrary to general opinion. New strains of Bermuda grass were found to be as palatable as common Bermuda grass because of their greater productivity.

The cow cafeteria did not always give a true picture of the value of a pasture plant, because cows must acquire a liking for the peculiar taste of some plants, such as sweetclover. In spite of these limitations, it is concluded that the cow cafeteria appears to be the most effective economical method for evaluating many new strains of grass. W.S.M.

FOOD VALUE OF DAIRY PRODUCTS

377. Nutritive Value of Milk Proteins. C. H. WHITNAH, Kans. Agr. Expt. Sta., Manhattan, Kans. Food Res., *8*, No. 2: 89. Mar.–Apr., 1943.

Digestibility and biological value of milk proteins were measured by the method of Mitchell. Cows fed different quantities and qualities of protein produced milk containing protein of uniformly high digestibility and biological value. Average values of 93.4 and 90.5 were obtained for fresh raw milk, 90.9 and 87.8 for experimental evaporated milk and 91.8 and 89.4 for commercial evaporated milk, respectively. Neither irradiation nor storage of evaporated milk, up to 14 months, had any effect on the values. Digestibility and biological value of the milk protein bore no relation to the stage

of lactation of the cows. It was possible to preserve milk samples with formalin or formalin plus superoxol at 5° C. for two weeks or at – 15° C. for three weeks without affecting the digestibility or biological value indices of the protein of samples of milk. F.J.D.

378. The Value of Dairy Products in Nutrition. III. The Riboflavin, Pantothenic Acid, Nicotinic Acid and Biotin Content of Several Varieties of Cheese. R. A. SULLIVAN, E. BLOOM AND J. JARMOL, Kraft Cheese Co., Chicago, Ill. Jour. Nutr., *25,* No. 5: 463–470. May, 1943.

The cheese samples used in this investigation represented 12 varieties. Four were processed cheeses and one was a dried, grated product. All others were natural cheeses. The Roquefort type was a domestic blue cheese prepared from cow's milk.

There was no marked difference observed in the riboflavin content of the various types of cheese. Velveeta (processed) showed increased amounts of the B-complex vitamins due to the inclusion of whey. Limburger, Camembert and Roquefort showed 15.5, 20.0 and 0.122 micrograms per cent of pantothenic acid, nicotinic acid and biotin, respectively, on the dry basis. These high values were due to the different processes of ripening. The increase in the amounts of these vitamins in Limburger cheese during the ripening process was marked. C.F.H.

379. Depressive Effects Produced on Appetite and Activity of Rats by an Exclusive Diet of Yellow or White Corn and Their Correction by Cod Liver Oil. CURT P. RICHTER AND KATHERINE K. RICE, Phipps Psychiatric Clinic, Johns Hopkins Hosp., Baltimore, Md. Amer. Jour. Physiol., *139,* No. 1: 147–154. May, 1943.

Female rats on an exclusive yellow corn diet for a period of 85 days showed a gradual loss of appetite, a scarce maintenance of starting body weights, a great loss of activity, and development of a diestrous condition of the vaginal mucosa. They did not, however, show any other signs of specific nutritional deficiency in this time. The feeding of cod liver oil resulted in an almost immediate increase in appetite, body weight, and activity while normal estrous cycles reappeared within 4 days.

Female rats on an exclusive white corn diet for a period of 85 days showed a similar picture, with the exception that after 45 days the cells of the vaginal smears became constantly cornified, and after about 76 days the upper teeth became worn and the lower teeth overgrown. They also showed deficiency symptoms of the eyes and hair. The supplementing of the white corn with cod liver oil had only a slight effect on activity, appetite, and

weight increase. The vaginal smears were changed from a condition of constant cornification to one of constant diestrous.

In white corn there is almost certainly a deficiency of vitamin A, as well as of the factor lacking in yellow corn, both of which are corrected by the cod liver oil supplement. Moreover, there is evidence to indicate that yellow corn contains some factor lacking in white corn and not present in cod liver oil. D.E.

380. Destruction of Vitamin B_6 (Pyridoxine) by Light. (A note to the editor.) M. HOCHBERG, D. MELNICK, L. SIEGEL AND B. OSER. Food Res. Labs., Inc., N. Y. Jour. Biol. Chem., *148,* No. 1: 253. 1943.

Marked instability of pyridoxine in aqueous solution in open beakers exposed 8 inches from artificial light from a 300-watt bulb with reflector and to natural light, for varying periods, was noted. The temperature varied from 35–40° C., and 15–20° C., respectively. Losses amounting to 32, 48, and 56% were noted after 12, 24, and 36 hours exposure to natural radiation, and losses greater than these when exposed to artificial radiation. The solutions examined were at pH 6.8. It is probable these observations may have some application to stability of pyridoxine in bottled milk, though no mention was made of this in the letter. K.G.W.

381. New Developments in Nutrition Research, Part I. C. A. ELVEHJEM, Univ. Wis., Madison, Wis. Cert. Milk, *18,* No. 203: 5. March, 1943. Part II. Cert. Milk, *18,* No. 204: 5. April, 1943.

An address given at National Dairy Summer Conference, Chicago, June, 1942, which reviews recent laboratory findings in nutrition and the possible application of these newer results. The most striking advance during the past year or two relates to improved methods of determining the following vitamins in foods: B_1, riboflavin, nicotinic acid, B_6 and pantothenic acid. No significant improvements have been made in the estimation of other vitamins, although some consideration has been given to vitamin A. It is emphasized that adequate diets cannot be calculated or consideration given to fortification programs unless the distribution of vitamins in foods is known accurately. Some progress has been made in further studies on the functions of the B vitamins.

At the present time the need of additional vitamins for humans is not clear, because the evidence for such needs must be based upon animal studies, and the number of additional factors needed depends entirely upon the kind of experimental animals used. Additional substances which have been found to be essential for some animals are: choline, biotin, inositol and folic acid. Since some of these new factors are destroyed during processing, the use of natural foods is emphasized. W.S.M.

HERD MANAGEMENT

382. The Job of Milking. G. H. Hopson, Vet., De Laval Separator Co., New York. Certified Milk, *18*, No. 205 : 7. May, 1943.

This is an enlightening article dealing with the various phases of the job of milking. Numerous figures are given, showing the tremendous amount of labor involved in harvesting the milk crop twice daily. It is pointed out that the knowledge of the physiology of milk secretion and milk ejection has not kept pace with the great strides in the breeding of cattle and in the handling of milk. When milking, animal health should be considered, not only from the standpoint of milk quality and safety but for the reason that healthy udders milk more easily, quickly, and produce more milk. The following principles are given, which should be considered in the job of milking:

1. The herd should be classified, so that if infected animals are present they may be housed separately or placed at one end of the line, to be milked last.
2. Milking should be done by those who enjoy and appreciate cows.
3. Cows should be milked at the same time each day, both morning and evening.
4. Just before milking udders and teats should be wiped with a warm cloth moistened in a warm (100° F.) chlorine solution or soapy water.
5. As the milker sits down to the cow, or just before the teat cups are applied, a few streams of milk should be milked into a strip cup.
6. The actual milking operation should not take longer than four minutes average.
7. Hands of the milker and teat cups should be rinsed or dipped in a chlorine solution (250 ppm.) before milking each cow.
8. Stripping either by hand or machine is merely a formality of inspecting the udder to determine if the animal has been milked clean. Less and less importance is being attached to stripping if the modern practice of milking is adhered to.
9. The dipping of the teats after milking is a strongly recommended practice.
10. Milking machine sanitation is very important. W.S.M.

