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Editorials

The opinions and ideas expressed in papers and editorials are those of the respective authors. The expressions of the Association are completely recorded in its transactions.

I'll See You at Jacksonville

If you fail to attend the International Association of Milk Sanitarians annual meeting in Jacksonville, Florida, October 26-28, you are bound to miss a golden opportunity to spend three of the most entertaining and educational days of your life.

By attending this meeting you will not only have the opportunity of greeting old friends and meeting new ones, but you will also be privileged to participate in a program devised to meet your needs, whether you are interested in milk from the standpoint of its official, industrial, regulatory, quality control, nutritional, or technical aspects.

"Nutritional Value of Milk", "Bangs Disease", "Plate Count for Measuring Quality", "Certified Milk", "Communicable Diseases Affecting Man", and many other equally important subjects will be discussed by eminent authorities, and you will be afforded the opportunity to participate in round table discussions should you have especial problems or questions which you desire to have dicussed or answered. Since this meeting is international in scope, many interesting contributions are expected from authorities and friends from our neighboring Pan-American countries.

As a regular feature of the meeting, field trips will be arranged to points of interest in the vicinity of Jacksonville and St. Augustine, and the program of entertainment will be replete with attractions and functions which will not cripple your pocket book.

If you desire to learn more about milk and milk products, want to make contacts that will be invaluable through the remainder of your life, and would like to spend three of the most enjoyable and entertaining days imaginable, you will meet me at the International Association Meeting in Jacksonville, Florida, October 26-28.

Remember, YOU NEED THE INTERNATIONAL ASSOCIATION AND IT NEEDS YOU!

V. M. EHLERS, *President.*

Mastitis and Milk Control

Laws designed to regulate public milk supplies contain provision that milk must be produced by healthy animals. An ideal which alert milk sanitarians are striving to attain is a milk supply produced by animals with healthy udders. Both the legal requirement and the ideal involve the problem of mastitis. The execution of the requirement is not a simple matter. Milk sanitarians of high professional attainments, long experience, and public health ideals have different ideas as to the most effective and desirable program to be used.

The facts in the situation are recognized by all. Mastitis in dairy cattle is widespread. This pathologic condition is always inimical to the economic production of milk and sometimes to the health of the consumer. A cow with mastitis is a liability to a dairyman. Such a cow eats as much food as a healthy, normal one but does not produce a normal yield of milk from the infected udder. The segregation and treatment of such a cow costs labor and money. Such udders are generally shedding large numbers of organisms and are likely to spread the infection. These quarters show considerable fibrosis with a corresponding reduction in milk secretion. Therefore one phase of the problem is economic.

Moreover, there is a bewildering variety of tests for the diagnosis of mastitis. Their very multiplicity is eloquent of the fragmentariness of our knowledge. No tests to diagnose this condition are as definite as the tuberculin test for detecting tuberculosis. Diagnosis is further complicated by the fact that the chemical and biochemical picture of the milk changes from milking to milking, so that a negative finding is no guarantee of freedom from infection. Typical reactions for chlorides, catalase, pH value, etc. are frequently obtained from quarters free from any recognized udder pathogens (1), and negative reactions may be obtained from some positive cases (2). The elimination of all cows whose milk is positive to any of these tests would probably create a decided milk shortage.

Another aspect of the matter is that of the public health. Some types of mastitis are caused by microorganisms which are pathogenic to man, such as those causing septic sore throat, erysipelas, and scarlet fever. Although the number of such cases in relation to the total number of infected udders is very small, the health hazard is very real to the victims and potentially so to the public at large.

Associated with this aspect is the fact that most competent observers agree that cows whose milk frequently shows clots, flakes, or other abnormal features should be eliminated, because this kind of milk is unacceptable for human consumption. Any abnormal milk from a diseased udder is obnoxious, especially when it contains inflammatory secretions of various kinds, together with high cell content and other debris from infection.

Conscientious and intelligent milk sanitarians are faced with the question, "How far shall I go in attempting to eliminate mastitis, and what shall be the basis for deciding what animals to eliminate?"

One group holds that a mastitis control program should be based mainly upon economic considerations. They hold that chemical and biochemical tests are complicated, non-specific, and undependable, so that reliance on their reactions does not have the confidence of the farmer. Moreover, many producers, when ordered to dispose of mastitic cows, prefer to sell these animals to other dairymen rather than to the butcher. Thus an attempt to reduce the incidence of mastitis by drastic regulatory measures may spread the infection to other herds. Human nature being what it is, it would seem that the only way that this situation could be prevented would be through ear-marking such animals and paying the farmer some compensation as in the tuberculosis eradication program. In general, this school holds that the approach to the farmer should be directed to enlist his cooperation and to convince him that it is to his advantage to dispose of such cows. To aid him in the control of chronic mastitis, the strip cup and palpation of the udder are dependable tests. The farmer himself can use the strip cup at every milking, or at least daily, so as to detect the active cases. If this can be supplemented by a physical examination (palpation) by an expert who can advise the farmer as to methods for reducing the spread of udder disease, then encouraging progress may be expected. Such an approach is likely to enlist the active cooperation of the farmer.

The other group believes that public health considerations must take precedence. This point of view provides the stimulus to utilize any or all present means of diagnosis for detecting cows with mastitis and eliminating them from the dairy herd. It recognizes that none of these chemical, biochemical, and microscopic tests are inclusively and exclusively completely specific and dependable. However, they serve as a rapid sorting test to reveal those milk samples which are suspicious, and to direct attention to those animals which should be examined physically. Any found to be infected are ordered to be excluded from the dairy herd, sometimes from the premises, entailing loss to the farmer. An additional economic loss has been revealed by Brooks (3) whereby the public are involved. An outbreak of milkborne disease resulting from mastitis in a small community was *costly to business.* The monetary loss far exceeded the total appropriation for an entire milk control organization.

Drastic exclusion of mastitic animals from a milking herd may introduce a regulatory problem of tracing the disposition of the excluded animal. To this may be added the resentment of the unconvinced farmer. It is doubtful whether the cause of an improved public health is advanced in such a circumstance unless the affected cow is cured or traced, and the farmer "sold" on the reasonableness of the procedure. He becomes a booster of the program when he is shown that he is better off. After all, the economic stimulus was the basis for the great success of the tuberculosis eradication program. It is newly evident in the campaign against Bang's disease. It should be invoked in the control of mastitis.

What school of thought do you adhere to? We should like to know your views. Write us.

(1) J. Agr. Research, April 1939.

(2) An evaluation of some of the tests used in detecting mastitis in dairy cattle. A. C. Fay, *J. Milk Technol.* 1, No. 4, 38 (1938).

(3) A study of milk-borne epidemics. P. B. Brooks, *Ibid.* 2, 168 (1939).

J. H. S.

Pasteurized Cream Production Coordinated With Simultaneous Milk Processing

W. B. Palmer

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A pasteurized cream supply is as important from the public health and technological points of view as a pasteurized milk supply. Heretofore it has been the practice and actual requirement that cream be pasteurized subsequently to separation. This procedure has been deemed necessary to insure against the possible contamination of the product during the handling of the milk and the production of the cream. In plant practice this means that a dual system of pasteurization of milk and of cream must be operated. This involves additional expensive equipment together with added maintenance, increased length of plant operation, and additional labor. All milk plants producing their own cream have thus been subjected to unnecessary expense. However, such practices and requirements do not necessarily protect the ultimate product.

IMPROVED CREAM PRODUCTION PROCEDURE

It is obvious that if milk, pasteurized for bottling, is also used for cream separation at the time the milk leaves the pasteurizer, the cream is certainly pasteurized and is as safe and wholesome as the milk from which it was produced. Furthermore, it is also obvious that if the separated cream is piped, cooled, and bottled without exposure to any human contamination or handling, it is of equal sanitary quality to the bottled pasteurized milk itself.

A process involving these principles was devised by the author in 1931. Upon our official recommendation, six plants adopted and have been successively operating under this process. This is attested by the bacteria counts shown in table 1.

TABLE 1

Bacteria Counts of Bottled Cream Separated from Pasteurized Milk

(Samples taken at time of delivery to consumer)

Milk	Light	Heavy
	1938	
500	2,000	9,000
2,000	12,000	16,000
600	5,000	1,000
1,000	2,000	1,000
3,000	2,000	4,000
2,000	4,000	6,000
2,000	100,000	100,000
400	1,000	3,000
11,000	23,000	9,000
1,000	5,000	5,000
1,000	2,000	4,000
1,500	1,000	1,000
1,000	10,000	15,000
2,000	2,000	1,000
400	1,000	1,000
	1939	
100	6,000	4,000
1,000	5,000	2,000
100	1,000	3,000
1,000	2,000	1,000
1,000	1,000	2,000
1,000	1,000	1,000
500	1,000	1,000
2,000	2,000	3,000
400	2,000	2,000
1,000	1,000	1,000

Note: Milk plated 1 : 100 and 1 : 1,000
Cream plated 1 : 1,000 and 1 : 10,000

Cream processed under this method is indistinguishable in appearance, and viscosity, contains less sediment, and is superior in flavor to cream processed by the older method.

EQUIPMENT ARRANGEMENT

The arrangement of equipment to produce pasteurized cream under this improved system is shown in figure 1. With modifications, this same principle can be applied to plants operating gravity-flow pasteurizing and bottling systems without milk pumps, or to plants operating with air-tight pressure cream separators.

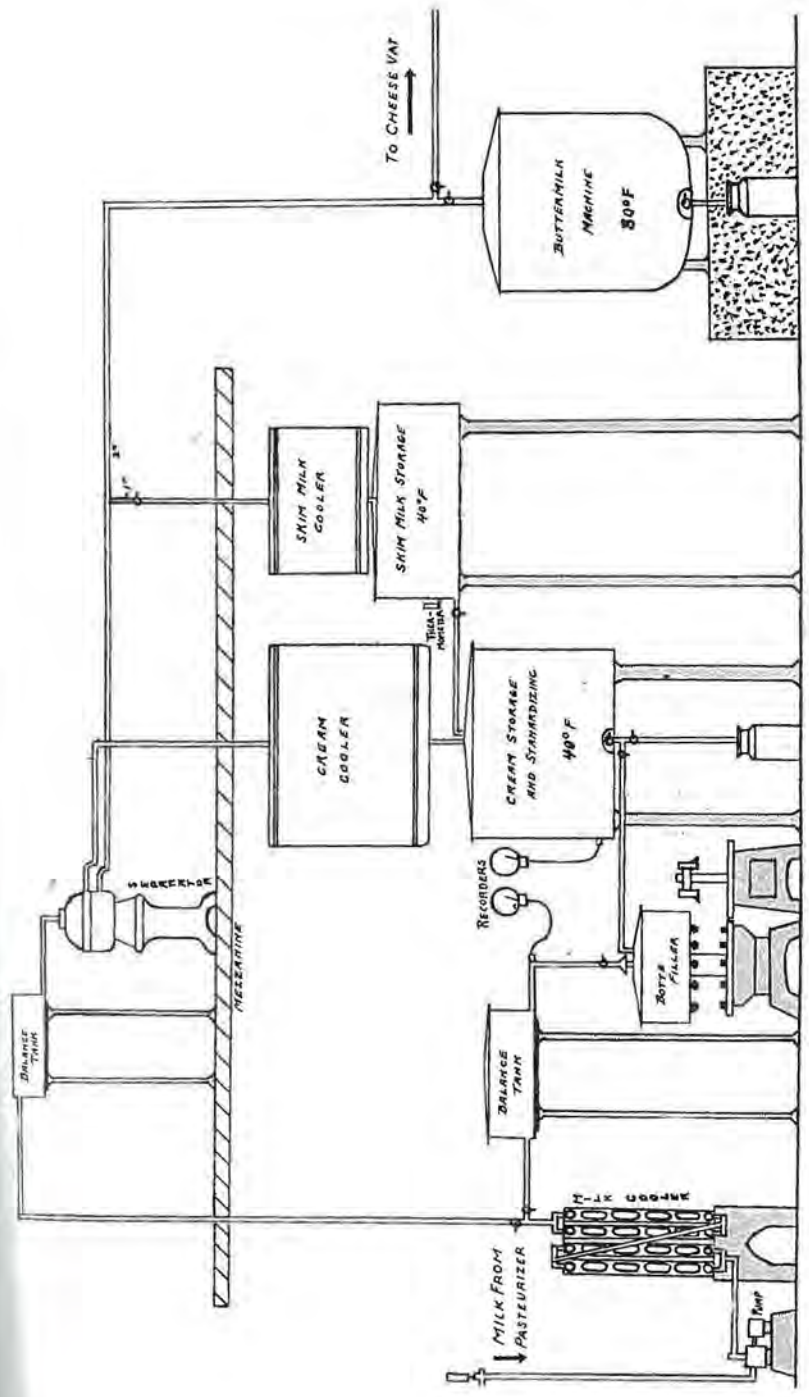

FIGURE 1

Equipment layout for production of pasteurized cream from pasteurized milk.

In explanation of operation of this system, the following is given as example. If the plant schedule is to pasteurize and bottle 100 cans of milk, and is to separate for cream 50 cans of milk, making a total of 150 cans to be processed, the 150 cans of milk are pasteurized in the one operation. There are optional methods for operating this system. One method is to pasteurize, cool, and bottle the 100 cans of milk, then shut off the ice water or refrigerant section of the milk cooler, thereby cooling the remaining 50 cans of pasteurized milk to 80-85° F. and diverting it to the separator, and then finally cooling the cream over a cream cooler to 38-40° F. Another method is to install a take-off milk line from the internal tubular cooler section at which the pasteurized milk is cooled to 80-85°F. and to divert the milk to the separator, with the result that the milk flow is thereby decreased through the balance of the milk cooler to accommodate the bottling of pints and half-pints of milk simultaneously with cream separating and cooling.

Of further interest and value, there is the possibility of applying this system to a high-temperature short-hold pasteurizing unit. To accomplish this, a take-off line could be installed in the cooler section where the chilled pasteurized milk has reached a temperature of 80-85° F. Such chilled pasteurized milk would be diverted to the cream separator. This would allow decreased milk flow through the balance of the cooler section and into the milk bottler for pints and half-pints without altering the rated flow of the machine.

New High-Short Pasteurization Research Program

Timely and in keeping with the pertinent editorial relating to the bacteriology of short time-high temperature pasteurization as published in the July issue of *The Journal of Milk Technology* it will interest readers to know that a critical comparative bacteriological study on the pasteurization of milk by the holding method and the short time-high temperature method of pasteurization is under way at this time. This research project has been inaugurated by the dairy industry and the dairy machinery industry and is being conducted by Dr. T. W. Workman in the department of bacteriology at Yale University, New Haven, Connecticut.

This critical investigation of the two methods of pasteurization will include in part: A comparison of bacterial counts, a systematic study of the surviving organisms, the determination of the thermal death times of the thermoduric organisms encountered, and an attempt at the practical identification and control of thermoduric organisms in the raw milk supplies involved. The two methods of pasteurization will be studied under both plant and laboratory conditions. In order to have a tie with the immediate past, both the new and the old standard nutrient agars will be used.

The counsel and cooperation of authorities in the industry and in the field of public health have been solicited in the general plan and execution of this study.

The work is being done in some ten plants located in New York and Connecticut in proximity to Yale University.

The sponsors of this study are:

Dairy Industry
- Borden Farm Products Division of The Borden Company
- Dairymen's League Cooperative Association
- Sheffield Farms Company

Dairy Machinery Industry
- Cherry-Burrell Corporation
- Creamery Package Mfg. Company
- De Laval Separator Company
- Taylor Instrument Company
- York Ice Machinery Mfg. Company

A. J. POWERS, *Chairman.*

The Sterilizing Quality of Chlorine Solutions Under Different Conditions

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The potency of a chlorine solution for sterilizing is measured by the quantity of "available chlorine" present. This "available" or "active chlorine" is not necessarily free chlorine but more often the unstable hypochlorous acid or its sodium salt. A more correct designation of "available chlorine" is that unstable substance in solution which, either as free or combined chlorine, has an active affinity for the proteins in the cells of microorganisms. This chlorination is incompatible with the life of the organisms. The active chlorine unites with the amino acids of the proteins so that it replaces the hydrogen combined with the nitrogen and forms a chloramine. This latter substance is a germicide. Other reactions may also take place to render some of the chlorine inactive.

The present work was planned for the purpose of improving the potency of available chlorine so that satisfactory results may be obtained with weak solutions. Specifically a test was made of the germicidal quality of hypochlorous acid as compared with neutral and alkaline solutions of hypochlorite.

Rideal and Evans (1) in their report of 1921 laid emphasis on the suggestion of the senior author in a publication of 1912 that the oxidizing power of hypochlorite solutions is particularly marked when they are made acid.

This is shown in the oxidation potential series which they give (see table 1.)

TABLE 1

Potassium permanganate	Eh = +1.48	volts
Chlorine in acid solution....	" = +1.39	"
Chromic acid	" = +1.12	"
Ferric chloride	" = +0.96	"
Chlorine in alkaline solution	" = +0.86	"

The table shows that chlorine in acid solution is about as powerful an oxidizing agent as potassium permanganate whereas chlorine in alkaline solution (i. e. hypochlorites) is less powerful than ferric chloride which is not a vigorous agent.

As the chlorination of the amino acids already described is an oxidation process, the work of Rideal and Evans furnishes the data that explains why the hypochlorite in acid solution (hypochlorous acid) should be a superior germicidal agent.

In this investigation it was necessary to study hydrogen ion control, the cultures to be used, the most practical method for determining bactericidal quality, and germicidal effects at varying pH values, temperatures, and times (2).

HYDROGEN ION CONTROL

In order to discover some of the fundamentals concerned in sterilizing with chlorine solutions, it became necessary to prepare a series with pH values from 6.0 to 11.0. Such solutions were made by dissolving 75.68 grams of a neutral lime solvent (hexametaphosphate) in 3.785 liters or one gallon of distilled water and then adding 18.92 grams of H. T. H.* Approximately 56 ml. of this solution diluted to 3.785 liters gave a solution of 50.0 p.p.m.

A reagent to convert the alkaline hypochlorite solution to the acid range was next selected. Mono sodium phosphate was finally chosen for the purpose.

The chlorine solution prepared as described with an available chlorine content of 50.0 p.p.m. had a pH* value of approximately 8.0. It was found that the pH value of this solution could be adjusted to that desired for the germicidal tests by the additions shown in table 2.

* This powder just happened to be a convenient one for our purpose. Almost any other powder or chlorine solution may be used equally well.

TABLE 2

Adjustment of Hydrogen Ion Concentration

Available chlorine p.p.m.	Original pH	Additions per gallon	Resultant pH
50.0	8.0	0.19 gram NaOH	11.0
50.0	8.0	0.00	8.0
50.0	8.0	0.45 gram $NaH_2PO_4+H_2O$	7.0
50.0	8.0	6.10 grams $NaH_2PO_4+H_2O$	6.0

All readings of pH values were made with a Beckman pH meter and with glass and calomel electrodes.

An examination was made of the effect of temperature on pH value. Readings were recorded at temperatures from 50° to 90° F. inclusive, in ten degree spans, as shown in table 3.