ICE CREAM

383. Storing Frozen Cream. T. R. Freeman, L. E. Mull and E. L. Fouts. Fla. Agr. Expt. Sta. Bul. 383. Feb., 1943.

This bulletin is based upon data obtained on three lots of cream produced on successive days (June 5, 6 and 7, 1941). The cream was stored in sealed tin cans at approximately 0° F. Periodically, samples of the stored cream were used as the entire source of fat in the manufacture of

experimental mixes. Ice cream of satisfactory quality was made from experimental cream seven months old. Homogenization of the cream before storage was of no advantage in preventing an oxidized flavor from developing in the stored cream. Avenex (1.5%), Avenex concentrate (0.1%) and trypsin (.003%) were of equal value as anti-oxidants in the stored cream. Ascorbic acid resulted in the formation of a cooked flavor. There was less cooked flavor in cream containing added copper.

No relationship was found to exist between oxidized flavor and oxidation-reduction potential in stored cream when the two were determined at the same time. However, a direct relationship was found to exist between the change in potential during storage and the intensity of the oxidized flavor at the end of the storage period. The importance of preventing metal contamination of cream to be stored was stressed. P.H.T.

384. The Control of Product and Material Costs in the Ice Cream Plant. C. J. ENGLAND, Silverwood Dairies, Ltd., London, Ontario, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 11: 32. 1942.

This paper was revised for publication from a talk presented before the annual meeting I.A.I.C.M. in 1941. Such items as the price of milk and cream, testing, efficient use of labor, use of electric power, and refrigeration are discussed. Shortages of butterfat may be accounted for by incorrect weighing-in, probability of test samples not being representative and improper record of transfers between departments. O.F.G.

385. Sweeteners for Ice Cream. A. H. WHITE, Sci. Serv., Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 10: 44. 1942.

Various methods for stretching the sugar supply for ice cream are discussed. The amount of sweetening used in the mix may be reduced to give a less sweet ice cream or sucrose may be supplemented with other sweetening agents. Canadian law now permits the use of such sweeteners as glucose, corn syrup, etc., up to 25% of the total sweetening use. Conversion of cane or beet sugar to invert sugar will give greater sweetening for an equivalent quantity of sucrose. Honey can be used if not more than 2% of the mix, but does not always blend well with other flavors. Dextrose or glucose is only 70 to 80% as sweet as sucrose but can replace sucrose in ice cream at the rate of 1.1 to 1.2 lbs. per lb. of sucrose. The use of this sugar means that a lower freezing temperature is necessary. O.F.G.

386. War-Time Ice Cream Problems. E. C. SCOTT, Res. Laboratories, Swift & Co., Chicago, Ill., Jour. Milk Technol., *6,* No. 1: 30. Jan.–Feb., 1943.

The major production problems of today are:

1. Labor.

2. Equipment.
3. Simplification of production schedule.
4. Ingredients and supplies.

Labor. The labor shortage is acute. Versatile workers are of great importance today. Individuals should be trained for several jobs. A sound industrial relations program is essential.

Equipment. Proper care and maintenance is vital. "An ounce of prevention is worth a pound of cure."

Simplification of production schedule. Flavors must be limited, and shortages of some of the flavors used may mean changing the assortment frequently. Novelties and specialty items wherein man-hour production is small should be limited.

Ingredients and supplies. Shortages of dairy products available for ice cream manufacture has been "spotty" and mostly of a temporary nature, chiefly in those territories close to large army cantonments.

Shortage in sugar allotments have been made up largely by the use of corn sugar, corn syrups and corn syrup solids.

Invert sugar has been successfully used. The author reports obtaining an increase in sweetness of 23 to 25% when sugar is 95 to 100% inverted.

Another method for meeting this shortage has been to reduce the sweetness of ice cream to about 13% (sucrose basis).

The method suggested by Leighton and Williams, of the Bureau of Dairy Industry, U. S. Department of Agriculture, is also mentioned. This method is to maintain one part of sugar to five parts of water in the mix.

No substitute has been found for chocolate, so ways for stretching the available chocolate over a greater volume of product is necessary. A saving of 25 to 30% of the chocolate flavoring can often be affected by reducing the sugar content of the mix.

Flavor boosters are also being used to a limited extent to intensify the chocolate flavor.

Domestic fruits and nuts will be used to greater extent to replace imported flavors.

Many manufacturers may turn to the use of some of our less commonly used fruits at this time.

Stabilization of mixes is of more importance than ever. Ample supplies of the common stabilizers are available.

The vanilla situation is not improving. Coumarin has been withdrawn from the market. L.H.B.

MILK

387. The Resazurin-Rennet Test. J. G. Davis, Natl. Inst. for Res. in Dairying. Milk Indus., *23*, No. 10: 33. April, 1943.

The resazurin-rennet test is useful in detecting those cases of mastitis in a producer's herd which are likely to affect the resazurin test. It is a

combination of the resazurin test and the rennet test. The latter measures chemical abnormality, and mastitis milk usually clots slowly with rennet on account of high pH (low acidity).

The equipment required, method of testing and recording of results are fully outlined.

Usually a quarter sample reducing resazurin quickly, *e.g.*, to pink in one hour, will clot slowly with rennet, give a high catalase value, give purple mastitis organisms, usually streptococci or staphylococci, in some numbers. Quick resazurin reduction means a milk high in cells, slow rennet clotting means an abnormal milk, high in pH and globulin. If the sample reduces resazurin quickly but clots normally, it may mean that the quarter is in the latent condition of the disease and so will be suitable for treatment.

If the sample clots slowly but does not reduce resazurin, it may mean that the quarter has suffered an attack of mastitis in the past.

The behavior of physiologically abnormal milks in the resazurin-rennet test is summarized in the following table:

Type	Cell count	Effect on resazurin test	Acidity	Effect on rennet test
Colostrum	Increased	+	Increased	Accelerated
Post colostrum	Normal	0	Sl. increased	Accelerated
Late lactation	Increased	Slight	Sl. decreased	Retarded
Admixed with blood	Increased	+	Sl. decreased	Retarded

H.P.

388. Pasteurization, Holder and H.T.S.T. Compared. H. T. R. MATTICK, E. R. HISCOX AND J. G. DAVIS, Natl. Inst. for Res. in Dairying. Milk Indus., *23*, No. 11: 39. May, 1943.

From the results of American investigations it would appear that the H.T.S.T. process (160 or 161° F. for 16 seconds) is not as effective as the holder process in the reduction of the general flora of milk. In some German plants the milk is frequently held at 71–75° C. (159.8–167° F.) for 42–44 seconds. This holding time is sometimes shortened by resorting to an "over-swinging" process, in which the heating takes place in more than one stage. It is claimed that this modification gives results equal to those given by 145° F. for 30 minutes. Two heating periods complicate the problem of defining equivalent temperature/time combinations at high temperatures. The margin of safety is not yet established competently for the temperature/time combinations 160, 161 or 162° F. for 15 seconds because of the difficulty of exactly reproducing with laboratory apparatus the rate of heating and the very short holding time. H.P.

389. Chlorine Sterilization. A. T. R. MATTICK, W. A. HOY AND F. K. NEAVE, Natl. Inst. for Res. in Dairying. Milk Indus., *23*, No. 9: 39. March, 1943.