Chlorine in the hypochlorite form is relatively unstable and volatile especially when the solution is acid. In order to determine the effect of changes of temperature upon the chlorine content, solutions containing 53.4 p.p.m. of available chlorine at pH values of approximately 6 and 11 were tested for chlorine content after holding at 50° and 90° F for 30 minutes. Neither the acid nor alkaline solutions held at 50° F. lost any chlorine. At 90° F. during the same time, the solution at a pH of 6 lost 0.87 p.p.m. of chlorine which is negligible, and the alkaline one showed no loss. The chlorine contents were determined by the usual titration method which consisted of adding the chlorine solution to a potassium iodide solution that had been acidified with hydrochloric acid. The liberated iodine was titrated with either tenth or hundredth normal sodium thiosulphate depending on the concentration of the chlorine.

CULTURES

Two cultures were used in determining the germicidal quality of the different chlorine solutions. One, a mixed culture, was obtained by adding some milk to a dirty milk botle and incubating at 37° C. for 6 hours and then plating. The resulting surface growth was suspended in 100 ml. of sterile tap water, replated, and carried in this way for stock. This culture proved as resistant in general as *S. aureus* No. 538. The latter was obtained through the kindness of the Hygienic Laboratory, U. S. Public Health Service, Washington, D. C. In tests for resistance, both the mixed culture and *S. aureus* grew after 5 and 10 minutes exposures to a 1:70 phenol solution but gave only faint growth after 15 minutes exposure. Both cultures failed to show any growth in a 1 : 60 phenol solution when exposed for the three periods described.

METHODS OF DETERMINING BACTERICIDAL QUALITY

The germicidal value of the solutions was determined according to the Federal Department of Agriculture method for determining the phenol coefficient but with the following modifications: Four ml. of the inoculum were suspended in 100 ml. of sterile tap water. Five ml. of this suspension were added to 45 ml. of the chlorine solution which had been raised to the temperature for the test. The times of exposure to the germicide also did not follow the F. D. A. method.

TABLE 3

Change in hydrogen ion concentration with temperature in chlorine solution of 53.4 P. P. M.

90° F. pH	80° F. pH	70° F. pH	60° F. pH	50° F. pH	Change 90° to 50° pH
10.90	10.50	11.30	11.20	11.30	+0.40
7.90	7.96	8.15	8.15	8.15	+0.25
6.85	6.90	6.99	7.00	6.90	+0.05
6.20	6.20	6.20	6.39	6.50	+0.30

They were nearer to those of the Rideal-Walker procedure. Two, 5, 7, and 10 minutes seemed better intervals for this work. At the end of the exposure time, 1 ml. was withdrawn and added to 10 ml. of fresh broth, and incubated in the usual way at 37° C. for 48 hours.

For plating examinations of germicidal power, the test organisms grown on an agar plate were suspended in 100 ml. of sterile tap water and shaken in the usual way. Five ml. were added to 45 ml. of the chlorine solution which had previously been raised to the temperature for the test. After shaking the container ten times, it was placed in a water bath at the specified temperature and exposed for the intervals indicated. At the end of each holding period, 1 ml. was withdrawn after shaking the bottle ten times and placed in a petri dish to which had been added some sterile 1 percent sodium thiosulphate solution*. Standard agar was added in the usual way and the plates incubated for 48 hours at 37° C. The determinations were all run in triplicate.

The data presented in all the tables have been verified by repeated tests except where otherwise noted. Numbers of course varied but the trends were the same.

* Where 2 or 5 p.p.m. of available chlorine were used in the test, 0.3 ml. of the 1 percent sodium thiosulphate was taken; if 10 or 20 p.p.m. were used, 0.5 ml. of the thiosulphate was employed; and when there were 30 or 50 p.p.m., 0.8 ml. was added to the petri dish.

GERMICIDAL STUDIES AT VARYING PH VALUES, TEMPERATURES, AND TIMES

The results of the exposure of the *S. aureus* culture to chlorine solutions of 50 p.p.m. of available chlorine under the conditions of different pH values and different times of exposure at different temperatures are shown in table 4.

A chlorine solution containing 50 p.p.m. of available chlorine at a pH of 11 did not sterilize the culture when held at any temperature from 50° to 90° F. for a period up to and including 10 minutes. Some tubes (not reported here) were held for 15 minutes at 90° F., but the results were the same. At a pH of 8, the cultures held at 60° F. up to 90° F. for 5, 7, and 10 minutes were sterile. At 50° F., the duplicates in the 10 minute set were also sterile. At a pH of 7, all the cultures held for 2, 5, 7, and 10 minutes were sterile at all temperatures except one for 2 minutes at 60° and 70° F. and two for the same time at 50° F. At a pH of 6, all cultures held from 5 to 10 minutes at all five temperatures were also sterile. At 90° F., both cultures held for 2 minutes were sterile. One of the duplicates held for 5 minutes at 50° F. showed growth. The others at this pH for 2 minutes grew scantily except at 50° and 80° F.

TABLE 4

Germicidal results with S. aureus exposed to 50 p. p. m. of availavle chlorine

Temperature	90° F.				80° F.				70° F.				60° F.				50° F.			
Exposure in Minutes	2	5	7	10	2	5	7	10	2	5	7	10	2	5	7	10	2	5	7	10
pH																				
11.0	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+
	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+	5+
8.0	0	0	0	0	1+	0	0	0	5+	0	0	0	5+	0	0	0	5+	5+	1+	0
	5+	0	0	0	1+	0	0	0	5+	0	0	0	1+	0	0	0	5+	5+	3+	0
7.0	0	0	0	0	0	0	0	0	5+	0	0	0	0	0	0	0	5+	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	2+	0	0	0	5+	0	0	0
6.0	0	0	0	0	5+	0	0	0	1+	0	0	0	1+	0	0	0	5+	1+	0	0
	0	0	0	0	5+	0	0	0	1+	0	0	0	1+	0	0	0	3+	0	0	0

Control 1,800,000 per milliliter

The luxuriance of growth is indicated by the following figures:

0 = No growth
1+ = Trace
2+ = Light
3+ = Medium
4+ = Heavy
5+ = Very heavy

The results with the mixed culture were very similar to those with *S. aureus* except that it showed a little more growth at a pH of 7 and 8.

These tests indicate that sterility is obtained in a shorter time with a solution at a pH of 6 or 7. The results also show that temperatures from 60° to 90° F. are satisfactory, but that 80° and 90° F. produce slightly better results.

Since a pH of 6 and 7 showed a satisfactory increase in the potency of the chlorine solution, the germicidal quality of different concentrations of chlorine at the former pH value was next determined. The results obtained are shown in table 5.

TABLE 5

Germicidal results with different chlorine concentrations at different pH values. All exposures for 3 minutes.

Chlorine Strength	pH	S. aureus	Mixed culture
0	7.0	9,000,000	7,000,000
2	6.0	8,300,000	6,700,000
5	6.0	2,200,000	2,000,000
10	6.0	1,000	1,000
20	6.0	750	800
30	6.0	130	380
30	11.0	1,300	3,800
50	6.0	130	130

These results show that at pH 6, 50 p.p.m. of available chlorine in 3 minutes kills from 99.9981 percent to 99.9985 percent of the organisms present. A slight increase in time, as indicated by the results in table 4, would, no doubt, produce a sterile condition.

The germicidal results obtained with solutions of 30 p.p.m. of available chlorine at pH 6 and 11 are included for comparison.

A more severe test of the germicidal quality of chlorine solutions was made by determining their potency against spores of *B. subtilis*. This organism and its spores, which commonly occur in the soil, is a frequent contaminant in all food plants. When spores that were a month old were exposed to 255 p.p.m. of available chlorine at a pH of 9.5 for 3 minutes, an original count of 48,000,000 per ml. was reduced to 30,000,000. In this case the potency of the strong chlorine solution had been reduced by the high pH value so that the killing was only 37.5 percent.

In another test, an original count of 21,000,000 spores per ml. was exposed to a chlorine solution containing 50 p.p.m. at a pH of 6 for 3 and for 5 minutes. Seventy-one and nine-tenths percent of the organisms were killed in 3 minutes and 99.89 percent in 5 minutes. A slightly longer exposure would probably give complete sterility.

GERMICIDAL POWER OF 50.0 P.P.M OF AVAILABLE CHLORINE UNDER PLANT CONDITIONS

In view of the fact that most Board of Health regulations require that a solution for spraying shall have an available chlorine content of 250 p.p.m. after it has performed the sterilizing process, any practical application of the results obtained here would have to be based on a comparative test of the effectiveness of an alkaline chlorine solution of this strength with an acidified one containing approximately 50 p.p.m.

Chlorine solutions for spraying purposes are frequently prepared from those purchased with a chlorine content of 15.0 percent. Such solutions when diluted to 255 p.p.m., the strength used in practice, have a pH value from 9.1 to 11.3.

A solution for circulating in equipment usually must have an available chlorine content of 105.0 p.p.m. and, if made from a 15.0 percent solution with tap water, may have a pH of about 0.3 less than the solution containing 255 p.p.m.

The 15 percent chlorine solutions, when manufactured, are made strongly alkaline because they are more stable in this condition. This stability renders them less active as germicides. Such solutions are commonly used in the industry for sterilization by diluting to the desired available chlorine content. One was employed as a basis of comparison in this work.

Accordingly from the same 15 percent stock solution a series of solutions was prepared with tap water just as it would be in the plant. The available chlorine contents of these solutions were 255, 106, and 53.1 p.p.m. The latter was divided into three parts: one received an addition of 1.25 grams of $NaH_2PO_4+H_2O$ per gallon of solution, another part received 1.5 grams of this salt per gallon, and the third received no addition. Readings were then made on the pH values of the five solutions. The results are shown in table 6.

TABLE 6

Hydrogen ion concentration of chlorine solutions prepared from a commercial 15% sodium hypochlorite solution.

No.	Available chlorine p.p.m.	Addition of $NaH_2PO_4+H_2O$ grams per gal.	pH at 22° C.
1	255.0	0	10.60
2	106.0	0	10.35
3	53.1	0	8.35
4	53.1	1.25	6.35
5	53.1	1.50	6.30

The comparison of the germicidal value of the solutions was first tested under plant conditions by spraying a stainless steel, insulated storage tank (capacity 425 cans), that had been washed and rinsed with cold water, with the alkaline hypochlorite solution containing 106.0 p.p.m. of available chlorine and an acid one containing 53.1 p.p.m. of chlorine at a pH of 6.35. Fixed areas were carefully sampled by swabbing before both treatments to obtain an average count per square foot of the untreated surface. The procedure used for obtaining these counts was described by Scales and Russell (3) in the Proceedings of the Laboratory Section of the International Association of Milk Dealers in 1930 and also published with an illustration of the frame in Food Industries, March 1931. The fixed areas were obtained by means of rigid steel wire frames with handles. There was an opening one foot square within each frame and this area was divided by wires into four equal parts, six inches on a side. For these examinations* the foot square areas were used for all swabbings. Twelve areas were thus swabbed on opposite sides of the storage tank. As soon as the swabbing of a square foot was completed, the swab was dropped into 10 ml. of dilution water and hurried to the laboratory for plating. When the dozen areas on opposite sides of the tank had been sampled, unswabbed areas were sprayed with the chlorine solution containing 106 p.p.m. with a pH of 10.35. At the end of 2¾ minutes exposure, the area was quickly wiped and the swab dropped into 10 ml. of dilution water containing 0.01 gram of sodium thiosulphate. These samples likewise were taken to the laboratory for plating. Then similar areas were sprayed with the chlorine solution containing 53.1 p.p.m. at a pH of 6.35. After the same exposure as the previous set, the areas were similarly swabbed and plated. Platings were made in quadru-

* The authors wish to acknowledge with appreciation the careful work of Dr. Charles W. Peterson in obtaining these counts from the storage tanks.

TABLE 7

Bacteria counts per square foot in storage tanks after 3 minutes exposure to chlorine solutions

Sample No.	Treatment	Left side	Average	Right side	Average
1	Unchlorinated areas	480		1,500	
2	Unchlorinated areas	250		530	
3	Unchlorinated areas	530		750	
4	Unchlorinated areas	2,600		1,800	
5	Unchlorinated areas	1,600		620	
6	Unchlorinated areas	2,400		1,400	
7	Unchlorinated areas	1,600		1,600	
8	Unchlorinated areas	1,900		4,200	
9	Unchlorinated areas	2,800		250	
10	Unchlorinated areas	390		860	
11	Unchlorinated areas	1,500		1,000	
12	Unchlorinated areas	3,900		790	
			1,662		1,275
13	Chlorinated 53.1 p.p.m. pH 6.35	0		50	
14	Chlorinated 106.0 p.p.m. pH 10.35	15		35	

plicate with one-tenth dilutions on standard media according to standard procedure. After 48 hours incubation at 37° C., the counts were obtained as shown in table 7.

The same procedure was then followed with a chlorine solution of 255 p.p.m. and a pH of 10.60, and one of 53.1 p.p.m. and a pH of 6.30. The counts were obtained as shown in table 8.

The results of both these plant tests indicate that when chlorine solutions are sprayed on the surface of equipment that has been cleaned and rinsed, a spray containing 50 p.p.m. of available chlorine with a pH value of about 6 will produce as nearly a sterile surface in 3 minutes as a spray of 255 p.p.m. and a pH value of about 10.

DISCUSSION

In determining germicidal power in the early part of this work, a period of 2 minutes frequently proved to be too short a time to produce sterility but one of 5 minutes was generally satisfactory. For this reason the intermediate time, 3 minutes, was selected as most likely to show differences in this quality. In plant treatment the exposures are usually longer than this so that the speed of germicidal action becomes a margin of safety.

In the different tests reported, the inoculum was always far heavier than would be likely to occur in practice. The purpose was to determine germicidal quality under the severest conditions. Allowance must be made for this difference if the results obtained under plant conditions are compared with those in any other part of this report.

Any recommendation for the most satisfactory concentration of chlorine for sterilizing must be determined not only by the speed of action and potency of the solution but also by its corrosive quality on various metals.

Since a solution containing 50 p.p.m. of available chlorine at a pH of 6 is a satisfactory sterilizing agent, any corrosion that such a weak solution might produce may be very much reduced or even entirely prevented by using it shortly before the processing time.

CONCLUSIONS

1. The results prove the greater germicidal efficiency of chlorine solutions when the pH is adjusted to around 6.
2. When the pH value of the solution is 8 or under, 90° F. appears to be a better temperature for steriling treatments than any lower one.
3. Chlorine solutions held at from 50° to 90° F. showed no important loss in chlorine content in half an hour in the pH range from 6 to 11.
4. The pH values of solutions containing 50 p.p.m. of available chlorine do not change materially through the temperature range from 50° to 90° F. The actual change was less than 0.5 pH.
5. Acid sodium phosphate is a satisfactory agent for adjusting the pH to the desired acid reaction.
6. Two minutes seems to be too short a time to yield dependable sterility results under the conditions employed in this work even with acid pH values.
7. It is shown by laboratory and plant tests that a solution containing 50 p.p.m. of available chlorine at a pH around 6 will produce as satisfactory germicidal results as a solution containing 255 p.p.m. of chlorine at a pH around 10.

TABLE 8

Bacteria counts per square foot in storage tanks after 3 minutes exposure to chlorine solutions.

Sample No.	Treatment	Left side	Average	Right side	Average
1	Unchlorinated areas	710		110	
2	Unchlorinated areas	700		590	
3	Unchlorinated areas	800		100	
4	Unchlorinated areas	830		430	
5	Unchlorinated areas	170		570	
6	Unchlorinated areas	450		120	
7	Unchlorinated areas	920		380	
8	Unchlorinated areas	430		670	
9	Unchlorinated areas	210		540	
10	Unchlorinated areas	500		370	
11	Unchlorinated areas	780		480	
12	Unchlorinated areas	550		300	
			588		388
13	Chlorinated 53.1 p.p.m. pH 6.30	0		50	
14	Chlorinated 255.0 p.p.m. pH 10.60	0		50	

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The Irradiation of Milk

Within the past few years, the irradiation of milk has increased until now there are approximately 130 licensed fluid milk dairies in the United States and Canada irradiating their milk, and over half of all evaporated milk produced is irradiated. The scientific data on which this great development rests have been assembled and correlated in an orderly and clear presentation in this new bulletin. The subjects dealt with begin with a discussion of the prevalence of rickets and the relation of vitamin D to adequate nutrition and health. There follows a discussion of the nature of light and radiation together with the physical basis on which the irradiation process rests. After this comes a discussion of the bioassay technic with full illustrations of the various steps and sections of bones to show the "line test" in various degrees of healing, indicated by the number of plus signs. Then the chemistry of vitamin D, and the character of radiant energy from various sources. Several illustrations are given of each type of commercial equipment using respectively the carbon arc, the quartz mercury vapor lamp, and the high voltage discharge tube (commonly called the cold quartz tube). Factors which control the effectiveness and constancy of irradiation follow, together with the control technic and equipment. The bulletin concludes with a discussion of other effects of irradiation, including that on flavor, and lists 85 references.—**The Irradiation of Milk,** by K. G. Weckel and H. C. Jackson, *Wisconsin Agr. Exp. Sta. Research Bul.* 136, 1939.

J. H. SHRADER.

New Law Book on Milk Control

Producers and distributors of milk and dairy products who wish to avoid liability and prevent conflicts with official regulations will find much of interest and value in a new book by Dr. James A. Tobey entitled "Public Health Law".

This comprehensive work of more than 400 pages was published in June by The Commonwealth Fund of 41 East 57th Street, New York City. It is a revised and enlarged edition of an earlier book by Dr. Tobey, first issued in 1926, and used as a textbook in all of the leading university schools of public health.

A feature of the book is a chapter on milk control. Also included are chapters on foods, drugs, and cosmetics, and on liability, while other sections are concerned with the powers, duties, and functions of federal, state, and local health officials.

Dr. Tobey is also the author of a book entitled "Legal Aspects of Milk Control," which was published by the International Association of Milk Dealers in 1936.

A Comparison of Plate Counts of Raw Milk on the Old Standard Nutrient Agar and on the New Standard Tryptone-Glucose-Extract-Milk Agar

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In anticipation of the mandatory use of the tryptone-glucose-extract-milk agar, (hereinafter designated as T-G-E-M) prescribed by the American Public Health Association Committee on Standard Methods for the Examination of Milk and Dairy Products (1) as the standard agar for milk plate counts after July 1, 1939, the Montgomery laboratory of the Alabama State Department of Health has plated samples of raw milk on the new medium as well as upon Standard Nutrient Agar in order to note the effect upon counts. Since average plate counts constitute one of the principal factors in the grading of milk supplies throughout the country, the effect of the use of the new agar upon milk grades is a question of deep interest.

The report of Abele (2), the prepublication data of which were available, dealt primarily with the effect of the use of the T-G-E-M Agar upon *pasteurized* milk counts. The present report presents an analysis of the comparative plate counts of 1000 raw milk samples examined between March 8 and July 20, 1939. The medium used was Bacto Tryptone-Glucose-Extract-Milk Agar with 1.0 percent Bacto skimmilk added since only 1:100 and 1:1000 dilutions were plated. The milk samples were those routinely delivered to the laboratory by the Montgomery dairy inspector, and such as were shipped from neighboring communities in the normal course of milk control. Slightly less than half the samples considered in this study were of milk for pasteurization, the remainder being street and special samples of retail raw milk.