The writers claim that steam sterilization is the cheapest and the most effective and foolproof but in times of emergency, alternatives must be available. Chemical disinfectants have little or no penetrative power, and unless washing is thorough, organisms remaining in crevices and in scratches on used utensils, in rusty areas or in milk films will not be destroyed by chlorine. The chlorine solution must come in contact with every part of the surface. All traces of milk must be removed before using the chlorine wash at a temperature above 105° F. The utensils should be inverted and allowed to drain after sterilization. The writers state that in general practice consistently good "bacteriological cleanliness" will be obtained with chlorine solutions for short periods only and, therefore, steam or boiling water must be used at least once a week.

Methods of applying chlorine solutions, treatment of small utensils, treatment of various types of milking machines, extra treatment during summer, and vacuum system treatment are discussed. The treatment of milk churns, large utensils, removable parts and milk bottles are also thoroughly discussed.

The various types of hypochlorites, purchase of hypochlorites, preparation of chlorine solutions and the chlorination of water are also taken up in detail. H.P.

390. The Relationship between the Temperature of Pasteurization (Holding Method) and the Appearance of Cooked Flavor in Homogenized Milk. BERNHARD SPUR, Milk Res. Lab., Children's Hosp., Philadelphia, Pa. Jour. Milk Technol., *6*, No. 2: 86. Mar.–Apr., 1943.

Homogenized milk may be pasteurized at 150° F. by the holding method without danger of developing a cooked flavor.

There seems to be slightly less danger of a cooked flavor developing when pasteurization precedes homogenization than when homogenization precedes pasteurization. L.H.B.

391. The Control and Maintenance of Milk Quality in War Time. J. G. DAVIS, Natl. Inst. for Res. in Dairying, Univ. of Reading. Milk Indus., *22*, No. 10: 31. June, 1943.

Milk is essentially a munition of war and must be maintained not only in quantity, but in quality. Many factors are concerned in this, the most important being the increased attention given to arable farming, labor difficulties and the redirection of dairy advisory staffs to non-dairying activities.

Keeping quality is enhanced by (1) cleanliness in production, (2) sterility of utensils, both on the farm and in the creamery, (3) adequate cooling on the farm and at the creamery, (4) rapidity of transport, (5) efficiency of handling at the creamery.

The writer found some disturbing features in various parts of the country: (1) the very poor keeping quality of a proportion of our supplies, (2) lack of proper equipment in many farms and some creameries, (3) lack of an adequate supply of good water on many farms, (4) lack of fundamental knowledge on such aspects as keeping quality, (5) the lack of uniformity in tests and standards, and (6) lack of co-ordination between teaching, advisory and controlling authorities.

The following suggestions are put forward to obviate the present losses in war time: (1) Co-ordination of control, (2) educational work on farm, and (3) monthly discussions, (4) a "gentlemen's agreement" between producer and buyer, (5) coolers on farms, (6) courses for farm inspectors and laboratory workers.

The essential tests for milk at the creamery are (1) methylene blue or resazurin, (2) Gerber and hydrometer or gravimetric S.N.F. and (3) catalase and/or rennet; acidity and sediment tests are usually made at most creameries.

Tests for routine grading of producer's milk are (1) resazurin, (2) resazurin-rennet, (3) catalase test, (4) mastitis index.

Other things discussed are (1) tests for milk in bulk, (2) test for wholesalers' churns, (3) test for distributors' bottles, (4) use of chlorine for sterilizing water supplies, (5) cow washing, (6) teat cups, (7) hand washing, (8) detergents for cleaning churns and bottles, (9) cleaning and sterilization of churns, (10) simple methods of cooling milk on the farm, (11) milking machines. H.P.

392. Cooling Milk on the Farm. JUNE ROBERTS AND GEORGE H. LARSON, Kans. Agr. Expt. Sta. Milk Plant Monthly, *32*, No. 5: 39–40. 1943.

A survey of 1,144 Kansas dairy farms showed that 24.55% of the farmers produced grade "A" milk, 74.45% grade "B" and 1% grades "C" and "D." Adequate cooling of milk is essential in preserving the high quality of milk. Milk in 10-gallon cans could be cooled to 64° F. in one hour using well-water at 58° F. when both water and milk were stirred. The same quantities of milk could be cooled to below 50° F. in 12 to 16 minutes in a mechanical wet-storage unit, when both the cooling water and the milk were agitated. Ice was effective in cooling milk but was very expensive in comparison with mechanical refrigeration. Insulated concrete storage tanks required 50% less electrical energy to cool milk than a similar tank without insulation. The most satisfactory method for cooling milk was electrical mechanical refrigeration. G.M.T.

393. **Delivery Restrictions and Milk Quality.** A. C. FAY, Dir. of Labs., H. P. Hood & Sons, Boston. Milk Plant Monthly, *32*, No. 4: 22–25. 1943.

Restricted delivery of milk, including every-other-day delivery, elimination of Sunday deliveries, elimination of special deliveries to wholesale customers and the elimination of deliveries during the early morning hours, has presented milk quality problems largely centering around inadequate refrigeration. The problem of inadequate home refrigeration facilities might be solved (1) by eliminating unnecessary items from the refrigerator, (2) by stacking bottles horizontally on lower shelves, (3) by use of insulated boxes for temporary storage, (4) by supplemental purchases at the store, and (5) through cooperation of the health agencies, by the distribution of literature focusing attention of the housewife on the problem. Where there is a total lack of refrigeration it is suggested that single order deliveries be accepted and then purchases made from the stores on alternate days. To overcome the problem when deliveries are made after some of the customers have left home for the day, the following suggestions were made: (1) allow route man access to the refrigerator, (2) use insulated boxes, (3) deliver to the neighbors or (4) purchase milk at the stores.

The problem of quality arising from the elimination of special deliveries to restaurants might be overcome (1) by more accurate estimation of daily needs and (2) by arrangement of merchandise carried over in the refrigerator so as to insure its sale first on the following day.

Inadequate refrigeration facilities in the stores might be overcome by use of some of the same procedures recommended in case of inadequate refrigerator facilities in the home. G.M.T.

394. **Laboratory Control of Homogenized Milk.** F. J. DOAN, Penn. State Col., State College, Pa. Internatl. Assoc. Milk Dealers Assoc. Bul., *35*, No. 23: 315–343. April, 1943.

The richer flavor of homogenized milk is well known. Detectable rancidity will develop 30–45 minutes after homogenization if the milk is not pasteurized. Raw milk and pasteurized homogenized milk when mixed will develop rancidity when neither separately will show the defect. The homogenized milk fat globule membrane is evidently permeable by lipase. Homogenized milk is protected from copper-induced oxidized flavor but very susceptible to "sunlight" flavor, oxidized or burnt flavors. Milk pasteurized at higher than usual temperatures is less susceptible to "sunlight" flavor defects.

Accurate Babcock fat tests may be obtained by using certain minor modifications, such as having both acid and milk at room temperature, using 17.0 ml. of acid and mixing after the first centrifuging. Homogenized milk will not show significantly higher counts as a result of homogenization with a

modern homogenizer, especially in the case of high quality milk. Although it has been said that no sedimentation will occur in milk with less than 100,000 leucocytes per ml., still the practical method of avoiding this difficulty is clarification.

Greater lowering of curd tension up to 2,500 lbs. of pressure is obtained in the case of higher testing milk, higher temperatures of pasteurizing and homogenizing after pasteurization. It should not be difficult to obtain curd tensions below 20 grams.