COMPARATIVE COUNTS ON THE TWO AGARS

The gross results of the comparative counts on the old and the new agars are presented in table 1.

TABLE 1

Comparative Plate Counts of 1000 Raw Milk Samples on Standard Nutrient and T-G-E-M Agars

Range of Counts on Standard Nutrient Agar	No. of Counts	Arith. Average of Counts on Standard Nutrient Agar	Arith. Average of Counts on T-G-E-M Agar	Percentage Aver. Increase of Count
0-5,000	125	3,518	5,006	42.6
5,100-10,000	144	7,552	9,544	26.4
11,000-25,000	218	16,591	22,346	34.8
26,000-50,000	168	35,637	47,030	32.0
51,000-100,000	136	74,191	95,574	28.8
110,000-200,000	90	144,778	158,222	9.3
210,000-500,000	72	349,444	439,000	25.6
510,000-1,000,000	24	733,333	965,000	31.6
Over 1,000,000	23	2,695,652	3,118,261	15.7
Totals	1,000	139,011	168,506	21.2

Examination of table 1 indicates a general lack of uniformity in the percentages of average increase in count on T-G-E-M Agar over Standard Nutrient Agar. The percentages of average increase in count range from 9.3 percent on 90 samples in the range 110,000 to 200,000 per cc., to 42.6 percent on 125 samples in the range of 0 to 5,000 per cubic centimeter. Considered cumulatively, however, these percentages of average increase are somewhat more uniform, as indicated by table 2.

TABLE 2

Cumulative Percentages of Average Plate Count Increases

Range on Standard Nutrient Agar	Percentage Average Increase on T-G-E-M Agar
0-5,000	42.6
0-10,000	30.9
0-25,000	33.6
0-50,000	32.7
0-100,000	30.9
0-200,000	22.6
0-500,000	23.9
0-1,000,000	25.7
0-1,000,000 plus	21.2

The figures in table 2 must be accepted merely as averages. For instance, the increase of not a single one of the 125 counts in the range 0-5,000 per cc. on Standard Nutrient Agar was exactly 42.6 percent; the nearest percentages to this average were 41.7 percent and 44.2 percent. Likewise, the increase of not one of the 655 counts under 50,000 per cc. on Standard Nutrient Agar was exactly 32.7 percent (the average for the group), and the increases of only 22 (3.3%) of the samples in this whole group lay between 30 percent and 35 percent.

The numbers and percentages of cases in which the counts were increased, decreased, or remained unchanged by plating on T-G-E-M Agar, and the ranges in the percentages of change from the counts on Standard Nutrient Agar, are given in table 3.

SEARCH FOR DEFINITE RATIO

In order to determine whether there is any definite ratio between the count on Standard Nutrient Agar and that on T-G-E-M Agar, within certain ranges of count magnitude, the groups of counts within each of the ranges used throughout this study were divided: first, into groups of twenty as they were recorded; second, into thirds, by grouping the alternate third samples; and finally, into halves, by grouping odd and evenly numbered samples separately. The results of these determinations of average increases in count are presented in table 4.

A glance at a work sheet of individual percentages of increase or decrease in count on T-G-E-M Agar of a series of any twenty samples comparatively examined would no doubt lead an observer to question the likelihood of group uniformity of percentage increase within certain range limits; but the data in table 4 should convince him of the improbability of such uniformity. With rare ex-

TABLE 3

Percentages of Increases or Decreases in Counts on T-G-E-M Agar (Increase or decrease based upon Standard Nutrient Agar count)

Range of Counts on Standard Nutrient Agar	Increased		Unchanged		Decreased		Range of Change	
	No	%	No	%	No	%	Decrease	Increase
0-5,000	97	77.6	4	3.2	24	19.2	−27.3%	to+ 255.5%
5,100-10,000	97	67.4	6	4.2	41	28.4	−55.2%	to+ 938.4%
11,000-25,000	149	68.4	21	9.6	48	22.0	−40.0%	to+1,718.1%
26,000-50,000	121	72.1	11	6.5	36	21.4	−37.0%	to+ 778.7%
51,000-100,000	99	72.8	5	3.7	32	23.5	−32.8%	to+ 345.3%
110,000-200,000	50	55.5	20	22.2	20	22.2	−27.3%	to+ 105.9%
210,000-500,000	57	79.1	2	2.8	13	18.1	−31.2%	to+ 480.0%
510,000-1,000,000	17	71.8	1	3.2	6	25.0	−26.8%	to+ 216.7%
Over 1,000,000	17	73.8	0	0.0	6	26.2	−30.2%	to+ 131.2%
Total	704	70.4	70	7.0	226	22.6	−55.2%	to+1,718.1%

TABLE 4

Comparative Percentages of Average Increase in Counts on T-G-E-M Agar

Range on Standard Nutrient Agar	Whole Groups Total No. of Counts	Whole Groups Percentage Average Increase	Groups of Twenty 1st 20	2nd 20	3rd 20	4th 20	5th 20	6th 20	7th 20	8th 20	9th 20	10th 20	Third Groups Percentage Avg. Increase 1st Third	2nd Third	3rd Third	Half Groups Percentage Avg. Increase 1st Half	2nd Half
5,000	125	42.6	44.7	52.6	35.7	30.3	27.3	57.7	34.9				42.6	34.6	49.5	47.1	37.2
100-10,000	144	26.4	7.4	14.1	26.2	12.8	53.6	35.7	20.9	22.5	32.6	72.5	28.1	17.3	33.6	16.3	36.4
1,000-25,000	218	34.8	10.5	17.6	5.4	28.7	88.4	38.3	9.5	27.2			38.9	14.9	49.7	34.8	34.5
5,000-50,000	168	32.0	3.9	63.5	24.0	38.7	23.8	53.0					29.6	32.8	33.5	26.8	36.9
1,000-100,000	136	28.8	7.0	15.0	21.1	34.7	43.3	44.8					31.0	28.2	27.1	30.0	27.7
10,000-200,000	90	9.3	4.4	19.9	3.6	8.9							11.4	11.0	5.2	6.0	12.4
10,000-500,000	72	25.6	43.3	11.5	22.7								16.1	35.9	24.3	27.9	23.5
10,000-1,000,000	24	31.6	31.5										33.1	40.6	21.5	21.5	43.3
Over 1,000,000	23	15.7	9.5										12.4	16.7	18.2	11.4	22.4
Totals	1,000	21.2											18.4	25.0	20.8	17.3	25.9

ceptions, no two percentage figures for any range group coincide.

The foregoing discussion has been somewhat academic. It is neither to be assumed that milk control authorities would continue to plate samples on Standard Nutrient Agar, and project the counts into higher figures; nor that samples would be plated on T-G-E-M Agar and that high counts would be discounted to Standard Nutrient Agar magnitudes. Either of these procedures is unthinkable.

EFFECT ON PRESENT GRADE DISTRIBUTION

The fundamental question with respect to the use of the new Standard T-G-E-M Agar is: "What will be the effect upon the grade of milk supplies now consistently within Grade A bacterial plate count limits?" It is obvious from the foregoing discussion that the application of any of the percentage figures of average increases obtained in this or other reported studies (3, 4) is most likely to yield unsound and misleading results. Although it appears that every group of 1,000 comparative counts may differ somewhat in its percentages of average increases from every other group of 1,000 counts, the differences may lie within comparatively narrow ranges. Therefore, the examination of the 1,000 counts under scrutiny, with respect to possible changes in grade, may be of interest.

Of the 529 counts of retail milk, 378 were 50,000 or less per cc. on Standard Nutrient Agar; and of the 471 counts of bulk milk for pasteurization, 384 were 200,000 or less per cubic centimeter. (These limits are used because they are those fixed by the U. S. Public Health Service Milk Ordinance for the upper grades of raw milk and of milk for pasteurization.) Approximately 10 percent of all (655) counts of 50,000 or less per cc. on Standard Nutrient Agar were over 50,000 per cc. on T-G-E-M Agar. But nearly 60 percent of these increases occurred in samples of bulk milk for pasteurization, and the grade was unaffected.

The numbers of instances in which the

T-G-E-M Agar yielded a count of a magnitude above the limit fixed for Grade A Raw Milk for retail distribution and for milk for pasteurization, but within which grade the Standard Nutrient Agar counts retained these supplies, is given in table 5.

Of the 378 counts of retail raw milk of 50,000 or less per cc. on Standard Nutrient Agar, only 7.4 percent were over 50,000 per cc. on T-G-E-M Agar and would have affected the grade adversely. Ten of the 28 counts over this limit on T-G-E-M Agar were between 40,000 and 49,000, inclusive, per cc. on Standard Nutrient Agar. Duplicate counts on Standard Nutrient Agar might readily have exceeded 50,000 per cc., and also affected the grade.

Of the 384 counts of bulk milk for pasteurization, of 200,000 or less per cc. on Standard Nutrient Agar, only 10, or 2.6 percent, were over 200,000 per cc. on T-G-E-M Agar; 6 of these ranged from 160,000 to 200,000, inclusive, per cc., on Standard Nutrient Agar.

Incidentally, 4 counts of retail raw milk over 50,000 per cc. on Standard Nutrient Agar were less than 50,000 per cc. on T-G-E-M Agar. One count of prepasteurized milk over 200,000 per cc. on Standard Nutrient Agar was under this limit on T-G-E-M Agar. These lower counts would have affected the grade favorably.

CONCLUSIONS

The plate count of raw milk, using T-G-E-M Agar, as compared with the plate count of the same milk on Standard Nutrient Agar, can not be prognosticated, in terms of percentage increase or decrease. This holds true for single counts or for groups of counts in the same range of count magnitude.

The percentages of average deviation of the T-G-E-M Agar counts from Standard Nutrient Agar counts of small groups of samples of similar size can not be expected to coincide; and it follows from this that the drawing of conclusions, as to interpolation, from the analysis of one group to be applied to other groups would be fallacious.

The numbers of samples (7.4 percent and 2.6 percent, respectively, of retail raw and prepasteurized milks) the grade of which was adversely affected by higher counts obtained by plating on T-G-E-M Agar were no greater than might have been expected to result from the plating of duplicate samples on Standard Nutrient Agar. The only logical conclusion to be drawn from this crucial finding is that, although the T-G-E-M Agar produces larger colonies and permits the growth of some organisms the multiplication of which is inhibited on Standard Nutrient Agar, the plate counts of low-bacterial-content milk are not (or only rarely) increased to an extent to jeopardize the grade. In the comparatively rare instances in which low counts on Standard Agar are increased on T-G-E-M Agar sufficiently to change the grade, it must be recognized that these organisms were nevertheless present in the milk, even though not developed by the Standard

TABLE 5

Grade Altered Because of Higher or Lower Counts on T-G-E-M Agar

Range on Standard Nutrient Agar	Retail Milk on T-G-E-M Agar		Milk for Pasteurization on T-G-E-M Agar	
	Under 50,000 per cc	Over 50,000 per cc	Under 200,000 per cc	Over 200,000 per cc
0-5000	100	0	25	0
5,100-10,000	95	1	48	0
11,000-25,000	121	4	93	0
26,000-50,000	62	23	83	0
51,000-100,000	4		77	2
110,000-200,000			58	8
210,000-500,000			1	

Nutrient Agar plate, and that the grade awarded on the Standard Nutrient Agar count was, to that extent, misleading.

It appears that average plate count limits now fixed in milk ordinances and regulations need not be raised to avoid anticipated chaos in the grades of milk supplies resulting from the higher counts obtained by the use of the new Standard T-G-E-M Agar.

SUMMARY

One thousand samples of retail and prepasteurized raw milk were plated in duplicate on Standard Nutrient and Tryptone-Glucose-Extract-Milk Agars.

The percentages of average deviation of the T-G-E-M Agar counts from those plated on Standard Nutrient Agar, in the various ranges of count magnitude, were extremely non-uniform.

It appears to be impossible to approximate the percentage of deviation in counts, or to translate the count on one medium into terms of that on the other.

The number of instances in which the higher count on T-G-E-M Agar would have altered the grade of a milk supply retained by the Standard Nutrient Agar count was very small—7.4 percent in the case of retail raw milk, and 2.6 percent in the case of bulk milk for pasteurization.

The results of this study, if they may be applied to raw milk supplies of approximately similar quality, do not indicate a need for change in the average plate count limits now fixed in milk control legislation.

ACKNOWLEDGEMENTS

The writers are indebted to Cooper Brougher, Assistant Director, of the Bureau of Laboratories of the Alabama State Department of Health for assistance in the preparation of this report, and to E. A. Van Eck, Junior Bacteriologist in the Montgomery laboratory, who made all the counts.

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A Single-Dip Stain for the Direct Examination of Milk *

J. Broadhurst and C. Paley

This stain is employed for making direct microscopic counts of milk, according to the Breed method. It combines fat extraction, fixing and staining.

The stain contains ethyl alcohol, a very small quantity of concentrated sulphuric acid, tetrachlorethane, methylene blue dye, and an alcoholic solution of basic red fuchsin.

The advantages of this stain are that there is a differential background permitting the easy differentiation between the bacteria and all other cells and foreign bodies, such as precipitated dye, etc. Eye strain is eliminated because the organisms do not have to be searched for and are not hidden by darkly stained, congealed serum solids on the smear. The serum solids appear very faintly pink while the organisms and other cells are blue. No decolorizing of a heavily stained smear is necessary.

The preparation of the stain is simple. The technique employed is basically the same as that employed when using the Newman-Lampert stain.

C. P.

* *Am. Vet. Med. Assoc.*, N.S. *47*, 525-526 (1939).

Testing of Bottle-Washing Solutions *

C. M. Moore

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In the machine washing of returned dirty milk bottles, two results are expected from the cleaning solution. First, it must be capable of removing, eliminating or otherwise destroying the visible dirt on the bottles; second, it must kill or be of such a nature as to be able to destroy the invisible dirt—bacteria, mold, and yeast. "Dirt" has been aptly defined by the early Greek philosophers as "matter in the wrong place." Dirt present on returned milk bottles will vary from the product itself which has dried on and adhered to the glass surface, to remnants of materials for which the bottle has been used as a container but for which it was never intended.

The more insidious forms of dirt, which cannot be seen with the naked eye —bacteria, mold, and yeast—are always present in dirty milk bottles, and find, in even the thin film of organic matter left, ideal breeding grounds. The three conditions necessary for growth—food, temperature, and moisture—are almost always present in such bottles.

As the washed bottles leave the machine and are set up on the inspection platform, they are usually carefully inspected to make sure that not even a trace of visible dirt is present. The ability of the solution to clean the bottles in so far as visible dirt is concerned can be accurately measured at this point. But how about the ability of the solution to sterilize the bottles? Can it be measured by examining the bottles as they leave the machine? No amount of looking at a washed bottle will tell whether or not it is free from bacteria, mold and yeast. Obviously, therefore, dependence must be placed upon the treatment given the bottles as they pass through the machine before it can be said with assurance that "these bottles are sterile and can be safely used as containers for the finest milk."

Of the various factors to consider in appraising the sterilizing treatment given the bottles in the washing machine, three are of outstanding importance. These are:

1. The temperature of the solution.
2. The time of contact between the solution and the bottle.
3. The strength of the solution.

The first two factors are easily measured. A thermometer can be placed in the solution tank and the temperature obtained at a glance. Most bottle-washing machines are already equipped with a thermometer for this purpose. The time of contact can either be obtained from the manufacturer of the bottle-washing machine or checked by actual observation of the machine in operation. The third factor—the strength of the solution—has proved somewhat of a stumbling block in the past. Just what actually comprises the strength of the solution and how can this best be measured?

The cleaning solution is expected both to clean and sterilize the bottles. Since the cleaning strength or ability of the solution to remove visible dirt is checked and measured by examination of the bottles as they come from the machine, it seems obvious that the test which provides the best index of the sterilizing ability of the solution would be the test to select in appraising the strength of the solution. Therefore, in considering the various tests that are used or that have been proposed for bottle-washing solutions, it would appear fundamentally sound to keep before us the question,

* Presented at Twenty-seventh Annual Meeting of the International Association of Milk Sanitarians, Cleveland, Ohio, October 19-21, 1938.

"Does this particular test of the solution provide an index of the ability of the solution to destroy bacteria, mold and yeast?"

At the present time there are perhaps three methods widely used for testing bottle-washing solutions. These are:

1. The hydrometer test.
2. The total alkali or alkalinity test.
3. The caustic test.

Two other tests have been proposed but are not in general use. These are:

1. The pH test.
2. The conductivity test.

Let us consider each of these tests on the basis of what it shows, or for that matter fails to show, and particularly whether or not it provides an accurate index of the sterilizing strength of the solution.

THE HYDROMETER TEST

In the earlier days of bottle washing operations the hydrometer was used almost exclusively for testing bottle-washing solutions. The hydrometer measures the weight of a solution without any regard for the particular material or materials present in the solution. A carefully calibrated hydrometer does, therefore, serve with reasonable accuracy as an index of the weight of a particular solution, without, however, any consideration as to what comprises the additional weight of the solution over plain water.

Now, if bottle-washing solutions were prepared from one material and that material alone, and only that material was ever present in the solution, and further, we knew the sterilizing strength of the particular material—then, and only then would the hydrometer provide a satisfactory means of testing the solution. However, such conditions cannot possibly exist in bottle-washing operations. Some of the dirt from the bottles is soluble and will tend to increase the specific gravity or weight of the solution. A hydrometer would indicate an increase in sterilizing efficiency of the solution, whereas actually the sterilizing strength has been reduced by the dirt. The cleaner itself may break down somewhat in the solution and be partially depleted in sterilizing strength, and yet the weight of the solution would not necessarily be affected. The hydrometer could not show this change. Because the hydrometer cannot distinguish one material from another, but depends entirely upon the weight of the solution, it is obvious that such a means of testing bottle-washing solutions is at best very poor indeed.

Table 1, taken from Educational Bulletin No. 1 of the American Bottlers of Carbonated Beverages, based on work conducted by Dr. Max Levine and Dr. J. H. Buchanan, shows the tremendous variation under practical operating conditions that may result between the hydrometer test and the actual caustic content of the solution. Only in the case of sample No. 2 was the hydrometer reading reasonably close to the actual causticity of the solution, and this, of course, is only a coincidence.

TABLE 1

Baumé and Causticity of Bottle Washing Solutions

Sample number	Baumé reading	Percent caustic by hydrometer	Actual percent as caustic	Percentage error
1	2.81	1.81	2.27	20.2
2	3.60	2.24	2.19	2.28
3	4.08	2.56	2.16	18.5
4	4.43	2.78	2.15	29.3
5	4.74	2.98	2.16	37.9
6	5.14	3.24	2.18	48.7
7	5.61	3.54	2.12	66.9
8	5.71	3.60	2.02	78.2
9	5.83	3.68	1.92	91.6

Data Courtesy DR. MAX LEVINE and A. B. C. B.

THE TOTAL ALKALI OR TOTAL ALKALINITY TEST

This test is made by withdrawing a sample of the bottle-washing solution, usually 10 cc. and then titrating it with standard strength acid. The indicator commonly used will be phenolphthalein. The results are generally expressed as either percent total alkalinity, as caustic equivalent, or in other cases caustic alkalinity. To illustrate, let us assume that our bottle washing solution comprises caustic soda, trisodium phosphate, and sodium carbonate. When titrated to the phenolphthalein end point, the standard acid will neutralize all the caustic soda, one-third of the trisodium phosphate, and one-half of the sodium carbonate. With other indicators, some of which have been proposed, different results would be obtained, depending upon the pH range of the indicator selected.

As can be readily appreciated from the method by which the test is made, the total alkalinity of the solution is nothing more nor less than the acid neutralizing value of the solution. It is true that these results may sometimes be expressed as caustic equivalent, but this of itself does not necessarily mean that the solution contains any caustic. A solution of, say, 3 percent caustic equivalent simply means that the solution has the same acid neutralizing strength to a specified indicator as a solution containing 3 percent caustic soda. The term "caustic equivalent" is very confusing, and it is unfortunate that it is used in many of our health department regulations dealing with the strength of bottle washing solutions. If it were true that the ability of a solution to neutralize an acid was an index of its sterilizing strength, then the test for total alkalinity would meet our requirements for an accurate test of the bottle-washing solutions. There is, however, no direct relationship between the ability of a solution to neutralize acids and its ability to kill bacteria, mold or yeast. Hence, the total alkali or test for caustic equivalent cannot be considered as a satisfactory test for bottle washing solutions.

FREE CAUSTIC TEST

The test for the total or free caustic content of a solution is made similarly to the total alkalinity test. However, it determines only the amount of caustic present in the solution without regard to the other alkalies that are always present. There are two general procedures for making this test. The sample, usually 10 cc., is treated with a solution of barium chloride. The barium chloride reacts with the non-caustic alkalies, such as trisodium phosphate and sodium carbonate, forming insoluble barium salts. It does not react with any free caustic present in the solution. The sample is then titrated to the phenolphthalein end point, and since only caustic soda is present, the amount of acid required to neutralize the sample is a direct index of the amount of caustic soda present in the solution.

The other method for determining total or free causticity is known as the double titration procedure. Here the sample is first titrated with standard acid to the phenolphthalein end point. The amount of acid required is carefully noted and the titration then continued with methyl orange as the indicator. Since the first titration results from the caustic present in the solution and a definite fractional part of each of the other alkalies, and since the second titration accounts for the same definite fractional part of each of these other alkalies, then merely subtracting the second reading from the first gives us the amount of acid required to neutralize only the caustic. This in turn is quickly factored to free caustic.

CAUSTIC AND ALKALI NOT THE SAME

The test for total or free causticity differs from the total alkali or alkalinity test in that the former measures the amount of only one particular alkali—caustic soda that is present in the solution—whereas the latter measures all the alkalies present. Unfortunately, many people use the word "causticity" and "alkalinity" interchangeably as meaning the same thing. This is the cause of much of the confusion that exists in testing of bottle washing solutions. "Alka-

li" is the family name of those materials which are neither acid nor neutral. Materials such as washing soda or soda ash, trisodium phosphate, metasilicate, caustic soda, and even baking soda, are all members of the alkali family. Because caustic soda is the most alkaline of the commercial alkalies, many of us get the impression that causticity and alkalinity are the same. It is important to note that just because caustic soda is an alkali, an alkali is not necessarily caustic soda. It could just as well be soda ash, trisodium phosphate, neutral soda, borax, or some other alkali. We think nothing of drinking a solution of baking soda, yet the consumption of even a small amount of a caustic soda solution would lead to disastrous results. Yet both are alkalies.

To further illustrate the difference between total alkalinity and total or free causticity, let us assume that we have some sodium carbonate and some caustic soda. Caustic soda is also known commercially as lye—chemically as sodium hydroxide and sodium hydrate. Now both sodium carbonate and caustic soda are alkalies, yet everyone knows there is a tremendous difference between them. Sodium carbonate is commonly used for washing clothes and various other household cleaning jobs. It is a common constituent of many dairy cleaners, and as such can be safely used in hand washing operations. It is indeed generally considered as a rather mild cleaner. Caustic soda, however, is a very harsh and corrosive material. If it were used for washing clothes or for general cleaning operations we would soon find that our clothes were ruined and our hands would require the attention of a physician; yet caustic soda and soda ash are both alkalies.

Just as there is a tremendous difference between the action of soda ash and caustic soda on cloth and skin, so too, is there a tremendous difference between them in their action on bacteria, mold and yeast. Soda ash is not ordinarily considered as a germicidal agent. Caustic soda, however, does destroy bacteria, mold, and yeast, under the proper conditions of concentration, temperature, and time of contact. These conditions have been pretty well established by numerous laboratory and practical plant tests. A test of the solution for total causticity does provide a reasonably accurate index of the sterilizing strength of the solution, while the test for total alkalinity is of little practical value in this respect.

Some recent bacteriological tests made by our Research Laboratories in conjunction with the Columbus Laboratories of Chicago illustrate the value of the three methods of testing bottle-washing solutions which we have discussed. In these tests we used three products for making up the solutions—commercial caustic soda; a mixture comprising 50 percent caustic soda and 50 percent sodium carbonate, or soda ash; and straight soda ash. The solutions were made up first at the same degree Baumé, then the same total alkalinity when titrated to the phenolphthalein end point, and finally to the same causticity. Table 2 shows the results when the tests were made with solutions of equal specific gravity, or degrees Baumé.

It will be noticed that with each product, solutions were prepared of 1, 2, 3, and 4 degrees Baumé. The actual causticity, total alkalinity, and number of pounds per 100 gallons are also shown at the bottom. The test organism selected for these tests was a strain of *Staphylococcus aureus* of standard phenol resistance. The test was made at a temperature of 98.6° F., this temperature being used so that the destruction of the organism was due entirely to the solution and not to outside factors, such as temperature. It is obvious from the results shown in this table that there is no connection whatsoever between the Baumé or specific gravity of the solution and its germicidal efficiency.

Table 3 shows the results of tests made under identical conditions, except that the amount of each product used was such as to give equal total alkalinity with the three products. The solutions were equivalent in acid neutralizing value, and yet their ability to destroy bacteria is obviously not connected with the neutralizing strength. For example, the solution containing 4 percent total alkalinity, prepared from soda ash, would neutralize just twice as much acid as the 2 percent solution prepared from caustic soda, and yet the caustic soda solution does kill the test organism, while the soda ash solution has no apparent effect upon it.

Table 4 shows what happens when the solutions are used at equal causticity. Of course, the soda ash solutions could not be included in this comparison because they do not contain any free caustic. It will be noticed from a close study of these last two tables that the germicidal efficiency of the various alkalies with this particular organism is closely related to the free caustic content of the solution, with one or two minor exceptions. It is particularly to be noted that where the *causticity* reached a definite concentration of slightly less than 1 percent, all the solutions of greater causticity did kill the test organism in less than 1 minute. This statement could not be made with solutions of equal alkalinity or equal specific gravity.

Within the last few years, several products have been offered for machine-washing of bottles, with the recommendation that they be used at a concentration which gives approximately ½ percent causticity. It is claimed that these materials contain substances other than caustic soda or available chlorine, and yet have marked sterilizing properties. Whether or not these products do have additional

TABLE 2

Germicidal Efficiency of Alkaline Materials

Test No. 1—Solutions of Equal Specific Gravity

Product	Caustic Soda				50% Caustic Soda 50% Soda Ash				Soda Ash			
Degrees Baumé	1°	2°	3°	4°	1°	2°	3°	4°	1°	2°	3°	4°
Time 1 Min.	+	+	—	—	+	+	+	—	+	+	+	+
3 Min.	+	—	—	—	+	+	—	—	+	+	+	+
5 Min.	+	—	—	—	+	—	—	—	+	+	+	+
10 Min.	—	—	—	—	+	—	—	—	+	+	+	+
% Causticity	0.63	1.30	1.97	2.64	0.30	0.60	1.0	1.35	NO CAUSTICITY			
% Alkalinity	0.64	1.33	2.02	2.70	0.38	0.76	1.27	1.71	0.25	0.48	0.76	1.0
Pounds per 100 Gallons	5.53	11.20	17.45	23.40	5.80	11.80	17.80	23.60	5.96	11.9	17.45	23.8

KEY: + = Bacterial growth; — = No bacterial growth
Organism: *Staphylococcus aureus* strain of standard phenol resistance
Temperature: 98.6° F.

TABLE 3

Germicidal Efficiency of Alkaline Materials

Test No. 2—Solutions of Equal Alkalinity (Phenolphthalein Titration)

Product	Caustic Soda				50% Soda Ash 50% Caustic Soda				Soda Ash			
10 Min. % Alkalinity	0.5	1.0	2.0	3.0	0.5	1.0	2.0	3.0	1.0	2.0	3.0	4.0
Time 1 Min.	+	+	—	—	+	+	—	—	+	+	+	+
3 Min.	+	+	—	—	+	+	—	—	+	+	+	+
5 Min.	+	—	—	—	+	—	—	—	+	+	+	+
% Causticity	+	—	—	—	+	—	—	—	+	+	+	+
Pounds per 100 Gallons	0.49	0.98	1.96	2.84	0.36	0.72	1.44	2.16	NO CAUSTICITY			
	4.25	8.50	17.00	25.50	6.12	12.26	24.50	36.80	22.55	45.1	67.6	90.2

KEY: + = Bacterial growth; — = No bacterial growth
Organism: *Staphylococcus aureus* strain of standard phenol resistance
Temperature: 98.6° F.

TABLE 4

Germicidal Efficiency of Alkaline Materials
Test No. 3—Solutions of Equal Causticity

Product	Caustic Soda				50% Caustic Soda 50% Soda Ash		
% Causticity	0.5	1.0	2.0	3.0	0.5	1.0	2.0
Time 1 Min.	+	+	—	—	+	+	—
3 Min.	+	+	—	—	+	—	—
5 Min.	+	—	—	—	+	—	—
10 Min.	+	—	—	—	+	—	—
% Alkalinity	0.51	1.02	2.05	3.06	.70	1.39	2.78
Pounds Per 100 Gallons	4.25	8.50	17.0	25.50	8.50	17.0	34.00

KEY: + = Bacterial growth; — = No bacterial growth
Organism: *Staphylococcus aureus* strain of standard phenol resistance
Temperature: 98.6° F.

sterilizing action over caustic soda seems to be beside the point. The main fact is that the sterilizing strength of the solution cannot be determined by any test other than bacteriological examination of the washed bottles. This should be enough for any conscientious health official or dairy plant to condemn the use of products with mysterious and unrecognized sterilizing action when used at low caustic strengths for washing milk bottles. Germicidal action which cannot be measured by a simple test is little better than guesswork, and has no place in bottle washing operations, when it is so easy to actually determine the sterilizing strength of the solution by the caustic test.

Table 5 shows the results of bacteriological tests with organisms that are somewhat more difficult to destroy than *Staphylococcus aureus*. This work was conducted by an independent consulting laboratory of recognized standing, and while the particular organisms used are closely related to brewing operations, it is likely that the same organism, or organisms of similar resistance, are apt to be present in returned dirty milk bottles, as well as the bottles used for beverages that are bottled, handled, and distributed by many dairies. Three types of organisms as listed in the table were used in this investigation. The solutions were all prepared from commercial bottle washing compounds, and are identified in this report as "A," "B," and "C." The comparison was made with solutions of equal causticity, and the solutions each contained 1 percent, 1.8 percent, and 3 percent causticity. The temperature in each test was 130° F. and the time of contact 1, 3, and 10 minutes. These conditions closely approximate average bottle-washing operations. It will be noticed that the destruction of the organisms with each of the three commercial products is rather closely related to the free caustic content of the solutions.

TABLE 5

Germicidal Efficiency of Bottle Washing Compounds

Compound	A			B			C	
% Causticity	1.0	1.8	3.0	1.0	1.8	3.0	1.0	1.8
Normal and Wild Yeasts								
Time 1 Min.	+	+	—	+	+	—	+	S
3 Min.	S	—	—	S	—	—	S	S
10 Min.	—	—	—	—	—	—	—	—
Mold Spores								
Time 1 Min.	+	+	—	+	+	—	+	+
3 Min.	+	S	—	S	+	—	+	+
10 Min.	S	—	—	S	—	—	S	—
Wild Yeasts, Rods, Cocci, and Sarcina								
Time 1 Min.	+	+	—	+	+	S	+	+
3 Min.	S	—	—	+	S	—	S	S
10 Min.	—	—	—	—	—	—	S	—
% Total Alkalinity	1.02	1.84	3.06	1.02	1.84	3.06	1.27	2.29
Pounds in 100 Gallons	9.35	16.8	28.05	9.54	17.2	28.6	17.95	32.3

KEY: + = Growth; S = Slight Growth; — = No Growth
Temperature: 130° F.

The bacteriological results shown in the last four tables are all made from fresh solutions. Other investigators have shown that the germicidal action of caustic soda is not materially affected by the presence of even excessive quantities of organic matter so long as there is sufficient free caustic present in the solution. During actual use in the bottle-washing machine, the solution will be contaminated with dirt from the bottles, which will tend to use up some of the causticity of the solution, as well as react chemically with some of the other alkalies. Some of the dirt will form alkalies of no sterilizing value with the free caustic, and, of course, the well known reaction with carbon dioxide in the air and caustic soda to form sodium carbonate or soda ash will also take place. Still another factor to consider is the carry-out of the solution on the bottles, and the dilution of the solution with water either from the pre-rinse or added directly to replace that lost from carry-over.

In order to determine the loss in strength of the bottle-washing solution, it is common practice to test it at the end of each day's run, and then add enough cleaner to bring the strength back to the initial charge strength. When the solution is tested in this manner for free causticity, it will be found that there is a tendency for the total alkalinity and the specific gravity, or weight of the solution, to increase. Since the causticity is maintained at a reasonably definite level, however, we can be quite sure that our solution is capable of sterilizing bottles during their travel through the machine. However, when the solution is maintained at the same total alkalinity by daily test for alkali only, then the causticity of the solution will gradually decrease and the solution in turn become less efficient in its sterilizing action. Under these conditions it would be possible for the solution to lose practically all of its sterilizing strength, and yet the test for total alkalinity would fail to reveal this serious condition. Daily testing of the solutions for its total causticity makes it possible to maintain the solution at the proper strength to insure destruction of bacteria, mold, and yeast.

The effect of temperature, time of contact and free causticity in the solution is shown in Figure 1. These results are

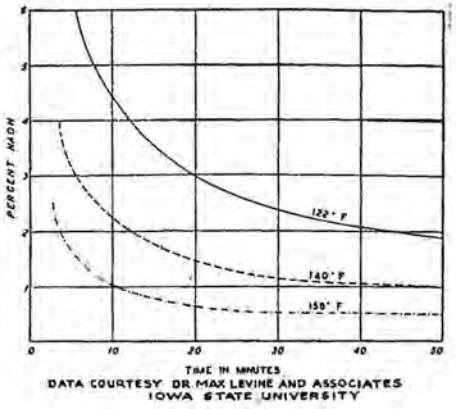

FIGURE 1

Relation of causticity, time, and temperature on germicidal effectiveness.

taken from work conducted under an American Bottlers of Carbonated Beverages Fellowship, by Dr. Max Levine, Dr. J. H. Buchanan, and Grace Lease of the Department of Chemistry and Bacteriology, Iowa State College, and used with their permission. The tests were made at temperatures of 122° F., 141° F. and 158.5° F. Acording to these investigators, the results at 158.5° F. are not entirely dependable, as the curve is based on an insufficient number of observations. As expected, the germicidal efficiency increases with the amount of free

caustic present in the solution, with the time of contact of the solution on the organism, and with the temperature of the solution. The type of organism used in this work was specifically selected because the difficulty with which it is destroyed makes it suitable for research work of this type.

THE TEST FOR pH

From time to time it has been proposed that the pH test be used for bottle-washing solutions. However, the fact that this test is rather difficult to make, particularly under plant operating conditions, has substantially limited its use to theoretical considerations. In addition, the relationship between the pH value and germicidal ability of the solution seems to vary considerably with different organisms and different materials. Likewise, the pH value of the solution does not necessarily take into consideration the reserve strength of the solution. For example: A solution may be of the proper pH to destroy bacteria at the time the test is made, and yet be unsuited for this work a half hour later because of the sudden drop in the pH value.

THE CONDUCTIVITY TEST

A recently proposed method for testing bottle-washing solutions is apparently based on the conductivity of the solution, which is the ability of the solution to carry an electric current. While conductivity tests may serve as a useful index of the strength of the solution when one material, and that material alone is present, this condition cannot be met in bottle-washing operations, as has been previously discussed. There will always be other materials present in the solut[ion] which will influence the conductivity [of] the solution, and yet contribute noth[ing] to its sterilizing efficiency. This [test], therefore, would seemingly fail to [meet] the requirements of a suitable test [for] bottle-washing solutions in that it do[es] not provide an index of the ability of [the] solution to destroy bacteria, mold, [or] yeast.

Table 6 summarizes the various meth[ods] ods of testing bottle-washing solution[s] which have been discussed. Notice th[at] only the test for total causticity is clo[sely] ly related to the sterilizing efficiency [of] the solution, and at the same time [can] be easily made.

CAUSTIC TEST MEETS REQUIREMENTS

If we accept the premise that the [best] for the strength of bottle-washing so[lu]tions must provide a reasonably accura[te] index of the sterilizing strength of [the] solutions, then I believe we will agr[ee] that only the test for total *causticity* meets our requirements. Moreover, the te[st] for total causticity is easily made [with] sufficient accuracy by even an unskill[ed] plant operator, so no difficulties are en[-] countered on that score. Testing the so[-] lution daily for total causticity makes possible to readily determine the amount of cleaner required for upkeep to main[-] tain the solution at a definite and known sterilizing value. While the main rea[-] son for testing bottle-washing solutions for total or free causticity comes from the fact that this test provides the best index of the sterilizing strength, there are two other advantages of the test [in] is a reasonably accurate indicator of the

TABLE 6

Summary of Methods for Testing Bottle Washing Solutions

Method of Testing	Measures	Is test readily made?	Relation to Sterilization
Hydrometer	Weight of Solution	Yes	No
Total alkali	Acid neutralizing power	Yes	No
Conductivity	Ability to carry electric current	?	No
pH	Degree of alkalinity	?	Slight, but not well established
Total or Free Causticity	Amount of free caustic	Yes	Very close

lubricating characteristic of the solution, which is quite important in preventing damage to the moving parts of the machine that come in contact with the solution. Further, a solution of sufficient causticity to sterilize the bottles has a corrective influence on the metal parts of the machine with which the solution comes in contact.