Homogenized milk when it freezes is more likely to break the bottle and result in a watery condition at the top of the bottle upon melting. Seepage from homogenized milk bottles is worse than in cream line milk because in the latter the cream helps seal the bottle. Best remedy is to fill a little lower and keep the milk cold. The protein has been rendered less stable by homogenization and is more easily coagulated in cooking by heat or acids. For removing the upper 100 ml. for fat analysis to determine effective homogenization under U. S. Public Health Service Milk Ordinance and Code the author presents figures to show that a syphon opening up will give results slightly lower but more uniform and reliable than the pipette and the syphon opening up is recommended. The syphon is made of 6-mm. outside diameter and 1-mm. wall thickness glass tubing fixed in a rubber stopper so as to draw off precisely 100 ml. of milk. The present 5% difference requirement is rather difficult to meet and an 8–10% difference would be more practical and entirely satisfactory from a nutritional viewpoint.

The Farrall Index of Homogenization Efficiency is considered to be a very satisfactory method of measuring effective homogenization. The Farrall Index may be defined as the number of globules, 2 microns in diameter, which could be obtained from all the globules larger than two microns in diameter which are observed in five 25-micron-square fields covered with a 70-micron-thick layer of a 1 to 25 dilution of milk in a 40% glycerine solution.

A Farrall Index of 5.0 was equivalent to 2.0–5.0% difference (U.S.P.H.) and a Farrall Index of 6.0 equivalent to 3–6% difference (U.S.P.H.). Details and precautions in obtaining Farrall Index figures are discussed.

E.F.G.

395. Means by Which Total Milk Production May Be Increased. EARL WEAVER, Mich. State Col., East Lansing, Mich. Internatl. Assoc. Milk Dealers Assoc. Bul., *35*, No. 21: 291–304. April, 1943.

Substantial increased production cannot be looked for in the higher production herds but rather in average and below average herds. Dairy Herd Improvement herds in Michigan with an average production of 347 lbs. of fat per year comprise only 1.42% of the herds of the state while those outside Herd Improvement Associations with an average of 200 lbs. of fat

per year constitute 98.58% of the herds of the state. Many low-producing herds contain animals with the breeding and inheritance capable of producing much more milk than they do. Better feeding and management of these animals with inherent producing ability offers the most promising avenue to increased production. The following are some of the means of getting more production from these animals.

1. Protect the health of the herd to eliminate losses and inefficient production. An increase of 18.3% in milk production in the Michigan State College herd from 1938–1942 was attributed largely to reduction of mastitis and other diseases.

2. Rapid milking in a proper manner can easily add 150 lbs. of milk to the lactation period of each animal.

3. With higher-producing animals an increase of 15–20% may be obtained with 3-time milking and a further increase of 6–8% with 4-time milking.

4. Good hay is the basis of an adequate dairy ration. Good legume hay alone with no concentrates is sufficient for a cow giving 20 lbs. of high-testing milk per day. An instance is given where a cow increased production from 20 lbs. to 30 lbs. of milk per day when changed from poor quality to choice quality hay. A cow will consume as much as 4 lbs. of good alfalfa hay per 100 lbs. of weight.

5. When concentrates were added to alfalfa hay for higher producing animals the production was increased in the case of nine different individuals, an average of 62%. On alfalfa alone the average production was 263 lbs. of fat and when concentrates were added productions were raised to 425 lbs. per animal.

6. Summer feeding should provide pasture in succession using alfalfa and brome or timothy or other legumes or grasses to supplement native permanent pastures. The silo may prove a help in supplementing pastures.

E.F.G.

396. Cost of Distributing Milk in New Jersey. LELAND SPENCER, Cornell Univ. Milk Plant Monthly, *32,* No. 3: 54–58. 1943.

The author presents a summary of the three-report findings on milk distribution costs in New Jersey. The costs are broken down as to location within the state and to the volume of business. It was believed the most striking fact disclosed by this study was the wide difference that exists in costs and profits between sections and between groups of dealers, plants and delivery systems within each of the principal areas. Selling and delivery were the most expensive operations in getting milk from the farm to the consumer's doorstep. The cost per quart for selling and delivering milk on retail routes ranged from a high of $0.0666 on a 273-quart or quart-equivalent route to a low of $0.0401 on a 334-quart route. Similar costs on

wholesale routes ranged from $0.04627 to $0.03509 per quart. Sub-dealer retail delivery costs for standard milk to the family trade averaged $0.04841 per quart; that to wholesale customers on retail routes was $0.02991 and to wholesale customers on wholesale routes was $0.02106.

The cost of handling and processing milk in a pasteurizing plant ranged from $0.0056 to $0.0197 a quart; the average for six representative plants being $0.0111 per quart. The total cost for handling and receiving milk in country receiving plants was about three-tenths of a cent a quart.

The indicated profit per quart on milk sold to family trade when the many-route sub-dealers operation costs were deducted from established minimum selling prices was $0.00784 a quart. G.M.T.

397. What Can the Dairy Bacteriology Laboratory Do to Aid in the War Effort in Milk Production? W. L. MALLMAN AND C. S. BRYAN, Mich. State Col., E. Lansing, Mich. Milk Plant Monthly, *32*, No. 2: 23–25. 1943.

A three-way program for maintaining a high quality milk supply during the war period is advocated. This program includes: (1) the maintenance as largely as possible of the milk inspection service; (2) checking producer milk at the receiving platform for total bacteria and for thermoduric bacteria; and (3) contacting individual producers whose milk supply is of poor quality. The direct microscopic and autoclave slide tests are recommended in making the routine bacterial examination of milk. While these procedures are presented as a war measure, the authors believe the plan or some adaptation of it should be the part of any milk sanitation program.

G.M.T.

398. Some Established Facts on Oxidized Flavor of Milk. G. M. TROUT, Mich. Agr. Col., East Lansing, Mich. Canad. Dairy and Ice Cream Jour., *22*, No. 4: 56. 1943.

This article reviews the present knowledge concerning the development of oxidized flavor in milk. The author lists 17 factors which may play a part in the development of the objectionable flavor and gives the following control measures:

1. Elimination of copper and iron contamination.
2. Removal of oxygen from the milk.
3. Homogenization.
4. Feeding high-carotene feeds.
5. Addition or growth of bacteria in milk prior to pasteurization. This is a step in the wrong direction.
6. Addition of reducing substances directly to the milk. This method is questionable. O.F.G.

399. Clean Milk Is Not Enough. O. R. IRVINE, Ontario Agr. Col., Guelph, Ontario. Canad. Dairy and Ice Cream Jour., *22*, No. 3 : 30. 1943.

The author suggests that, in the future, methods of producing and handling dairy products must go beyond sanitation and must seek to further improve the position which dairy products hold as items of diet in the world's food supply. The goal of producing dairy products of June quality is set. Three advantages would result from the attainment of this goal, namely:

1. Dairy products would have, on the average, an increased content of some of the important vitamins.

2. Tendencies for certain products to develop stale, flat, and oxidized flavors would be lessened.

3. Other undesirable flavors of non-bacterial origin would be reduced. Lipase action is cited as an example. O.F.G.

400. Factors Influencing the Sanitation of Dairy Cans. M. C. JAMIESON, Univ. of Manitoba, Winnipeg, Manitoba. Canad. Dairy and Ice Cream Jour., *22*, No. 1 : 21. 1943.