It is not to be assumed that proper testing of the solution used for washing bottles will by any means solve all the problems connected with the efficient and economical machine washing of bottles. The proper test of the bottle-washing solution is important to the milk sanitarian and the dairy in that it provides one of the safeguards on the quality of market milk. While caustic soda alone provides a satisfactory sterilizing action in the bottle-washing solution, it leaves much to be desired in other characteristics. Products specially designed for bottle-washing operations, which contain caustic soda as a base, will generally give better results in the bottle-washing machine. Such products are capable of attacking dirt in practically any of the many forms in which it will be encountered on dirty bottles. Such products are decidedly superior to caustic soda in softening water, and this characteristic is of particular advantage in hard water localities in producing bottles that are free from film or scale, at the same time keeping the machine at the peak of operating efficiency. Solutions prepared from straight caustic soda are difficult to rinse, while those from specially designed bottle-washing compounds rinse much faster and more completely. There are many factors to consider in selecting a cleaner for bottle-washing operations which are beyond the scope of this paper. The proper use of bottle-washing compounds insures bottles that are free from bacteria, mold, and yeast, and bottles that have a brilliant lustre and sparkle—that reflect the quality of the milk. The glass bottle has long been recognized by the public as a symbol of purity. A product well displayed is half sold. Properly washed glass bottles make it possible to display milk in an attractive manner.

Chlorine Rinse Reduces Bacteria at Low Cost

J. W. Yates

Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.

We wonder sometimes if milk producers appreciate the good work a proper chlorine bactericide will do, and how little it costs to use for bacterial control on farm milk utensils. It does not take many pennies to put utensils in excellent sanitary condition for handling pure milk.

For a herd of thirty cows, there is needed 3 to 4½ pounds of chlorine powder a year at a cost of about $3.00 to $4.00. Certainly that is economy in view of the excellent results you get. There is very little work to the operation which enables a producer to take advantage of this efficiency and economy in chlorine powder.

After the utensils have been used, they should be rinsed free of milk solids and then scrubbed with hot water and a good inorganic washing compound. Then the utensils are to be rinsed further with water hot enough to dry them when they are inverted to drain. Just before use, they should be put in a chlorine bacteria-killing rinse to cut down the large percentage of bacteria which they may have collected. They are then in an excellent condition to handle the milk.

This practice of bacteria control is very inexpensive. The cost in some instances runs as low as a cent a day. The rewards of good quality milk and low bacteria count are well worth the small extra labor and cost involved in this program. The practice is general at this time on hundreds of thousands of farms, and is approved by milk plants and health officers.

Application of Resazurin Test in Determining Quality of Raw Milk and Cream *

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INTRODUCTION

The results discussed in this paper were secured by the Quality Control Department of the United Farmers' Co-operative Creamery Association in its Morrisville, Vermont, and Boston, Mass., Laboratories.

The data were compiled from the daily routine tests which were made in determining the advisability of changing from the routine methylene blue reduction test to a routine resazurin reduction test for the control of raw milk and cream supplies. All tests were carefully controlled and supervised with a view to compiling the results for analyses, in the hope that the results might be applied generally and compared with those of other similar tests.

HISTORICAL

The strength of the resazurin dye solution (0.05 percent) was recommended by Ramsdell, Johnson, and Evans (6) in 1935 and was used also by Barrett, Rutan, and Keenan (1) of the Whiting Milk Company, Boston, and reported in 1937. Other papers studied were those of C. K. Johns (3), Central Experimental Farm, Ottawa, of A. Moldavan (4) of the Guaranteed Pure Milk Company of Montreal, Canada, and of G. A. Ramsdell in the Tenth Annual Report of the New York State Association of Dairy and Milk Inspectors (5).

All the above mentioned workers and papers have indicated that the resazurin test is very useful in the control of raw milk supplies and is very sensitive in selecting poor quality milk. References have been made continually to the high sensitivity of the dye to light and to abnormal milks. Several writers, notably Barrett, Rutan, and Keenan, have referred to the time—and money—saving values of the test. A very high percentage of agreement with other bacteriological tests in grading raw milk supplies has been mentioned in private discussion by Fay (2) of the H. P. Hood Company of Boston. Moldavan uses the color developed at the end of one hour as a basis for grading the patrons' shipments. Barrett, Rutan, and Keenan smear the samples, which have changed color in one hour, to determine the cause of the poor quality.

EXPERIMENTAL

It was thought early in the resazurin studies that the use of 0.05 percent resazurin solution as recommended by Ramsdell (5) was not sufficiently accurate when speed is required, therefore the modification suggested by Moldavan (4) (1 cc. of 0.005 percent) was adopted.

Preliminary studies also indicated that an intermediate pink color could be read fairly uniformly by several workers, consequently, this color, a *pronounced pink* but not a vivid pink, was selected as the end point.

It was essential to establish the relationship between the reduction of methylene blue to white and of resazurin to pink as well as the relationship of resazurin pink to other bacteriological tests. These objectives could be worked out best by means of the routine control tests, with patrons' milk, tank car shipments of raw milk, and batches of raw cream.

METHODS

Ten milliliter quantities of the product to be tested were placed in sterile test tubes. The tubes were then tempered to 98° F. in a large, temperature-controlled, water-bath for 5 minutes. One milliliter of the fresh 0.005 percent resazurin dye was then added by means of a 10 ml. pipette and the sample mixed by inverting. The resazurin solution was made up *weekly* and stored in brown bottles. After the addition of the resazurin, the samples were incubated, either in the large, temperature-controlled, covered, water-baths or in the 37° C. incubators. The samples were prepared and read in medium light but away from direct or reflected sunlight.

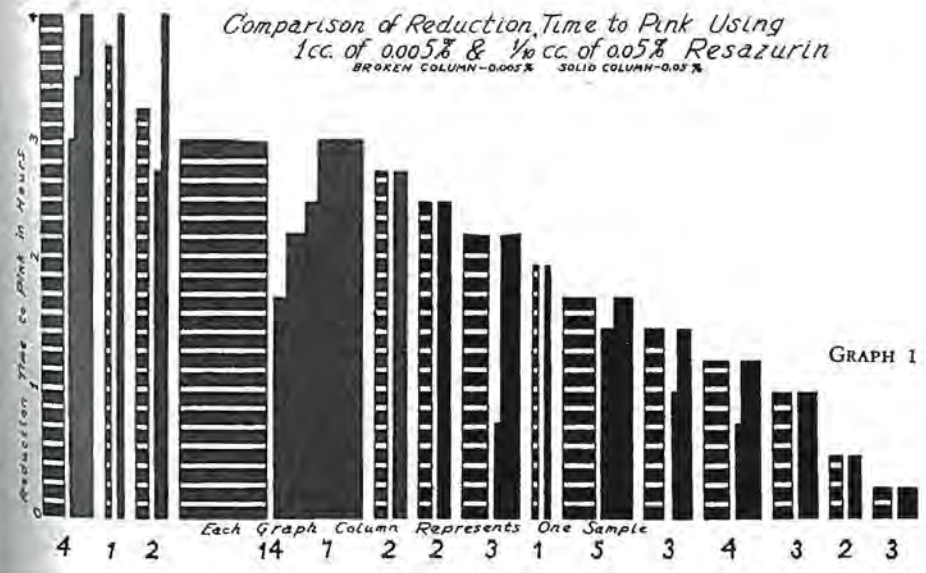
Observations for color changes were made at 15 minute intervals. If reduction appeared to be at the pink end point, and the pink color had developed slightly irregularly from top to bottom, the tube was inverted once to bring the entire contents to a uniform color. Pronounced pink color, intermediate between the purple pink and the vivid pink, was considered the end point of reduction. Reduction time to white was determined by continuing the incubation time to the point of complete color reduction.

The results, accumulated to show the comparisons of the reduction times of resazurin to pink or white and of methylene blue to white as well as to show the relationships of resazurin color changes to microscopic or plate counts and acid increases, are presented in Graph 1 and in Tables 1 to 8, respectively.

COMPARISON OF SOLUTIONS

The results secured when the reduction time of 1 ml. of 0.005 percent resazurin was compared with the reduction time of 1/10 ml. of 0.05 percent resazurin are presented in Graph 1. Duplicate samples of patrons' milk were used. The number of comparisons is shown on the graph.

The first column represents the 4 hour reduction time of 0.005 percent dye to pink with 4 samples. In the duplicate samples in which were used 0.05 percent resazurin, 2 samples became pink in 4 hours, one in 3.5 hours and one in 3 hours. Similarly are compared the results of the groups which were reduced in other time durations. Of the 50 comparisons made, 33 or 66.66 percent agreed completely and of the 17 which



GRAPH 1

* Presented at the Twenty-seventh Annual Meeting of the International Association of Milk Sanitarians, Cleveland, Ohio, October 19-21, 1938.

did not agree completely, only one pair of samples differed by more than 50 percent, while 9 other pairs differed by 25 percent or less. Seven pairs of samples (16 percent) differed by more than 25 percent and by less than 50 percent. Only in one instance did the 0.05 percent resazurin show a longer reduction time than the 0.005 percent solution.

The data indicate that reduction times to pink of the 2 strengths of resazurin solution (when the amounts of the dye itself are equal in both) are closely comparable but that *a slightly slower reduction may be expected with the 0.005 percent than with the 0.05 percent solution.*

COMPARISON OF REDUCTION TIMES OF RESAZURIN AND METHYLENE BLUE

To establish a relationship between the two dyes, duplicate samples of raw cream were run with the 0.005 percent resazurin and triple strength (3 tablets in 200 ml. of sterile, distilled water) methylene blue. The cream samples were taken from 200 gallon, full vats of raw cream just prior to pasteurizing. The results secured from the study of 151 samples are presented in Table 1.

The above grouping on the basis of the reduction time of methylene blue shows not only the quality of cream which may be separated from raw milk of varying qualities but also the corresponding reduction times with the two dyes. The times for complete reduction (to white) of the two dyes were fairly similar. It is interesting to note, however, that the methylene blue reduction time was longer with the good quality cream and shorter with the poor quality cream than the reduction time of resazurin to white. Compared with the reduction time of resazurin to pink, there was more difference with methylene blue than with resazurin white in the highest quality groups and less spread with methylene blue than with resazurin white in the poorer quality groups. There was a close agreement of the methylene blue and resazurin reductions to white in all the intermediate groups. *The results would indicate that for practical purposes the reduction times of methylene blue and resazurin to white on vat samples of raw 35.0 and 40.0 percent cream are equal; while the above reduction times are generally double the reduction time of resazurin to pink. The relationship of resazurin pink to methylene blue white may therefore be considered 1 to 2 for vat samples of raw cream.*

A further comparison of the reduction times of methylene blue and resazurin to pink or white was made with tank car shipments of milk. These data were grouped to determine the agreement between the two methods in picking out good or poor milk. They are presented in Table 2.

TABLE 1

Comparison of reduction times of resazurin to pink and white with the reduction times of methylene blue on batch cream shipments

Methylene blue range in hours	No. of samples	Reduction time in hours: Methylene Blue	Resazurin: White	Resazurin: Pink	Factors based on red. time of resazurin to pink as the unit: M.B.	R.W.	R.P.
7.5 to 8 (excellent)	11	7.91	6.47	3.52	2.25	1.83	1.0
6.5 to 7.25 (very good)	15	6.75	5.75	2.58	2.61	2.23	1.0
5.5 to 6.25 (good)	17	6.09	5.63	2.54	2.40	2.21	1.0
4.5 to 5.25 (fair to good)	39	4.90	5.04	2.23	2.20	2.25	1.0
3.5 to 4.25 (fair)	38	3.82	3.99	1.75	2.18	2.28	1.0
2.5 to 3.25 (poor to fair)	22	2.90	3.34	1.42	2.04	2.35	1.0
0.0 to 2.25 (poor)	19	1.37	1.75	0.75	1.83	2.33	1.0

TABLE 2

Comparison of reduction times of methylene blue and resazurin to pink on tank car milk shipments.

Group	Agreement of resazurin pink: No.	%	Disagreement of resazurin pink: No.	%
Methylene blue, 6 hours or more; Resazurin Pink, 4 hours or more	38	92.6	3	7.4
Methylene blue, 4 to 5¾ hours; Resazurin Pink, 2 to 3¾ hours	9	64.3	5	35.7

In this set of results the reduction times of methylene blue to white and resazurin to white of 55 samples were 7.31 and 7.31 hours respectively.

The average of the reduction times to pink of the 55 samples was 4.95 hours, the relationship being resazurin to blue 1 : 1.48.

The results indicate that 92 percent of 55 tank car shipments were graded good by both tests. In the fair milk group there was a 64.3 percent agreement. The data show also that the average reduction times of methylene blue and resazurin to white were equal, being 7.31 hours, while the average reduction time of methylene blue was 1.48 times the average reduction time of resazurin to pink.

The relationship of the reduction times of resazurin pink to methylene blue was 1 to 1.48.

Additional information on the relationship between methylene blue and resazurin pink was obtained on patrons' shipments. The samples were grouped according to their reduction times. The results are compiled in table 3.

The reduction times of the resazurin and blue were grouped on a 1 to 2 basis because the averages of the 230 samples were 2.39 and 5.17 hours respectively. The methylene blue reduction times were more than double the resazurin reduction times in groups 1, 3, and 4. In these three groups the agreement between the two tests was closer than in group 2 where the spread between the two tests was less. The agreement of the two tests for the 230 samples was 76.08 percent. It is interesting that the highest agreements were shown in the highest quality and the lowest quality groups. *We may conclude from these results that the average time of reduction to pink is approximately half the methylene blue reduction time on patrons' raw milk.*

RELATIONSHIP BETWEEN REDUCTION TIMES OF RESAZURIN TO PINK, AND MICROSCOPIC AND PLATE COUNTS ON TANK CAR SHIPMENTS OF RAW MILK

Having established comparative reduction times for methylene blue and resazurin to pink, it was considered important to compare the resazurin reduction to pink with bacterial counts. The microscopic counts were selected because they were made in connection with the type studies. Groups, pairs, and chains were counted as single cells. The data secured on 134 samples of patrons' raw milk are assembled in four groups in table 4.

A standard of 3 hours or more for resazurin pink was considered equivalent

TABLE 3

Comparison of reduction times of methylene blue to white and resazurin to pink on patrons' milk

Group	Ave. Hrs.	Factor	Agreement: Number	Agreement: Percent	Disagreement: Number	Disagreement: Percent
M. Blue, 6 hrs. or more	7.35					
Resazurin, 3 hrs. or more	3.49	2.10	84	83.1	17	16.9
M. Blue, 4-5¾ hrs.	4.85					
Resazurin 2-2¾ hrs.	2.82	1.71	29	52.7	26	47.28
M. Blue 2-3¾ hrs.	2.98					
Resazurin 1-1¾ hrs.	1.34	2.22	31	72.1	12	27.9
M. Blue 0-1¾ hrs.	1.22					
Resazurin 0-¾ hrs.	0.51	2.39	31	100.0	0	0.0
Average	5.17					
of 230 Samples	2.39	2.16	175	76.08	55	23.92

TABLE 4

Relationship between reduction times of resazurin to pink and microscopic counts on patrons' raw milk

Group	Relationship of reduction times to microscopic count: No. Samples	% under 400,000	% 400,000-1,000,000	% over 1,000,000
A				
Resazurin reduced in 3 or more hrs.	47	43–91.5	3– 6.39	1– 2.13
B				
Resazurin reduced in 2-2¾ hrs.	32	18–56.25	3– 9.37	11–34.38
C				
Resazurin reduced in 1-1¾ hrs.	34	5–14.70	4–11.76	25–74.54
D				
Resazurin reduced in 0-¾ hrs.	21	0– 0.0	3–14.27	18–85.71
TOTAL	134	66	13	55

to a methylene blue reduction time of over 6 hours. This has been considered, for many years, satisfactory for market milk. This grouping should agree, therefore, with the generally accepted plate count standard for raw market milk, delivered to the Boston Market, of under 400,000 bacteria per ml.

The results show that 91.5 percent of the samples in Group "A" had microscopic counts below 400,000 while no samples in Group "D" belonged to this microscopic-count group. Only one of 47 Group "A" samples had a microscopic count of more than 1,000,000, while 18 of 21 Group "D" samples were in this class. *The results indicate that a resazurin pink of 3 hours or more represents as good quality milk as is considered satisfactory on the basis of the methylene blue or the microscopic tests.*

RELATIONSHIP BETWEEN REDUCTION TIMES OF RESAZURIN AND PLATE COUNTS ON TANK CAR SHIPMENTS OF MILK

Tank car shipments of milk loaded at the Morrisville, Vermont, plant during the months of April, May, June and part of July were checked by the resazurin test and by the plate count (Standard Methods). The results are summarized and compared in table 5.

Of the 110 individual tank samples checked by resazurin, less than 10 percent showed reduction to pink in less than 4 hours. It was considered there-

TABLE 5

Relationship between reduction times of resazurin to pink and bacterial plate counts on final tank car shipments of raw milk

Month of Shipment	Reduction time of resazurin to pink	No. samples in group	Average hours reduct. to pink	Log. average of plate counts
April	4 hrs. or more	11	5.39	94,000
	3–3¾ hrs.	2	3.38	430,000
	2–2¾ hrs.	3	2.25	520,000
	0–1¾ hrs.	0	0	
May	4 hrs. or more	42	5.80	56,000
	3–3¾ hrs.	3	3.40	480,000
	2–2¾ hrs.	1	5.55	353,000
	0–1¾ hrs.	0	0	
June	4 hrs. or more	38	5.80	89,000
	3–3¾ hrs.	5	3.45	360,000
	2–2¾ hrs.	1	2.75	320,000
	0–1¾ hrs.	0	0	
July	4 hrs. or more	9	7.61	87,000
	3–3¾ hrs.	0	0	
	2–2¾ hrs.	0	0	
	0–1¾ hrs	0	0	
Summary	4 hrs. or more	100	5.62	81,000
	3–3¾ hrs.	10	3.41	420,000

fore that four hours was not too high a standard to set for fresh tank car shipments leaving country plants. Only "Special Grade" shipments were made during July and this accounts for the high average reduction time of the nine samples checked during that period. Attention is drawn to the close agreement of average reduction times for the two upper grades in the months of April, May, and June. Logarithmic averages of the plate counts on 91 samples which were tested in April, May, and June, and which were over 4 hours on the resazurin test, were under 100,000 bacteria per ml. In the 3 - 3.75 hour groups for the three months, the logarithmic averages were 430,000, 480,000, and 360,000 bacteria per ml. respectively. There are insufficient samples reported in the 2 - 2.75 hour group to be considered. There was more than two hours difference in the average reduction times of the two upper grades of milk during April, May, and June and a corresponding difference of more than 300,000 in the logarithmic averages of the plate counts for the same samples.

The results show that samples having average reduction times for resazurin pink of 5 - 6 hours have corresponding plate counts under 100,000 *bacteria per ml.*

Results of tests secured in the city laboratory from the same tank car shipments discussed in table 5, plus tests from tank car shipments from other United Farmers plants are given in table 6.

The data summarized in table 6 compare closely with those in table 5. Eighty-one samples tested in May, June, and July and having resazurin reduction time of 5 to 6 hours had comparative plate counts under 100,000 bacteria per ml. Twenty-six samples in the 3 to 4 hour group had logarithmic average plate counts of 330,000 to 380,000, while three samples in this group averaging 3.58 hours had a logarithmic average plate count of 120,000 bacteria per ml. With this last mentioned exception on the small number of samples, the results are in line with those of table 5 and show that samples having resazurin pink tests of 5 to 6 hours have comparable plate counts of less than 100,000 bacteria per ml. Such tests would indicate a raw milk of excellent quality.

TABLE 6

Relationship between reduction times of resazurin to pink and bacterial plate counts on tank car milk shipments.

Month of Shipment	Reduction time of resazurin to pink	No. samples in group	Average hours reduct. to pink	Log. average of plate counts
April	4 hrs. or more	11	4.66	320,000
	3–3¾ hours	11	3.31	380,000
	2–2¾ hours	1	2.50	390,000
	0–1¾ hours	1	1.50	1,400,000
May	4 hrs. or more	35	5.63	98,000
	3–3¾ hours	7	3.46	350,000
	2–2¾ hours	1	2.50	355,000
	0–1¾ hours	0	—	
June	4 hrs. or more	40	5.40	93,000
	3–3¾ hours	8	3.31	330,000
	2–2¾ hours	1	2.75	320,000
	0–1¾ hours	0	—	
July	4 hrs. or more	6	5.92	82,000
	3–3¾ hours	3	3.58	120,000
	2–2¾ hours	0	—	
	0–1¾ hours	0	—	
Summary	4 hrs. or more	92		160,000
	3–3¾ hours	29		270,000

Results secured in Boston laboratory on samples taken from tank car shipments upon their arrival in the city.
Ave. of pinks, 4.91; Ave. of Whites, 6.42
Relationship—pink : white :: 1 : 1.31

RELATIONSHIP BETWEEN THE REDUCTION TIMES OF RESAZURIN TO PINK, AND MICROSCOPIC COUNTS AND ACID INCREASES OF VAT SAMPLES OF CREAM

The resazurin test was applied to vat samples of raw cream and compared to the microscopic counts on the same cream before pasteurizing, and to the incubation tests on the cream after pasteurizing. The samples were taken from 200 gallon batches of cream just before heating commenced. The resazurin sample and the 1/100 ml. quantity for the Breed count were taken from the bottle immediately. The pasteurized samples were held in ice water until 5 P. M. when the samples were placed in the incubator. The incubation time was 14 hours and the temperature was adjusted from time to time depending on the quality of the cream. The incubator temperature desired was one which would cause at least a titratable acid increase in all the samples. Differences in the acid rises were interpreted as being indicative of different keeping qualities. Little use could be made of the incubation test if the temperatures were not sufficiently high to show definite differences in the acid increases of the respective samples.

The results were grouped on the basis of the reduction time of resazurin to pink and a microscopic count of 150,000 was selected arbitrarily on the basis of previous counts made in the company laboratories. The results secured on 676 samples are summarized in table 7.

The summary at the bottom of table 7 shows that 18.3 percent of all the samples were in the 3 hour, or more, group and 35.2 percent in the 2 - 2.75 hour group. In other words, 53.5 percent of the cream samples were over 2 hours on the basis of resazurin pink. This would indicate, by reference to the 1 : 2 relationship of resazurin pink to methylene blue white (see table 1), that 53.5 percent of the cream samples would stand up 4 hours or more with the blue test. Cream in these groups is considered satisfactory. The 18.3 percent having resazurin pink tests of 3 hours or more are considered excellent.

A careful study of the logarithmic averages of the microscopic counts shows that they varied from 190,000 to 1,050,000 bacteria per ml. from the top grade to the bottom grade cream. *The Summary indicates that raw cream samples averaging about 2 hours with resazurin pink (4 hours with methylene blue) have microscopic counts averaging, logarithmically, from* 130,000 *to* 480,000 *bacteria per ml.*

Comparing the average acid rises on incubation with the 4 resazurin groups, one can see that they are consistent for the 4 monthly periods and increase progressively as the resazurin reduction times decrease and as the microscopic counts increase. However, there was not a very definite or close correlation between reduction times and acid increases on the individual samples. This lack of definite correlation is no doubt due to the great variation in the types of bacteria present and to the relationship of types to reduction times of either resazurin or methylene blue.

COMPARISON OF COUNTRY AND CITY RESULTS ON THE SAME TANK CAR SHIPMENTS OF MILK

When the above data had been accumulated it seemed of interest to compare the results secured in the country and city laboratories on the same tank car shipments. There were 94 samples in all on which complete records were available. These comparisons are shown briefly in table 8.

These data show that 54 duplicate samples taken approximately 20 hours apart by the two laboratories gave resazurin times which differed one hour or less. Three of these pairs of samples gave similar reduction times. The disagreements in the other 51 duplicates varying from 0.25 to 1 hour were evenly divided between the two laboratories, indicating that either the quality or the reading or both may have varied. However of the 40 duplicates on which the reduction times varied by more than 1 hour.

TABLE 7

Relationship between the reduction times of resazurin to pink, and the microscopic counts and acid increases of cream

Month of Shipment	Reduction time of resazurin to pink	Number samples in group	Percent samples in group	Microscopic counts over 150M Number	Microscopic counts over 150M Percent	Logarithmic averages of microscop. counts	Number acid increases studied	Average* increases of acid in hundredths
April	3 or more hrs.	40	24.7	18	45.0	160,000	15	.0253
	2–2¾ hrs.	62	38.31	31	50.0	180,000	44	.0461
	1–1¾ hrs.	54	33.3	37	68.5	350,000	57	.0624
	0– ¾ hrs.	6	3.7	6	100.0	860,000	6	.0666
May	3 or more hrs.	33	15.6	15	45.5	130,000	55	.0189
	2–2¾ hrs.	83	39.3	50	60.5	220,000	67	.0445
	1–1¾ hrs.	89	42.1	71	79.8	390,000	93	.0646
	0– ¾ hrs.	6	2.84	6	100.0	510,000	11	.100
June	3 or more hrs.	35	15.3	25	71.4	290,000	22	.0282
	2–2¾ hrs.	75	33.3	65	86.7	480,000	60	.0393
	1–1¾ hrs.	78	34.2	71	91.0	620,000	73	.0555
	0– ¾ hrs.	40	17.5	39	97.5	1,200,000	21	.0670
July	3 or more hrs.	16	16.8	7	43.8	230,000	13	.0370
	2–2¾ hrs.	38	40.0	19	50.0	295,000	30	.0410
	1–1¾ hrs.	27	28.4	14	51.9	390,000	28	.0520
	0– ¾ hrs.	14	14.7	13	92.9	2,300,000	—	—
Summary of Four Months	3 or more hrs.	124	18.3	65	52.4	190,000	105	—
	2–2¾ hrs.	238	35.2	165	69.3	270,000	201	—
	1–1¾ hrs.	248	36.6	193	77.8	440,000	251	—
	0– ¾ hrs.	66	10.7	64	96.9	1,050,000	38	—

* Incubation conditions were variable depending on season—Temp. from 84° to 74° F.—Holding time 14 hrs.

TABLE 8

Comparison of country and city results on same tank car shipments of milk—20 hours apart.

Agreement	Diff. ¼ hour		Diff. ½ hour		Diff. 1 hour		Diff. over 1 hr.	
	Country	City	Country	City	Country	City	Country	City
3	+8	+6	+13	+11	+6	+7	+31	+9
4.12%	14.43%		24.74%		15.46%		41.24%	

\+ meaning longer time.

31 showed up better in the country than in the city. This would suggest that when the reading disagreed appreciably, there likely was a deterioration in quality during the 20 hour aging in transit to the city.

The comparisons of duplicate tests made in the two laboratories indicate that when the quality remains about the same, the resazurin test can be read quite uniformly in different laboratories where the same standards are followed.

CONCLUSIONS

1. One Milliliter of 0.005 percent resazurin dye mixed with 10 ml. of milk or cream makes a convenient and practical quality-control test and gives uniform results when carried out under definite and standardized conditions.

2. The reduction times of 0.005 percent resazurin and standard methylene blue (1 tablet in 200 ml. of water) to white are approximately equal.

3. The reduction time of 0.005 percent resazurin to pink is approximately 2/3 the reduction time of methylene blue when used on fresh tank car shipments of good milk and slightly more than 2/3 of the methylene blue when used on the same tank car shipments one day older.

4. The reduction time of resazurin to pink is approximately one-half the methylene blue test on patrons' shipments of raw milk. This is a wider ratio than with tank car shipments.

5. There is a high agreement between the resazurin pink and the methylene blue tests in selecting good quality or poor quality raw milk.

6. A high percentage of patrons' milk samples that test 3 hours or more with resazurin have bacterial counts of less than 400,000 per ml.

7. A resazurin pink of 3 hours or more represents as good quality milk as a 5.5 hour methylene blue test.

8. Samples having resazurin pink tests of 5 to 6 hours have corresponding plate counts of under 100,000 bacteria per ml.

9. A predominance of the samples of batch, raw cream having resazurin pink tests of 2 hours or more have microscopic counts averaging, logarithmically, 150,000 to 300,000 bacteria per ml.

10. There is an indefinite correlation between the acid rises developed when fresh pasteurized cream is incubated at approximately room temperature for 14 hours and the resazurin reduction times of the same batches of cream before pasteurization.

11. The resazurin test can be applied in different laboratories with uniform results when the methods are standardized.

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Recent Advances in New Jersey Dairying and the Direction of Future Developments *

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MASTITIS CONTROL

Laboratory methods in general use have shown that not all milk which comes from animals whose udders are not visibly swollen or whose milk is abnormal in appearance is "milk from healthy animals". The "blinding" of a cow's udder creates a very definite loss of farm economy, since the maintenance of the cow remains a constant 100% while the return can not exceed a maximum of 75%.

During the past year a voluntary mastitis control and eradication program has been initiated through the cooperation of three New Jersey agencies. These agencies are the Bureau of Animal Industry of the State Department of Agriculture, the Dairy Extension Service of the Agricultural Experiment Station, and the Dairy Department of Rutgers University. The purpose of the program is to educate New Jersey producers in the practices designed to prevent infection of animals and in the methods of identification, isolation, and care of animals found to be ailing. Demonstrations are made before farm groups in which the principles of maintaining a clean herd are discussed. The use of ledges between stalls to avoid the movement of one animal's bedding to another's place, and of individual water cups and feed bins is shown to be a factor in the avoidance of transmission of infection. The relationship between the readily used farm methods for identification of ailing animals and the more elaborate laboratory techniques is also demonstrated. The advantages of sterilizing milkers' hands and cows' udders are stressed. A simple wooden rack which is easily carried from one cow to another, and which holds a pail of chlorine sterilizing solution in which are immersed a number of wash clothes equal to the animals to be milked, a pan for the disposition of the individual cloths, a black sheet fore-milker device, and a brom-thymol-blue kit are shown and demonstrated in actual use. The milker sterilizes his hands by ringing out the individual wash cloths. The potency of the chlorine solution is maintained by preventing the entrance of organic matter into it. The wash cloth after once being used to wipe a cow's udder is placed in the pan supplied for that purpose. The first stream of fore-milk from each quarter is examined by the black strip fore-milker. The brom-thymol-blue test kit is used for milks which show any abnormality, and brom-thymol-blue tests of all quarters of all cows are taken at regular intervals.

The voluntary mastitis control program has met with extraordinary response. It is believed that if legislation is passed for complete eradication of mastitis, the New Jersey dairy industry will not be found in a position similar to that which existed at the time that tuberculosis eradication was ordered.

ARTIFICIAL INSEMINATION

Artificial insemination of live stock has been a theoretical possibility for many years. The practical use of artificial insemination with dairy animals has been retarded by the inability to maintain spermatazoa for extended periods, and to dilute the seminal fluid without affecting the virility of the sperm cells.

* Condensed from the paper of the same title presented at the 23rd Annual Meeting of the Central Atlantic States Association of Dairy, Food, and Drug Officials, on May 19, 1939, in New York City (Hotel McAlpin).

In 1935. Dr. Elie Ivanov found that spermatazoa could be kept virile for extended periods by their storage at low temperatures. Another Russian worker, Professor S. Milovanov, reported in 1936 on diluting media which did not affect the virility of sperm cells. Russia began using artificial breeding on a practical basis in 1937. Denmark followed, and Professor E. J. Perry, Dairy Extension Specialist at the Agricultural Experiment Station of New Jersey, observed the functioning of the first Danish breeding unit immediately after its organization.

Artificial breeding offers a number of advantages to the dairy farmer. By the selection of bulls which possess good blood lines and which have proved their ability to transmit high milk production and good health, many animals can be inseminated without any strain. The mechanism involved in the establishment of a breeding unit consists of organizing twelve hundred to fourteen hundred cows under the care of a veterinarian. This veterinarian examines all animals before they are to be impregnated to determine whether or not they are in proper physical condition. The seminal fluid is recovered from a bull by bringing it into the presence of an animal in heat and obtaining the seminal discharge by means of an artificial vagina. The seminal fluid thus obtained is standardized to a definite concentration with one of the special diluting formulas. The dairy animals which come into heat during the next seven days may then be impregnated with this solution. It has been found that the percentage of impregnation is much higher with this method than with the orthodox method. In addition, diseases can not be transmitted from cow to bull and vice versa. The artificial insemination technique has been accepted to such a degree that there are now four units operating in New Jersey alone. There are fifteen units already established in other sections of the country as well (3).

OXIDIZED FLAVOR

A number of unrelated theories as to the cause of oxidized flavor are available. A conclusion which has been established by all investigators is that summer milk is less susceptible to oxidized flavor than winter milk. New Jersey educational agencies have therefore attempted to decrease the prevalence of oxidized flavor by making the materials characteristic of summer milk production available during the winter time. Professor C. B. Bender (2) Dairy Feeding Specialist at Rutgers University, has shown that the feeding of grass silages during the winter maintains summer flavor and color in the milk to an extent unparalleled by normal feeding materials. A campaign of educating New Jersey dairymen to the manner of preparing grass ensilage has been prosecuted vigorously during the past year through the county extension men, working under the direction of Professor Bender. The processing plants, too, have been receiving instructions as to the manner of handling of milk supplies so that there will be no damage to flavor through processing. It is interesting to note here that anti-oxidants developed for other industries have been used successfully in the experimental counteracting of oxidized flavor in market milk. Although Avenex Concentrate has been used most successfully in commercial ice cream manufacture for this purpose, it has not yet been accepted for use in New Jersey milk supplies.

THE COLIFORM INDEX

The convenient Scharer (4) modification of the phosphatase test developed during the past year has given dairy control officials a rapid efficient method for checking proper pasteurization. In the absence of heat resistant species, and the constitution of a medium which elevates the thermal death point of the coliform group, many New Jersey health departments have adopted the interpretation that the presence of coliform organisms in pasteurized dairy supplies is evidence of incomplete sanitation of plant equipment used after pasteurization.

The ability to ferment lactose with the production of gas, possessed by some organisms which are not completely destroyed by pasteurization, had led to the use of the complete American Public Health Asosciation (1) procedure, rather than the presumptive test alone, to avoid the confusion resulting from reporting the false positives. The samples should preferably be obtained directly from the processing plant. The preparation of milk supplies which possess no coliform organisms in 25 ml. portions necessitates the absolute sterilization of processing equipment, and the maintenance of truly aseptic conditions throughout the period of plant operation. The records of a number of plants show many days when this result has been achieved. No plant has yet been found where a coliform index of 0 per 25 ml. has been maintained indefinitely, but the order of magnitude of coliform concentrations has been kept very close to that value, whenever these plants do show the positive presence of the group in their fluid products.

New Jersey health officers have been well satisfied with the progress made in lowering the coliform index at fluid product plants, and are now giving some attention to other dairy manufactures as well. Much has been done with ice cream plants, where the contamination of old style homogenizer heads has been a potent factor. Legislation similar to that adopted in the New York metropolitan area, requiring "sanitary head" homogenizers is under consideration. The practice of complete sterilization of freezers and packaging machines has been incorporated into the routine of many plants. Considerable difficulty is still being found by the persistance of the practice of ruining good ice cream mixes by the addition of contaminated colors, fruits and flavors just prior to freezing.

CONTROL OF RETAIL OUTLETS

During the past few years, many New Jersey control divisions have adopted legislation requiring the serving of individual packages of milk to consumers at retail outlets. Steps taken to avoid the dissemination of unsound dairy products have included establishment of requirements for the sterilization of restaurant and soda fountain glasses, ice cream dispensing equipment, etc. Samples taken of products sold over retail counters have shown that contamination at the point of sale frequently assumes mammoth proportions.

The number of roadside stands along New Jersey's key highways has increased, due to the New York World's Fair. The control of dairy products and of the manner of their dispensation at these establishments has been arranged for, through the cooperation of local and state officials.

DAIRY PRODUCTS CONTAINERS AND CLOSURES

A consideration of the closure problem by New Jersey agencies in the past year has led to the following reasoning: The primary purpose of a dairy products closure is to prevent the entrance of contaminating materials into the product under the conditions of commercial handling. The first criterion to be applied to a closure, then, is that under normal icing, storage, transportation, and delivery, efficient closures would be those which would resist the entrance into the product of whatever might be carried in the ice as a vehicle. The protection of the pouring lip is, then, a secondary criterion, since closures which allowed the entrance of contaminants into the product must have also contaminated the pouring lip.

The methylene blue drip technique has shown that capillary creep and osmotic transfer are important factors in the functioning of a dairy products closure. The technique possesses limitations, however, as far as the entrance of foreign materials into the dairy product is concerned, for a relatively large amount of material must enter in order to show itself. To avoid this, a modification of the technique has been developed which employs the use of a bacterial culture. The entrance of even a minute portion of the culture into the dairy product will

show itself by the recovery of the organism from the product. The procedure consists of developing a culture of *B. prodigiosus Flugge* (*Serratia marcescens*). This organism has been selected because it is never found in properly pasteurized products, and because it develops large characteristic colonies when cultured in a suitable manner. The culture is diluted with water and frozen into ice. The concentration of organisms in the ice is determined and the ice is then mixed with normal ice to yield a concentration of 500,000 organisms per gram. The bottles of dairy product, after having been sealed with the closure under consideration, are packed in cases, iced according to the normal manner, given agitation equivalent to four hours of transportation, then held at room temperature for four hours (equivalent to the length of time bottles remain unrefrigerated after delivery from a route wagon) then placed into a refrigerator uniced for four hours. The contents of the bottles are then cultured for the presence of the chromogenic organism. Seven cases of bottles are stacked to parallel commercial handling conditions. This procedure also reduces the experimental error, since more than 100 bottles are included in the usual assortment of three cases of quarts, two of pints, and two of half pints. The information obtained has been extremely valuable to show closure manufacturers how modifications of standard designs may influence closure efficiencies.

THE DIRECTION OF FUTURE DEVELOPMENTS

From present indications, New Jersey's next thoughts in dairy sanitation will be along the lines of homogenized market milk, high temperature - short time pasteurization, and soft curd milk.

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Silos — Types and Construction

A new Government bulletin on the types and construction of silos has just been issued. It should be of interest to all directly concerned in dairying or livestock farming. The bulletin deals with the various kinds of above-ground and below-ground silos, and carries the necessary details of construction, with handy tables of dimensions and helpful illustrations. Sections of nine types of silos are shown. The new bulletin supersedes Farmers' Bulletins on pit silos and homemade silos.

Construction needs for silos to hold different kinds of silage are given. Extra reinforcement is recommended for walls of silos to be filled with silage made from sunflowers, pea vines, hay, and molasses, or from corn very high in moisture. The danger from fermentation gas in the silo receives special attention, and means are suggested in the bulletin for insuring safety and for reviving victims.