For the duration of the war, poorly surfaced dairy cans and the accompanying ineffective sanitation are likely to be serious unless more painstaking care is exercised in handling and sanitizing and a good substitute for tin is found. The dominant bacterial flora of cans is an important factor in effective sanitizing, especially where spore-formers are dominant. The length of time between sanitizing cans and their eventual use is a factor that should not be overlooked. Clear-water rinsing of the cans should follow thorough washing. Thorough cleansing and sterilization of the can lids is essential for low-count milk. O.F.G.

401. Lipase Activity—Its Relation to Rancid Flavours in Milk. C. H. CASTELL, Ontario Agr. Col., Guelph, Ontario, Canada. Canad. Dairy and Ice Cream Jour., *21*, No. 9 : 28. 1942.

Lipase has two functions. Under certain conditions it causes a combination to take place between glycerol and fatty acids to produce fats. Under other conditions it reverses the process and breaks down fats into glycerol and fatty acids. It is this latter action which produces rancidity in milk. The problems involving lipase may be divided into (1) the factors that determine the initial amount of lipase secreted into the milk, and (2) the factors that influence its activity. Very little is known about the first. More is known about the factors that influence lipase activity. Lipase activity varies directly with temperature within wide limits. It acts most vigorously in an alkaline reaction. Homogenization and shaking permit increased activity. Oxidizing agents cause a decrease and reducing agents

an increase in activity. Lipase seems to be more active in milk from cows late in lactation. Salt has an inhibiting effect while ammonia has an activating influence. Methods for detecting lipase are discussed briefly.

O.F.G.

402. Emergency Sanitation Standards for Raw Milk for Pasteurization. ANONYMOUS. Jour. Milk Technol., *6*, No. 2: 101. Mar.–Apr., 1943.

Standards for acceptance of interstate shipments of milk for pasteurization during the war emergency as recommended by the U. S. Public Health Service, and approved by the U. S. Public Health Service Sanitation Advisory Board on December 4, 1942, are given.

These standards are practically the same as those for Grade A raw milk intended for pasteurization as given in the U. S. Public Health Service Milk Ordinance and Code, Bul. 220, 1939 edition.

They have been modified slightly to render them more applicable to different climatic conditions and to reduce the use of critical materials.

L.H.B.

403. Report of the Committee on Dairy Farm Methods, International Assoc. of Milk Sanitarians. HORATIO N. PARKER, Chm., Dir. of Laboratories, City Health Dept., Jacksonville, Fla. Jour. Milk Technol., *6*, No. 2: 89. Mar.–Apr., 1943.

A number of methods for cleaning milking machines are discussed. It is suggested that the Committee on Standardization of Technological Procedure make a study of milking machines and set standards of easy cleaning so that machines may be barred from the market if they are so constructed that they cannot be easily cleaned.

Thermophilic and thermoduric organisms have been a matter of considerable concern. No new facts have been developed, but pertinent points regarding these bacteria and their control are listed.

The care of milk utensils is important both from the standpoint of sanitation as well as care in handling, as replacements are difficult to obtain.

An outline of the procedure used in the Evaporated Milk Industry Farm Quality Program is given. L.H.B.

Bovine diseases come in for a brief discussion.

404. Serious Flaws in Milk Control Policy Which Impair Our War Effort. L. C. BULMER, Dir., Bur. of Food and Dairy Insp., Jefferson Co. Board of Health, Birmingham, Ala. Jour. Milk Technol., *6*, No. 2: 79. Mar.–Apr., 1943.

The growing shortage of fluid milk for our army and civilian populations can be attributed to several things. Among those discussed are:

Present lack of uniform milk regulations. The Standard Milk Ordinance has failed to be universally adopted.

Farm dairy control often trespasses too far into the aesthetic. Need for more adequate supervision and control of milk as received, handled and processed at plant is lost sight of.

Economic and nutritional angles of the milk problem are frequently mishandled due to poor organization and lack of well-rounded experience in personnel.

Conditions point to the advisability of removing farm inspection from the activities of local health departments and in some way placing it under the U. S. Department of Agriculture through a new form of organization to be studied and set up.

The apointment of a National Technical Commission consisting of milk sanitarians, nutritionists, and economists to study the field of milk control, including the question of trade barriers is advocated. L.H.B.

405. Report of Committee on Sanitary Procedure for the International Assoc. of Milk Sanitarians. C. A. ABELE, Chm., City Health Dept., Chicago, Ill. Jour. Milk Technol., *6,* No. 2: 77. Mar.–Apr., 1943.

The committee has studied the possible use of glass tubing as a substitute for metal milk piping and after considering all of the disadvantages, such as susceptibility to breakage. danger of chipping, possibility of glass particles appearing in the bottled milk, and the extra time required to dismantle, wash and assemble the glass piping, due to the added care necessary in handling same, they do not believe that these disadvantages "constitute justification for opposition by milk sanitarians to the use of glass piping as an alternate for metal milk piping, in the light of existing knowledge on the subject."

The committee has approved the Howell Sanitary Motors built in frames Nos. 204, 224, 225, and 254. They meet the 3A specifications for sanitary motors. L.H.B.

406. The Importance of Cooperation between the Milking Machine Industry and the Milk Sanitarian in Milking Machine Sanitation. G. H. HOPSON, D.V.M., The DeLaval Separator Co., New York City. Jour. Milk Technol., *6,* No. 1: 39. Jan.–Feb., 1943.

Milking machines have made it possible for farmers to milk more cows without the necessity of requiring more help. In this day of labor shortage many dairymen have purchased milking machines from necessity and probably were not milking-machine minded. It may require more time in these cases to educate them to properly handle and care for their machines.

The milk sanitarian and milker agent or dealer should cooperate more closely in their work with the dairyman who has a milking machine. A set of rules should be set up which will serve as a guide for the sanitarian and dealer to instruct the dairyman on how to clean the milker. A list of rules agreed upon by representatives of the New York City Department of Health, the milk industry and the milking machine manufacturers to be used as a guide for the proper instructions on the care of milking machines is given.

L.H.B.

407. Problems in Milk Sanitation Due to the War. A. W. FUCHS, Sanitary Engin. Dir., U. S. Pub. Health Serv. Jour. Milk Technol., *6*, No. 1: 23. Jan.–Feb., 1943.

The army recognizes three grades of milk. Type II, No. 1, is Grade A, pasteurized, conforming to the Public Health Service standards and produced in an area which has formally adopted this ordinance. Type II, No. 2, is the highest quality pasteurized milk as defined in the local milk ordinance and used by the majority of the population in areas not using the Public Health Service Milk Ordinance. Type III is milk pasteurized in plants conforming to the pasteurization plant specifications of the current Public Health Service Ordinance and Code. It must be produced, handled, stored, and transported in such a manner as to assure a wholesome milk as delivered to the pasteurizing plant. It must not contain more than 1,000,000 bacteria per ml. by the plate count before pasteurization nor more than 50,000 per ml. after pasteurization.

Type II, No. 1, milk must be purchased when available in adequate quantity, and cost must not be greatly in excess of cost of Type II, No. 2. Type III pasteurized milk may be purchased whenever neither of the Type II milks are available in sufficient quantities.

In some areas where shortages of graded milk are not severe, the shortages may be overcome by issuing temporary permits to a few of the better producers of manufactured milk who may be able to qualify for Grade A by improving their methods and without the use of a great deal of critical materials.

Some army authorities refuse to accept Type III milk when there is a shortage of Type II even though the Quartermaster General authorizes such a procedure.

Pasteurization of milk supplies becomes doubly important in many areas where population has increased tremendously. In many of these areas milk supplies normally intended for a few hundred now must serve many thousands. Sanitary production and supervision under such conditions are very difficult and pasteurization must be relied upon.

Shortage of experienced help both on the farms and in the plants is a big problem.

Differences in price between neighboring communities may also be a problem.

Another great problem is the fact that goals for increased production and maintenance of sanitary conditions must be accomplished even though there is a lack of sufficient equipment due to the need of conserving critical materials for war. L.H.B.

408. Dairy Inspection in War-Time. ERNEST KELLY, Asst. Chief of Bur. of Dairy Indus., U. S. Dept. of Agr., Washington, D. C. Jour. Milk Technol., *6*, No. 1: 19. Jan.–Feb., 1943.

As the author sees it, "the job of the dairy sanitarian during the war is in the main not so much to improve present sanitary conditions as it is to hold on to improvements already made."

Flagrant unsanitary practices are not to be condoned, but nonessential requirements must be eliminated. This would particularly apply to new equipment.

Educational efforts are important. An inspector should be able to show a producer or plant operator how to actually take a piece of equipment, such as a milking machine or separator, apart and efficiently clean it if necessary.

Educating the younger generation along sanitary lines is especially important. The work being done by the Baltimore City Health Department on its training course in sanitary milk production for high school vocational students is mentioned. L.H.B.

409. Wisconsin's Quality Improvement Program. L. G. KUENNING, Chief, Dairy Div., Wis. Dept. of Agr., Madison, Wis. Jour. Milk Technol., *5*, No. 6: 348. Nov.–Dec., 1942.

Wisconsin's plan is to lay a firm foundation with sound reasons for quality improvement needs, then select local leaders, usually members of schoolboards, in preparation for schoolhouse meetings. Meetings are held in every schoolhouse in a county because it has been found that farmers are more likely to express their opinions when meetings are kept small.

Following the schoolhouse meetings, the plants collaborate by making sediment tests, and methylene blue tests and return the results to the farmers. State inspectors help plant operators and follow through with any farmers who cannot or will not improve. It has succeeded in Wisconsin because it has had the support of every agency interest in the welfare of the dairy industry. Results have shown a decided improvement. L.H.B.

410. Roccal in the Dairy Industry. ANDREW J. KROG, F.A.P.H.A., Health Off. of Plainfield, N. J., AND CHARLES G. MARSHALL, New York City. Jour. Milk Technol., *5*, No. 6: 343. Nov.–Dec., 1942.

Roccal is a 10% solution of alkyl-dimethyl-benzyl-ammonium chloride.

It has a phenol coefficient of 40 against *Eberthella typhosa* and *Staphylococcus aureus,* and of 35 against *Escherichia coli.* It is non-toxic, non-corrosive to metals and rubber, quite stable and almost tasteless and odorless in concentrations utilized.

Using sterile swabs on milk plant equipment at eighteen points in the system, before and after using Roccal, the average bacterial count for a period of 14 days at these various points was reduced 60 to 99%. L.H.B.

411. Iodoform Flavor in Milk. H. G. LINDQUIST, Asst. Prof. Dairying, Mass. State Col., Amherst, Mass. Jour. Milk Technol., *5,* No. 6: 334. Nov.–Dec., 1942.

Two instances of iodoform flavor being detected in milk are cited. In both cases the cause was traced to the treatment of cows by veterinarians for suppurative inflammations with iodoform preparations introduced into the uterus.

When this treatment is used, it is essential that the milk from such cows be withheld from the regular supply until such time as no iodoform flavor can be detected. There is no definite time in which such flavor will disappear. Taste alone should be the determining factor. L.H.B.

412. Pasteurization of Small Milk Supplies. C. S. LEETE, Prin. Milk Sanit., N. Y. State Dept. of Health, Albany, N. Y. Jour. Milk Technol., *5,* No. 5: 298. Sept.–Oct., 1942.

The importance of pasteurization of small milk supplies is stressed, and it is shown that as pasteurization increased milk-borne epidemics decreased. In New York State, other than New York City, there were 84 outbreaks from 1917–1928, of which 68% were in rural areas and 32% in urban. From 1928 to 1938 pasteurization increased greatly and mostly in the urban centers. During this period there were 67 outbreaks, of which 94% were in the rural as compared to 6% in the urban.

In the past the reason for not having pasteurized milk in the rural areas was due chiefly to the fact that suitable equipment was not available to efficiently and economically pasteurize small supplies. Today such equipment is available. There are now in operation in the state pasteurization units which are doing an efficient and practical job on quantities of 50 quarts and upward.

These pasteurizers are of two kinds: one is an in-the-bottle pasteurizer electrically operated; the other is a vat type, which requires a boiler for steam. The in-the-bottle type is made in two sizes, 48 quarts and 96 quarts. The vat type is made in three sizes, 40 quarts, 80 quarts and 120 quarts.

The prices range, exclusive of boiler, bottling or filling machines and cappers, from $300 to $1000. The in-the-bottle types are higher priced, but

they include an electrical refrigeration unit and storage capacity for the bottled milk. A description of the equipment is given. L.H.B.

413. Survey of Sediment Testers and Methods. DR. JOHN A. KENNAN, Whiting Milk Co., Boston, Mass. Jour. Milk Technol., *5*, No. 5: 294. Sept.–Oct., 1942.

Six sediment testers (names of all were not given) in common use were studied. It was determined that one of the off-the-bottom testers removed the sediment from a circular area about $3\frac{1}{2}''$ in diameter; or about one-tenth of the sediment on the bottom of a 40-quart can is removed by this type of tester.

In view of the fact that the sediment content for individual cans from the same producer will vary, it is the author's opinion that taking a well-mixed pint sample of milk from the weigh tank is a fairer and more accurate method for determining the sediment of each producer's milk.

For speed of operation the Hinman off-the-bottom type tester proved superior. Average time required per test was 22 seconds. L.H.B.

414. Studies on Measurement of Sediment in Milk. K. G. WECKEL, Dept. of Dairy Indus., Univ. of Wis., Madison, Wis. Jour. Milk Technol., *5*, No. 5: 287. Sept.–Oct., 1942.

Glass-bottom cans were used in these studies to show the distribution of sediment on the bottom of the cans. Both an "off-the-bottom" and a vacuum type tester were used to augment interpretations of the observations made through the glass bottoms.

It was found that the method of stirring affected the distribution of sediment when it settled to the bottom of the can. When milk is stirred with a circular motion, the sediment tends to aggregate in the center area. When stirring is done by a transverse motion (across or vertical), the distribution is more uniformly distributed over the bottom of the can. It usually takes less than three hours for the major portion of the sediment to settle. Holding longer did not seem to affect the intensity of sediment on the filter disc when the off-the-bottom tester was used.

Holding milk for 16 hours or more after it is produced has a tendency to reduce the amount of sediment, probably due to solution of some of the extraneous matter. "In some of the tests a noticeable decrease was observed in the amount of sediment in the lower third of the can when the holding period was extended to 16 hours or more." Thus, evening milk is favored by sediment tests as a grading procedure.

Temperature and viscosity had no significant effect on the rate of sedimentation. L.H.B.