This publication, Farmers' Bulletin 1820, may be obtained free while the supply lasts by writing to the Office of Publication, U. S. Department of Agriculture, Washington, D. C.

The Nutritional Properties of Milk *

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For over 2000 years including the 1830's, scientists spoke and wrote of only one kind of food. A medical text book of 1834 is the first mention of three kinds of foods. Those three are the bulk foods. Then in the next 60 years came a slight change which included iron, calcium, and a few others. But within the last fifteen years we have come to realize there are forty or more substances that must be classed as necessary foods, or rather food factors, since such very small quantities of many of them are required. How many of these are as yet undiscovered is of course unknown.

The main source of these food factors is naturally the material we eat as food. And if our food does not contain them, or enough of them, the body will be deficient of that particular factor and a sub-normal condition develops. In many instances the amount is small and the lack of it may go unnoticed for some time. The needed amount of calcium is one-half pound a year, so what appears to be a very slight decrease in the daily requirement may go unnoticed for some time. It may never be noticed. But it cannot but make a difference in the state of health of the individual. And milk is the only food that can supply a sufficient amount of this mineral in the portions ordinarily consumed daily.

In nature, the position of milk is unique. It is the only food that has but one function, namely, that of a food. Plant products have other functions whether it is root, leaf, fruit, seed or blossom. That function ceases when we harvest it for food. The same situation holds for animal foods. They too have another function in nature.

Since milk then is produced naturally as the only food containing some of all our known food factors, it is natural to expect a better product from a nutritional point of view than from those foods we adopt and adapt from animal and vegetable life.

When these points are considered we can readily understand why milk of all foods has been and will continue to be the most studied and most safeguarded food. More money is spent on safeguarding milk than all the other 300 odd foods combined. The public has yet to recognize this important point.

FOOD FACTORS

Many elements are classed as food factors. Minerals, such as iron, copper and iodine, and elements such a chlorine, potassium, and sodium are needed by the body but in such small amounts that they were formerly considered of little importance. Yet the science of nutrition has shown their value and that we cannot do without them.

While they are all present in milk as a usual thing, it is easy to understand that anyone or several might be missing. No mineral element can appear in the milk that is absent in the food of the cow producing the milk. That statement is not wholly true but the exception only gives weight to the statement. The exception is that the cow will continue to supply for a short time some minerals in the milk that she is no longer receiving in her feed. She is then supplying from her own tissues the mineral that she herself needs.

The milk of a number of animals is used by people in various parts of the world. The animals usually selected is the one that gives a fair amount of milk with the least care. In North America

* Presented at Twenty-seventh Annual Meeting of International Association of Milk Sanitarians at Cleveland, Ohio, October 19-21, 1938.

the animal selected, the cow, is the highest producer of all the milk-producing animals. Several factors operate in the selection of the animal used. Today we find some increase in goat milk consumption. Its grading is approaching that of cow's milk.

FAT

There are a number of differences in the milk of various animals and the nutritional value has been a point of controversy. We are here calling attention to three of these differences. The first is the fat content. The fat content varies with the growth requirements of the infant animal. It varies from 1⅛ percent in the ass and the mare to 54 percent in the porpoise. (There are several species of animals living in the sea that suckle their young. They are not fish, of course.) The milk of reindeer runs about 17 percent fat and has probably the highest fat content of natural milks used by man. Infant animals must early in life be protected from low temperatures, and the high fat content of their milk supplies the need. We also have the 8 percent and 10 percent fat content of the buffalo and caribou which is between the high and low, since they have the assistance of hide and hair in addition to the fat as a temperature protection.

MINERALS

The second important difference is the mineral content. While the mineral content of milks of various animals is small in actual amount, it varies considerably in percentage. This variation is related to the weight increase of the infant animal. The normal human infant doubles its weight in the first 180 days of life. The calf of the cow doubles its weight in about 47 days. We should therefore expect to find about three times as much minerals or ash in cow's milk as in human milk and other animals in proportion. This is not exact but does in the main hold valid for most animals.

The shift from copper to stainless steel and other metals in the processing of milk may have an important bearing on nutrition. Copper is a necessary mineral element in nutrition. As the amount of copper decreases in plants due to a decrease in the soil and a deficiency in fertilizers, its importance in milk becomes more pronounced. With the elimination of copper in canned food processing, the amount of copper in milk takes on an added nutritional significance.

VITAMINS

The third difference is not a quantity factor as are the other two, since the amount is exceedingly small and is not measurable by the same methods. Two of the vitamins, C and D, are present in less than human requirements. These two have been supplied from other food sources — Vitamin C from all citrus fruits, many vegetables, and some animal sources; and Vitamin D principally from fish oils, until the discovery of ultra-violet irradiation.

In the case of Vitamin D, the situation is quite different. Two foods apart from fish oils, namely egg yolk and milk, contain Vitamin D, but only to the extent that they contain sufficient for the animal for the few days of very dependent infancy. Neither contains a sufficient amount of Vitamin D for structural development. The only source of Vitamin D known is ultra-violet irradiation of several substances present in vegetable and animal life. The original source of ultra-violet is the sun. We have successfully substituted sources of artificial light for the light of the sun. The same is true of heat substitution. The ultra-violet or health rays are being used very generally now to supply Vitamin D in milk. The exhibition here this week shows fully three times as much new equipment for increasing the Vitamin D content of milk as that of several years ago.

The yellow pigment of milk is a good source of vitamin A since this pigment is the pro-vitamin substance. Milk also contains the colorless substance vitamin A in considerable quantities. While generally the liver can reduce the pro-vitamin pigment to vitamin A, where this function is impaired milk becomes an important supplier of vitamin A. Again, where the particular breed of cow gave less of the yellow pigment the milk usually contained more colorless vitamin A.

DIGESTIBILITY

When we speak of the nutritional value of milk another factor must be taken into consideration, namely, the digestibility of milk. The increased interest in soft curd milk and the methods of securing this are of more than passing interest to the milk sanitarian. In order to increase the digestibility of milk, three separate and distinct types of machines have been developed. Here again the milk sanitarian must become cognizant of the equipment that makes these changes. Not only the operation, but the equipment and the material as well as the results to be attained by the process itself require attention.

BACTERIAL ATTACK

Milk is a very favorable environment for bacteria. Many types depend on vitamin-like compounds. And milk offers bacteria an excellent source. When we realize however that bacteria consume an amount of food equal to their own dry weight in five minutes, and consume just about double their size and weight in twenty minutes, another reason for clean milk presents itself. The nutritional value of milk is lowered where the count is high.

DIETARY EDUCATION

No substitute for milk has ever been found. If its nutritional value can be kept at a high standard by constant supervision it will continue to remain at the head of the list of the necessary foods for growth and health. One factor that must be kept in mind is "people are not self-regulatory in their diet". They must be regularly told of the value of milk as a food. You cannot depend on the instinct of the human to properly feed himself. There is a great deal of medical evidence on this point. Nor will instinct plus sense be sufficient. A guide is needed constantly.

A Study of the Effect of the Growth of Some Organisms in Milk on the Phosphatase Test

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Although the destruction or inactivation of enzymes in milk by heat was known, and tests for raw milk and heated milk were based on the destruction of enzymes (1), it was not until Leahy (2) reported a test for pasteurization of milk depending upon destruction of amylase during the pasteurizing process and Kay and Graham (3) published the study of the phosphatase test for pasteurized milk that an effort was made to control definitely the efficiency of a pasteurizing process by the use of the enzyme test. The two methods that appear to give the most reliable results are the Kay and Graham method, described by Gilcreas and Davis (4), and the Scharer method (5). These methods were used in this work.

This study of the phosphatase test or the phosphomonoesterase test was suggested by the statement of Tracy and Hahn (6), "What effect does the growth of organisms commonly found in pasteurized milk have upon the accuracy of the test?" This appeared to be quite important, since during the processing of milk after the milk is heated and held it is conducted through pipe lines, over coolers, into balance tanks, bottle fillers, bottles or cans before this product becomes ready for consumption. These parts of the equipment may harbor some con-

TABLE 1

Phosphatase tests on samples of inoculated and incubated milk

Sample No.	Test Material	Plate count Colonies per cc. B. I.	Plate count Colonies per cc. A. I.	Kay-Graham Method (Gilcreas-Davis) mgs. phenol/0.5 cc. B. I.	Kay-Graham Method (Gilcreas-Davis) mgs. phenol/0.5 cc. A. I.	Scharer method units B. I.	Scharer method units A. I.
1	Control	36,000	110,000	0.02	0.02	2.0	
	B. lacticus		3,500,000		0.02		
2	Control	4,100	13,500	0.03	0.03	1.0	
	B. lacticus		60,000,000		0.03		
3	Control	10,000	28,000	0.03	0.03	2.0	
	B. lacticus		10,000,000		0.02		
4	Control	12,000	60,000	0.04	0.04	4.0	
	S. aureus		600,000		0.04		
5	Control	40,000	91,000	0.01	0.01	2.0	
	S. aureus		350,000		0.01		
6	Control	75,000	210,000	0.02	0.02	2.0	
	E. coli		10,000,000		0.03		
7	Control	3,000	13,000	0.03	0.03	2.0	
	E. coli (strain No. 1)		20,000,000		0.03		
8	Control	7,500	80,000	0.02	0.02	1.5	
	E. coli (Strain No. 1)		39,000,000		0.03		
9	Control	16,000	60,000	0.02	0.02	3.0	
	L. acidophilus		10,000,000		0.02		
10	Control	25,000	78,000	0.02	0.02	3.0	
	L. acidophilus		16,000,000		0.02		
11	Control	12,000	20,000	0.01	0.01	2.0	
	L. bulgaricus		3,000,000		0.02		
12	Control	2,100	18,000	0.02	0.02	2.0	
	L. bulgaricus		12,000,000		0.02		
13	Control	86,000	220,000	0.02	0.03	2.0	
	L. bulgaricus		1,000,000		0.03		
14	Control	15,000	75,000	0.03	0.03	3.0	
	S. lactis		3,000,000		0.03		
15	Control	11,000	120,000	0.04	0.04	3.0	
	S. lactis		12,000,000		0.04		
16	Control	12,000	43,000	0.03	0.03	3.0	
	S. lactis		10,000,000		0.03		
17	Control	12,000	60,000	0.02	0.02	3.0	
	B. subtilis		300,000		0.02		
18	Control	40,000	52,000	0.02	0.02	3.0	
	B. subtilis		100,000		0.03		
19	Control	16,000	60,000	0.03	0.03	2.0	
	S. albus		120,000		0.04		
20	Control	42,000	200,000	0.02	0.02	4.0	
	S. albus		300,000		0.03		
21	Control	6,300	12,000	0.01	0.01	1.5	
	E. coli (Strain No. 2)		12,000,000		0.01		
22	Control	14,000	68,000	0.02	0.02	3.0	
	E. coli (Strain No. 2)		5,000,000		0.02		
23	Control	16,000	76,000	0.04	0.04	2.0	
	Old Milk		1,200,000		0.04		
24	Control	24,000	58,000	0.02	0.02	3.0	
	Old Milk		450,000		0.02		
25	Control	6,500	26,000	0.02	0.02	3.0	
	Old Milk		340,000		0.02		

Note: B. I.—Before incubation
A. I.—After incubation

Note: The bacteriological plate counts were made by Rose Nyman, Bacteriologist, Cerri... Laboratories, Inc., New York City. The phosphatase tests were performed by the au... in conjunction with Dr. Walter H. Eddy, Columbia University, N. Y.

Remarks: This study was begun in February, 1938. The Scharer Method employed was t... original method. The use of butyl alcohol was described later (7). Results ... phenol readings were obtained by comparison with standards.

...minating organisms or some old milk. The milk may also be contaminated by small amounts of improperly pasteurized milk which contains some of these contaminating organisms. The amount of improperly pasteurized milk in many cases may be in such small amounts that it cannot be detected by the phosphatase test. It is therefore of importance to determine whether any organisms that may not be destroyed or may find their way into the milk will produce or reactivate the phosphatase enzyme.

To develop this problem, we proceeded to introduce into milk various organisms, some normally found therein and other organisms that might find their way into pasteurized milk through contamination in the processing or handling of milk or that might remain on equipment or receptacles in the preparation of cultured milks. Pasteurized Grade "B" milk was permitted to curdle by standing at room temperature and was then thoroughly shaken and also used as a testing medium to see what effect old sour milk would have on the tests. At the same time, we compared the results obtained by the Kay and Graham (Gilcreas and Davis) method and the Scharer method. Plate counts were also made of the milks. Nutrient Agar was the medium used for determining the counts for all organisms but *E. coli.* Levine's Eosin Methylene Blue medium was used for determining the *E. coli* counts. The incubating temperature was 37° C.

EXPERIMENTAL PROCEDURE

Specimens of New York City Grade "B" pasteurized milk from different dealers were used, and each milk before inoculation with the test material was examined simultaneously by the Gilcreas and Davis and the Scharer methods for the purpose of control. Ten cc. of the control milk were inoculated with 1 cc. of the culture of the test material, and incubated at 37° C. for from 4 to 5 hours after which they were again subjected to the tests. The test organisms used were *B. lacticus, S. aureus, E. coli* (2 strains obtained from different sources), *L. acidophilus, L. bulgaricus, S. lactis, B. subtilis,* and *S. albus.* Old soured pasteurized milk (well mixed) was also used. Control samples of pasteurized milk, not inoculated, were incubated and tested similarly. These data are presented in table 1.

CONCLUSION

1. The growth and presence of *B. lacticus, S. aureus, E. coli* (2 strains obtained from different sources), *L. acidophilus, L. bulgaricus, S. lactis, B. subtilis,* and *S. albus* do not reactivate or increase the phosphatase enzyme to any extent where it would interfere with the test, neither does old, sour milk.

2. The pasteurized milks kept at an incubation temperature of 37° C. for 5 hours do not show a reactivation of phosphatase as measured by an increase of the enzyme.

3. The Gilcrease-Davis and the Scharer methods compared favorably as laboratory methods for the determination of the phosphatase content of the milk.

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On Phosphatase Methods in the Control of Long-Time Pasteurized and Stassanized Milk.

Comparative Investigations of Stein's, Kay and Graham's (1935), and Scharer's Methods With Special Regard to the Importance of Prolonging the Time of Reaction of Scharer's Method.

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Milk designated as long-time pasteurized should be held at a temperature between 63 and 65° C. for at least 30 minutes according to the Danish ordinances. Milk designated as stassanized should be heated to at least 73° C. in a Stassano apparatus either with a milk film of 1.2 mm. thickness and a time of flowing through of at least 15 seconds, or with a milk film of 0.6 mm. thickness and a time of flowing through of 1.4 seconds plus 5.4 seconds in a holder.

The authors have tested the applicability of the three modifications of the phosphatase test to the control of the pasteurization in accordance with the Danish ordinances.

1. *Stein's* method published in 1937, which is a modification of the Kay and Graham method of 1933. The method is based on the liberation of phosphorus.
2. *Kay and Graham's* method of 1935, which is based on the liberation of phenol.
3. *Scharer's* method published in 1938, which is a modification of Kay and Graham's phenol method.

The Stein and the Scharer method with 1 hour incubation showed about equal sensitivity in detecting faulty heat treatment. Scharer's method becomes nearly as sensitive as Kay and Graham's if the time of incubation is extended to 3 hours, and Scharer's method is definitely superior to the other two methods in detecting minor faults in the pasteurization if the time of incubation is prolonged to 20 hours.

Of the three methods, Scharer's is by far the easiest to conduct.

The main result of the comparative investigation are set forth in the following table:

The experience with Scharer's method has been as follows: The phenol reagent should be micro-crystalline and of a clear canary color. An admixture of dirty brownish crystals indicates a beginning decomposition which is associated with a reduced reacting ability.

The amount of phenol reagent prescribed by Scharer is only sufficient for the development of about 50 blue units.

For non-specific reasons the phenol is liberated from phenylphosphate if the samples are allowed to stand without cooling and filtration after the lead acetate precipitation.

7.5 blue units is the limit for proper pasteurization in the 20 hour test. A blank is run on inactivated milk.

Milk held for 30 minutes at	Stein	Kay and Graham	Scharer 1 hour	Scharer 20 hours
63 C°	—	—	—	—
62.5 C°	—	—	—	—
62 C°	—	—	—	(+)
61.5 C°	—	—	—	+
61 C°	(+)	+	—	+ +
60.5 C°	(+)	+ +	(+)	+ + +
60 C°	+	+ + +	+	+ + +

In the 20 hour test, 0.2 percent raw milk in inactivated milk is easily detected. The phosphatase which is not destroyed by the heat treatment is concentrated in the cream layer. A considerable phosphatase content is found if the cream layer of properly pasteurized milk is tested. A similar test is obtained on the cream layer after the milk has been mixed and the cream again allowed to rise.

The Scharer phosphatase test with prolonged incubation is considered suitable for the control of pasteurization under Danish conditions. The test of numerous samples of commercially pasteurized milk showed that a control by the phosphatase test is urgently required.

A. J.

Food Control: Its Public Health Aspects

A New Book on the Inspection and Supervision of Food Supplies

To discharge their duties adequately, the food control personnel, whether government officials or industrial employees, need information and training in a variety of fields—food technology, public health principles and practices, public relations, chemistry, bacteriology, regulatory procedure, quality supervision, etc. This book takes these factors into account in its consideration of general principles and applications of food control. Although it deals more particularly with regulation from the public health standpoint, it also carries much material on the enforcement of food standards.

From a wide range of sources, it brings together data on why food control is necessary, what industrial practices are concerned in such control, how control measures are applied, and what steps should be taken in a food-poisoning outbreak.

The first several chapters are devoted to a discussion of principles. These are followed by chapters on each of the classes of food which have been found to have an important bearing on public health: milk, meat, poultry, eggs, sea food, cereals, fruits and vegetables, and food preservation. Each division deals systematically with the technology of the food concerned, its industrial aspects, its relation to the public health, and the procedure commonly followed in the commercial and regulatory examination of samples, and the official control practices. The comprehensive picture is of the control that is now being exercised and the control that should be exercised.

The author's wide experience in federal and municipal food regulatory supervision, in commercial food production and its quality control, in the teaching of food technology, in the organization and direction of industrial control and research laboratories, and in the fostering of favorable public relations, comes into use in all the chapters, particularly in the expert chapters on milk production, milk certification, milk pasteurization, concentrated milks, other dairy products, and canning and preserving.

A feature which particularly recommends the book is the extensive up-to-date bibliography of about eight hundred references. It will be of considerable value to those using the book as a starting point for more extensive or intensive research on a specific phase of the subject. The references carry the literature into 1939.

The book reads along well. It is written for a wide audience and is not highly technical. An exhaustive index allows easy access to information that is dependable, accurate, and understandable.

Food Control: Its Public Health Aspects, by J. H. Shrader, Ph.D., John Wiley & Sons, Inc., New York, 496 pages; 6 x 9; $4.00.

W. B. P.

Bacteriological Program of the Paper Industry

The use of paper in the food industries has contributed greatly to sanitary packaging of foods. The demonstrated utility of paper in food packaging has widened its use so that at the present time about one-third of the fifteen million-ton consumption of paper in the United States is used for packaging food stuffs.