415. Some Problems in Sediment Testing. H. L. DeLozier, Chief, Milk Control Div., Dept. of Health, Louisville, Ky. Jour. Milk Technol., *5*, No. 5: 291. Sept.–Oct., 1942.

Three types of sediment testers were studied. The small hand-operated vacuum tester was least satisfactory for plant conditions but all right for laboratory. The Hinman off-the-bottom type was most efficient if milk is not stirred.

The L. and W. vacuum tube type is also an off-the-bottom tester and should be used for unstirred milk. It is simple to operate, but is somewhat difficult to sterilize. For average plant conditions, the off-the-bottom testers are best suited.

There may be a decided difference in amount and kind of sediment present in cans of the same shipment. L.H.B.

416. The Sediment Testing of Milk. Report of Committee on Applied Laboratory Methods for the Internatl. Assoc. Milk Sanitarians. T. H. Butterworth, Chairman. Jour. Milk Technol., *5*, No. 5: 281. Sept.–Oct., 1942.

The report gives the results of three studies, one made at a university, one made by a public health authority and one by a commercial milk company.

The committee offers several suggestions as to possible approved methods depending on the probable purpose of the test.

1. As a research measure, no standard is necessary, and the tester to be used should be the most accurate obtainable.

2. If test is to be used as an object lesson to a careless dairyman, no standard is recommended other than the comparison with a filter disc from any reasonably clean milk. One of the "off-the-bottom" testers would be best to use.

3. As a general check on the incoming milk supply, it is recommended that the vacuum type filter be used in connection with the 1939 Connecticut standards. A one-pint sample of the well-mixed milk should be used.

L.H.B.

417. Constructing and Equipping a Milk Pasteurizing Plant. C. W. Weber, N. Y. State Dept. of Health, Albany, N. Y. Jour. Milk Technol., *5*, No. 5: 276. Sept.–Oct., 1942.

The author discusses such features as selecting a location, plant arrangement, size of building and rooms, construction of building, and installation of equipment. L.H.B.

418. Should Congress Help Unify Milk Control onto a War-Time Footing? L. C. Bulmer, Dir., Bur. of Food and Dairy Insp., Dept.

of Health, Birmingham, Ala. Jour. Milk Technol., *5*, No. 5: 261. Sept.–Oct., 1942.

The author answers his own question in the affrmative and discusses the present status of the fluid milk industry, its importance, and offers suggestions as to what Congress could do to help. In this connection he would have appointed a national public health and economic milk commission, the functions of which would be as follows:

"(1) To speedily consider and streamline the present U. S. Public Health Milk Ordinance, and to place it on a practical economic war-time footing, without sacrificing any of its essential health safeguards. (2) To sponsor vigorously the adoption of such uniform milk regulations in every state in the Union. (3) To find legal ways and means to encourage every state to cooperate. (4) To serve in an advisory capacity to all such state commissions, and act in the form of a supreme court of appeals, relative to abuse of state milk regulations, or enforcement of same, involving interstate shipments." L.H.B.

419. California's Manufacturing Milk and Cream Grading Program. O. A. GHIGGOILE, Chief, Bur. of Dairy Serv., Dept. of Agr., Sacramento, Cal. Jour. Milk Technol., *5*, No. 6: 253. Nov.–Dec., 1942.

California undertook the grading of milk and cream on a voluntary basis in 1925. Since that time the grading program has been extended to every section. Plants are voluntarily supporting the hiring of 29 inspectors to carry on the work.

Direct microscopic counts, sediment tests, flavor and odor and temperature examinations are made in grading milk. For manufactured cream, the acidity test and flavor and odor are used.

In one project a one cent differential is used between first and second grade cream and three cents between second and third grade cream.

In two other projects a two cent differential exists between first and second grade cream. L.H.B.

The methods in use have proven very satisfactory.

420. Pasteurized Chocolate and Evaporated Milk. GIDEON HADARY, H. H. SOMMERS AND JOHN D. GONCE, JR., Univ. Wis. Milk Dealer, *32*, No. 7: 26–28 and 58–66. April, 1943.

To compare the rate of gastric emptying time of untreated whole milk with chocolate milk and with other milk possessing soft curd characteristics (evaporated milk) this study was undertaken.

Milk for control and chocolate milk were from same cow and pasteurized according to accepted practices for each type of milk. Barium sulphate was added to facilitate x-ray measurements; curd tensions of all milks used were determined by accepted methods. Children from 4 to 13 years were used

as subjects of experiments with Roentgenograms made at stated intervals, and tables and pictures indicating results are shown. Results of study do not indicate "any difference between rate of stomach emptying time of bariumized unmodified whole milk having a high curd tension and chocolate and evaporated milk, both having low curd tension. No difference in rate of colonic elimination was detected between chocolate milk and unmodified whole milk." C.S.T.

421. Wartime Operation of Refrigeration Machinery. LEON BUEHLER, JR., Creamery Package Mfg. Co. Milk Dealer, *32*, No. 7 : 29, 80–84. April, 1943.

With advent of total war, the operation of available refrigeration machinery at maximum efficiency, under either increased or decreased load due to exigencies of war and demands for conservation of power, priorities on materials, Government orders, and avoidance of spoilage, becomes a national and wartime necessity. Particularly is this true in the maintenance of efficient operation of present machinery. For minimum power requirements per ton of refrigeration the suction pressure should be kept as high as possible by (1) defrosting coils frequently; (2) keeping evaporators free of oil; (3) adjusting expansion valves and (4) utilizing two units if available; other operating methods towards conservation of power and efficiency are cited and final recommendation is to hire a competent operating engineer and hold him responsible for efficient maintenance and operation. C.S.T.

422. Better Light for the Fluid Milk Industry. ANONYMOUS. Milk Dealer, *32*, No. 6 : 24–25, 64–68. March, 1943.

Beneficial effects of good illumination, both natural and artificial, have long been established and as applied to milk plant operation these effects may be measured in terms of economic gain in reduction in breakage, improved cleanliness, better utilization of floor space, less eye-strain and greater safety. The best type and foot candles to use is recommended for various plant departments and equipment such as loading and unloading platforms, bottle storage rooms, bottle washers (including special inspection box to examine cleaned bottles); vat interiors; filling rooms; gages, scales and thermometers and meter panels, pasteurizers, laboratories, weigh room, storage tanks, refrigerators, offices and general lighting, together with a discussion of proper reflection material and type of lights to use. C.S.T.

MISCELLANEOUS

423. Conservation of Equipment and Materials. THOS. J. KULLMAN, Bowman Dairy Co., Chicago. Internatl. Assoc. Milk Dealers Assoc. Bul., *35*, No. 24 : 353–361. April, 1943.

A system is suggested by which a complete test of all machinery requir-

ing lubrication and inspection is made and the periods when attention is required are set down on a chart. This chart is used as a check list. Any breakdowns are investigated to determine if the failure was due to avoidable neglect. Also one large concern has a specialized can washer maintenance and repair man who goes from one plant to another and works solely on can washers. In the same way a boiler specialist and a refrigerating engineer spend their entire time in various plants on just such equipment. This system results in the most expert attention for machinery and definite responsibility. E.F.G.

424. It Worked for Us—Why Not for You? J. R. NELSON, Muller Dairies Inc., New York City. Internatl. Assoc. Milk Dealers Assoc. Bul., *35*, No. 22: 307–312. April, 1943.

In 1933 the Muller Dairies, Inc., reached a peak of accident frequency and as a result established a safety department and employed a full-time safety engineer. An analysis of records of accidents showed what unsafe practices were responsible. "Trailing Observations" brought to light the unsafe practices of each driver and the problem was discussed with the driver at the time on the street. Complete reports are made on each accident to show what unsafe practice is responsible in each case. The personal work with each employee secures the abandonment of the unsafe practice. Daily vehicle inspection, careful instructions of new drivers and placing responsibility for safety training upon supervisors are essential parts of the system which has proven highly effective. E.F.G.

425. Hard Facts on Equipment Life and Availability. O. K. BURROWS, Cherry-Burrell Corp., Chicago. Milk Plant Monthly, *32*, No. 4: 36–42. 1943.

Maintenance of equipment is a responsibility each plant operator must assume. The life of the plant itself may depend upon keeping the machinery in order as replacements may not be had. The author recommends a five-point program in maintenance of equipment as follows: (1) survey the equipment, noting its condition and order repair parts early, or see if they may be repaired locally; (2) appoint someone within the plant as maintenance operator, giving him responsibility to see that equipment is properly lubricated, cared for, cleaned and in operating condition at all times; (3) secure specific instructions from manufacturers relative to the proper care of equipment manufactured by them and follow these instructions; (4) take time to train "green" help, using for this purpose when possible sales and service representatives of equipment and supply houses; and (5) make use of any available inspection service for lectures to new employees on the matter of necessary plant and equipment sanitation.

G.M.T.

426. **Future of the Dairy Industry.** J. P. NADEAU, Foods Admin., Wartime Prices and Trade Board, Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *22,* No. 2: 25. 1943.

Further wartime measures may have to be adopted regarding the sale of milk products and it may be necessary to simplify operations in getting milk to consumers. Consumers have criticized strongly the use of manpower in the distribution of milk. All efforts should be made to maintain the dairy industry and to disrupt it in the least possible way. In the post-war period surpluses of dairy products seem likely and consequently there will be a drop in prices and sales volume. O.F.G.

427. **The Dairy Industry as Seen by the Foods Administrator.** J. G. TAGGART, Foods Admin., Wartime Prices and Trade Board, Ottawa, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 12: 26. 1942.

The official position of the Foods Administrator is that the dairy industry of Canada is an essential industry but it is not a wartime industry since most of its products are for civilian consumption. The foundation for future development and expansion of the industry in Canada is sound but greater competition from vegetable oils and fats can be expected in the future. O.F.G.

428. **How to Prolong the Life of Rubber Dairy Equipment.** W. S. RICHARDSON, B. F. Goodrich Co. Canad. Dairy and Ice Cream Jour., *21,* No. 11: 70. 1942.

Present conditions demand that dairymen give close attention to the preservation of their rubber. The follow suggestions are made:

1. Protect the rubber equipment from sunlight.
2. Avoid bringing rubber into contact with oil, gasoline, grease and other petroleum products and vegetable oils wherever possible.
3. Prevent frictional abrasion.
4. Do not overload tires, belts, etc.
5. Avoid excessive heat or cold which destroys certain properties of rubber.
6. Avoid constant bending and flexing because they tend to shorten the life of rubber.

Special suggestions are given for the proper handling of water hose, steam hose, V-belts and rubber clothing. O.F.G.

429. **A Study of New Detergent and Sterilizing Agents.** M. C. JAMIESON AND M. H. CHAN, Univ. of Manitoba, Winnipeg, Canada. Canad. Dairy and Ice Cream Jour., *21,* No. 11: 29. 1942.

The major complications in the selection of a detergent are intertwined with (1) the nature of the surfaces to be cleaned, (2) the nature of the

materials to be removed, and (3) the nature of the water in which the cleansers are dissolved or the equipment washed. Findings indicate that the new types of products are suitable for use through a wide range of water hardness and give efficient wetting. The research reported here pertains to the cleaning of patrons' milk cans. A survey showed that over 63% of patrons' cans which had been cleaned with ordinary detergents contained over one million bacteria per can. Over 52% of these cans contained more than 100,000 proteolytic organisms and over 46% contained more than 100,000 thermoduric organisms. Trials with several modern cleansers or detergents show that these products are an effective answer for more sanitary cans and higher quality cream. O.F.G.

430. Sanitary Glass Piping Developed to Relieve Metal Shortage in Dairy Industry. ANONYMOUS. Jour. Milk Technol., *5*, No. 5: 302. Sept.–Oct., 1942.

A brief story about glass piping and its place in the dairy industry and how to prepare beaded glass piping for dairy lines is told with pictures. L.H.B.

431. Repair of Concrete Floors in Dairy Plants. JAMES T. DOLEY, Emmadine Farms, Beacon, N. Y. Milk Dealer, *32*, No. 6: 32 and 58. March, 1943.

The problem of constructing new floors and repairing old floors in a milk plant together with specific directions for each is discussed. Emery aggregate as a top dressing either for new or patched floors is recommended as most suitable for milk plant floors because of its hardness and wear-resistant properties for use (1) where traffic loads are heaviest; (2) where danger from slipping is greatest; (3) where resistance to lactic acid is needed; (4) for loading platforms; (5) driveways, and (6) for pasteurizing, bottling and cold storage rooms. Cost figures for various kinds of floor toppings are given. C.S.T.

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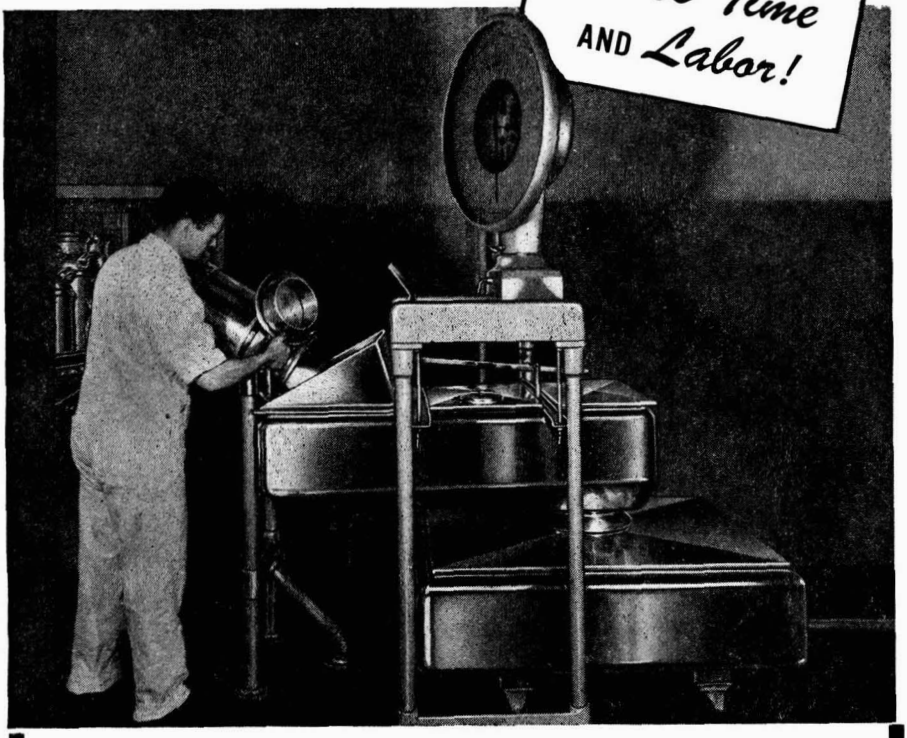

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