During the last three or four years, introduction of the paper milk container has made new opportunities for use of paper. Believing that paper can make just as great a contribution in this new field as it has in the entire field of food packaging, paper manufacturers are eager to cooperate in every way in investigations on paper to be used for paper milk containers.

Buildings of the Institute of Paper Chemistry at Appleton, Wisconsin

Paper manufacturers have over a long period of years undertaken programs of improvement in operating conditions, not only to increase the utility of paper but also to improve its sanitary qualities. These programs have been carried on by individual manufacturers, either in their own laboratories, by grants to research laboratories, or in cooperation with public and industrial agencies.

In line with this policy, to prevent unnecesary duplication of research in this field and to coordinate work in the future, the industry has recently undertaken a cooperative program which will contribute to better control of sanitation in manufacture of paper, establishment of sanitation standards, development of methods of analysis to accompany such standards, and cooperation with health agencies. This coordinated program, to be administered through the American Paper and Pulp Association, will be expected to relate investigations now in progress and suggest the trend of new experiments. The Association has enlisted The Institute of Paper Chemistry to carry on the fundamental work prerequisite to the establishment of standard technics, and to expand through the use of these technics the understanding of sanitary problems involved in the manufacture and conversion of paper to be used in the packaging of foods. Acting with the Institute in an advisory capacity will be Dr. Fred W. Tanner, Professor of Bacteriology at the University of Illinois. Dr. Tanner and the Institute will work closely with a special committee comprised of experts from the paper industry and specially created for this purpose by the Association.

The Imperial Bureau of Dairy Science

In 1936 the British Commonwealth Scientific Conference which met in London to consider the working of the organizations controlled by the Executive Council of the Imperial Agricultural Bureaus, recommended that an Imperial Bureau of Dairy Science be established. The conference also suggested the National Institute for Research in Dairying as the most suitable location for the Bureau.

Following agreement by all the authorities concerned, the new Imperial Bureau of Dairy Science has now been established at Shinfield, near Reading, and is housed in the Stenhouse Williams Memorial Library of the National Institute for Research in Dairying (illustrated in figure 1). Professor H. D. Kay, O.B.E., Ph.D., D.Sc., Director of the National Institute, has been appointed Director of the Bureau. Mr. W. G. Sutton, M.Sc., A.I.C., from Massey Agricultural College, New Zealand, has been appointed Deputy Director and began his duties in August 1938. Other members of the staff include Miss Adelaide H. King, B.A., Ph.D., and Miss M. M. G. Mackintosh, B.Sc. The Bureau is financed cooperatively by the Governments of the British Empire in the same way as the other Imperial Agricultural Bureaus.

The functions of the Bureau are to index research work in dairy science, whether carried out in the Empire or elsewhere; to collect, abstract, and collate information bearing on dairy science, and to distribute such information both by publication and by private communication to research workers, officials, and advisory officers throughout the British Commonwealth of Nations. In addition

Stenhouse Williams Memorial Library Buildings which house the Imperial Bureau of Dairy Science

the Bureau is charged with the duty of establishing and maintaining contact between research workers with common interests, promoting conferences of workers and visits to research centres, and in general encouraging the circulation of information, ideas, material and personnel.

The field of dairy science to be covered by the Bureau was defined by the Conference when recommending its establishment. This field includes: the microbiology, chemistry, and physics of milk and its products; animal diseases in so far as they affect milk and its products; the technology of processing milk and manufacturing dairy products; the physiology of milk secretion as affecting quality and quantity of milk and dairy products; standards for, and methods of control of, the composition and quality of milk and its products. The chief publication of the Bureau is a quarterly Journal, "Dairy Science Abstracts" the first number of which has just appeared.

The routine duties of the Bureau, such as indexing and abstracting, will already be familiar to many dairy workers from the activities of the Bureaus already established in other subjects. An aspect of Bureau work which may not be so well known and understood is the more informal service which can be given to dairy research workers, teachers, milk sanitarians, and other field officers. The Bureau will deal directly with the individual workers in dairy science, who are invited to write to the Bureau for information which is not obtainable in their own countries. The Bureau may be able to supply the information itself, or to put the enquirer in touch with someone who can do so more effectively.

The new Bureau of Dairy Science has been established in answer to requests for a clearing house for information in dairy science, technology, and practice; its value to dairy science, and to the dairy industry generally will largely depend on the extent to which research workers and others avail themselves of its services.

H. D. K.

Dairy Science Abstracts

It is announced that this new quarterly abstract journal aims at providing a record of current research work in all fields of dairy science irrespective of the country in which it is carried out or of the language in which it is published. Titles of articles will be included with full details of place of original publication, and where considered necessary, abstracts written by dairy scientists. Special attention will be paid to papers published in journals of limited distribution and in less well-known languages. The subscription price is 25/- per volume of four numbers, post free, payable in advance, with a discount of 5/- to British subjects who send their subscriptions direct to the Bureau. Each number will contain an author index and each annual volume author and subject indexes. Authors of papers will draw attention to their work if they will send three copies of their papers to the Bureau immediately when they are available. These will be catalogued and preserved as a collection available for loan.

A copy of the first issue of this excellent abstract journal contains abstracts and publication notices of 426 papers or reports printed on 113 pages and covers the literature for January, February, and March 1939. The abstracts are well written, easily readable, and do indeed cover many sources of dairy information not usually encountered by the average milk sanitarian, laboratorian, and technologist. It is a valuable addition to dairy literature and deserves wide support.

J. H. S.

Doctor Brooks Reappointed on Board of Medical Examiners

Dr. Paul B. Brooks, 1st vice-president of the International Association and deputy commissioner of health of New York State, has been reappointed by the Board of Regents of the University of the State of New York as a member of the State Board of Medical Examiners for a term of three years from August 1, 1939.

Standard Methods for the Examination of Dairy Products

This valuable manual, so necessary to the milk laboratorian and sanitarian, has appeared as the seventh edition of the former Standard Methods of Milk Analysis, published by the American Public Health Association, 50 West 50th Street, New York City. It now carries 190 pages, including a useful index—a sizeable increase over the 105 pages (no index) of the last edition. Valuable new laboratory methods have been included, and their interpretation has been revised in the light of the latest information.

This kind of work, comprising a labor of love by numerous collaborators during "out of hours," embraces a great amount of detailed and critical examination of data, rendered all the more difficult in such an active field as the examination of dairy products changing while type is being set. Hence, it is to be expected that errors will creep into such a compilation. It is surprising that there are not more. A list of those discovered thus far is published herewith. However, some of these items are new data, developed after the text was in type It would be appreciated that any errors found be reported to the publishers.

ERRATA

Page 17, 4th paragraph, line 5, should read *contain* not *deliver*.

Page 48, Legend for Fig. 14, interchange *right* and *left*.
Legend for Fig. 15, last line, interchange *right* and *left*.

Page 96, Line 9 of 2. Plate Method. Change to read: containing crystal violet to a final dilution of 1:700,000.

Page 115, line 29. Change to read: to pH 3.5 ± 0.1.

Page 164, line 11, Delete: to avoid the later use of sodium carbonate. Insert: to avoid the formation of a precipitate.

Page 167, under Reagents insert: (c) Sodium carbonate solution. Dissolve 140 gm. (1.32 molar solution) of pure anhydrous sodium carbonate in distilled water and make up to 1 liter.

Page 168, line 11. Delete last sentence of second paragraph reading: Transfer 10 cc. of the filtrate, taken immediately after the filtration, into a test tube and heat in boiling water (kept boiling) for 3 minutes. Substitute: To 10 cc. of the filtrate add 2 cc. of the sodium carbonate solution, mix and heat in boiling water (kept boiling) for 2 minutes.

Line 19. Delete last sentence of 4th paragraph reading: Heat 10 cc. of this filtrate in a test tube in boiling water (kept boiling) for *exactly* three minutes. Substitute: To 10 cc. of the filtrate add 2 cc. of the sodium carbonate solution, mix and heat in boiling water (kept boiling) for 2 minutes.

Page 169, line 22. Delete last sentence of 3rd paragraph reading: Transfer 10 cc. of the filtrate into a test tube, and place in boiling water (kept boiling) for 3 minutes. Substitute: To 10 cc. of the filtrate add 2 cc. of the sodium carbonate solution, mix and heat in boiling water (kept boiling) for 2 minutes.

Page 172, line 4, line 7, and line 2 below table: It is understood in all A. O. A. C. reports that strengths of acid, when not otherwise specified, are those of the ordinary concentrated reagents.

Page 174, line 2. Insert footnote: Recent work indicates that a phenol value of 0.05 mg. phenol per 0.5 cc. of sample generally indicates milk heated to 143° F., for 30 minutes [Gilcreas, *Am. J. Pub. Health*, **29**, 158 (1939)]

Page 176. At bottom of page in table of COLOR SOLUTIONS, the values of the red and yellow solutions should be reversed: the heading given as red should be yellow and the heading given as yellow should be red.

Page 177. At top of page in table of COLOR SOLUTIONS, the values given for the blue should be red and vice versa.

JOURNAL OF MILK TECHNOLOGY

Official Publication of the

International Association of Milk Sanitarians

(Association Organized 1911)

THE JOURNAL OF MILK TECHNOLOGY is issued bimonthly beginning with the January number. Each volume comprises six numbers. It is published by the International Association of Milk Sanitarians, and is printed by The Chronicle Press, Inc., Orange, N. J., U. S. A.

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Advertising: All correspondence concerning advertising, reprints, subscriptions, and all other business matters should be addressed to the Managing Editor, W. B. Palmer, 29 North Day Street, Orange, N. J.

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Membership and Dues: Active and Associate Memberships in the Association are $5.00 per year. This includes all issues of the Journal. All correspondence concerning membership in the INTERNATIONAL ASSOCIATION OF MILK SANITARIANS, including applications for membership, remittances for dues, failure to receive copies of the JOURNAL OF MILK TECHNOLOGY, and other such matters should be addressed to the Secretary of the Association, C. Sidney Leete, State Department of Health, Albany, N. Y.

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Tentative Program* of the 1939 Convention

INTERNATIONAL ASSOCIATION OF MILK SANITARIANS, INC.

October 25-27, 1939

October 25

WEDNESDAY MORNING, *8:30* O'CLOCK

Registration

Welcome

Necessity for and Some Difficulties of Public Health Milk Control
F. D. Brock,
State Department of Health,
Austin, Texas.

Nutritive Value of Milk
Ouida Abbott,
University of Florida,
Gainesville, Fla.

The Effect of the Bang's Disease Control Program on Milk Production in Florida Dairies
J. V. Knapp,
State Veterinarian,
Tallahassee, Fla.

Applied Laboratory Methods (Committee Report)
C. A. Abele, *Chairman,*
State Department of Health,
Montgomery, Ala.

WEDNESDAY AFTERNOON, *2* O'CLOCK

Is the Standard Plate Count the Proper Yardstick for Measuring Quality?
M. E. Parker,
Beatrice Creamery Co.,
Chicago, Ill.

Farm Pasteurization
A. H. Williamson,
State Board of Health,
Jacksonville, Fla.

Improvement of the Hotis Test for the Detection of Mastitis Streptococci
J. Frank Cone,
U. S. Department of Agriculture,
Washington, D. C.

The Training of Personnel for the Field of Milk Sanitation
T. H. Butterworth,
Health Department,
San Antonio, Texas.

Education and Training of Milk Sanitarians (Committee Report)
H. E. Miller, *Chairman*
University of Michigan,
Ann Arbor, Mich.

WEDNESDAY EVENING, *8* O'CLOCK

The Future of the Southern Dairy Industry
A. D. Burke,
Alabama Polytechnic Institute,
Auburn, Ala.

Training of Pasteurization Plant Operators
Kenneth M. Renner,
Texas Technological College,
Lubbock, Texas.

Communicable Diseases Affecting Man (Committee Report)
Paul B. Brooks, *Chairman*
State Department of Health,
Albany, N. Y.

October 26

THURSDAY MORNING, *9:30* O'CLOCK

Successful Dairy Inspection
Frank E. Kitchen,
Department of Health,
Greenville, S. C.

Sanitary Milk Control Situation in Havana
Raoul Cowley,
Instituto Tecnico De Salubridad Rural
Havana, Cuba.

Sanitary Control of Ice Cream (Committee Report)
F. W. Fabian, *Chairman*
Michigan State College,
East Lansing, Mich.

BUSINESS SESSION

THURSDAY AFTERNOON, *2* O'CLOCK

Inspection of Dairies and Farms in Jacksonville and Vicinity

THURSDAY EVENING, *7* O'CLOCK

Banquet and Cinema Entertainment

October 27

FRIDAY MORNING, *9:30* O'CLOCK

The Voluntary Grading of Milk Supplies in Alabama
F. H. Downs, Jr.,
State Department of Public Health,
Montgomery, Ala.

Findings in Comparative Studies of the Old and New Culture Media
C. A. Abele,
State Department of Public Health,
Montgomery, Ala.

Forum Discussion of Experiences with the New Medium as a Factor in Quality Control
J. A. Keenan
A. C. Fay
A. R. Tolland
All of Boston, Mass.

Sanitary Procedure (Committee Report)
W. D. Tiedeman, *Chairman*
State Department of Health,
Albany, N. Y.

FRIDAY AFTERNOON, *2:30* O'CLOCK

Seeing Jacksonville (Official)

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*Order of Appearance Subject to Change.

New York State Association of Dairy and Milk Inspectors

Preliminary Program for the Annual Meeting at Hotel Syracuse, Syracuse, N. Y., September 27, 28, 29, 1939.

WEDNESDAY, September 27, 1939

9:00 A. M. (Eastern Daylight Saving Time)

Opening of the meeting by the president, Dr. Clyde L. Kern, Dairymen's League Cooperative Association, New York City.

Welcome by Honorable Rolland B. Marvin, Mayor, and Dr. H. Burton Doust, Commissioner of Health, Syracuse.

Short business session.

A Survey of Mastitis Control under Several Plans, by Dr. F. W. Graves, State Department of Health, Albany, N. Y.

The Relation of the Elimination Program to the Control of Mastitis, by Dr. G. J. Hucker, State Agricultural Experiment Station, Geneva.

A Discussion of the International Classification of the Streptococci of Bovine Mastitis, by Dr. Ralph B. Little, The Rockefeller Institute for Medical Research, Princeton, N. J. (Including bacteriological demonstration.)

Noon — Registration

1:30 P. M.

Progress Report on Grade A Control Laboratories, by Dr. C. E. Safford, State Department of Agriculture and Markets, Albany.

New Tests for Chlorine, by Harry Scharer, Department of Health, New York City.

Precision in Reading Phosphatase Test Results, by F. W. Gilcreas and W. S. Davis, State Department of Health, Albany.

The Application of Wetter Water to Dairy and Milk Plant Use, by Dr. F. M. Scales, Sheffield Farms Company, New York City.

Deaeration of Market Milk, by P. F. Sharp, D. B. Hand, and E. S. Guthrie, Cornell University, Ithaca, N. Y.

6:00 P. M.

Official Milk Inspectors and other group dinners.

THURSDAY, September 28, 1939

9:00 A. M.

The Importance of Milk Trucking in Maintaining Sanitary Quality, by Dr. F. D. Holford, Borden's Farm Products Company, New York City.

Sanitary Control of Ice Cream, by Dr. F. W. Fabian, Michigan State College, E. Lansing, Michigan.

Practical Value of Deck Inspection as Compared with Farm Inspection, by Sol Pincus and Samuel Abraham, Dept. of Health, New York City.

Goat's Milk and Its Supervision, by J. C. Marquardt, State Agricultural Experiment Station, Geneva.

1:30 P. M.

The Production of Milk in the New York Milkshed as Affected by State and Federal Marketing Control, by H. H. Rathbun, 1st Vice President, Dairymen's League Cooperative Association, New York City.

Has the Approved Inspector System Tended Toward Uniformity?, by R. E. Irwin, Chief Bureau of Milk Sanitation, State Department of Health, Harrisburg, Pa.

The Digestibility of Processed Milks, by Dr. Leslie A. Chambers, School of Medicine, University of Pennsylvania, Philadelphia, Pa.

Some Bacteriological Problems Involved in High-Temperature, Short-Time Pasteurization, by Dr. E. H. Parfitt, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

Question Box, by Dr. G. J. Hucker, State Agricultural Experiment Station, Geneva.

6:30 P. M.

ANNUAL BANQUET—Hotel Syracuse.

FRIDAY, September 29, 1939

9:00 A. M.

Modern Fly Control for Dairies, by W. A. Pohlman, Detjen Corporation, New York City.

Flavors and Odors in Milk, by C. J. Babcock, Market Milk Specialist, U. S. Dept., of Agriculture, Washington, D. C.

Milk Tank Sizes and Power Requirements, by H. W. Riley, Cornell University, Ithaca.

Milk Cans and Pails, by H. T. Coates, Dairymen's League Cooperative Association, New York City.

Regular Business Session.

W. D. TIEDEMAN,
Secretary-Treasurer.

School for Milk and Dairy Inspectors

Fourteen persons attended the two weeks' school for dairy and milk inspectors which was held at the New York State College of Agriculture, Cornell University, June 19 to July 1. The course was the second of its kind given in this State as a means of raising standards of milk inspection and of assisting dairy and milk inspectors to meet the qualifications prescribed by the State Sanitary Code for Grade I personnel. The registrants were interested in the field and laboratory aspects of milk sanitation and the course was planned so as to coordinate both branches of the work. The school was conducted as part of the general training program of the Muncipal Training Institute of New York State.

Massachusetts Milk Inspectors Association

The fall meeting of the Massachusetts Milk Inspectors' Association will be held at the State College, Amherst, Massachusetts, in October, the date to be announced later. Officers will then be nominated for election at the January meeting in Worcester. A good program is being arranged.

A summer outing for members, their guests and prominent officials, was held on July 19, at the certified farm of H. P. Hood & Sons, Inc. (Cherry Hill Farm), at North Beverly, Mass. There were about 250 persons present. Games, sports of all kinds, and a fine dinner were provided.

The bill sponsored by the Association in the last legislature for regulating the sale and defining a chocolate milk beverage was enacted. This bill allows a skim milk beverage as well as a whole milk beverage but was amended to exempt drug stores where chocolate milk shakes are served at the fountain.

ROBERT E. BEMIS, *Secretary-Treasurer.*

Indianapolis Dairy Technology Club

The Indianapolis Dairy Technology Club will hold its first meeting of the season on October 2. The speaker will be Ralph Gorley, Professor of Biochemistry at Purdue University, and his subject "What is New in Vitamins".

The Club held ten successful meetings last year with an average attendance of 67 persons. An outstanding meeting was one in which the entire membership participated in answering true and false questions and multiple answer questions related to the dairy industry. Approximately 300 questions were prepared. It appears that such an educational feature may be a valuable and interesting part when used occasionally. The State Board of Health and the Boards of Health of several Indiana cities are preparing a list of true and false and multiple answer questions in regard to the state and municipal dairy laws. It is planned to use these questions at the December meeting.

E. H. PARFITT, *Secretary-Treasurer.*

Michigan Association of Dairy and Milk Inspectors

The first summer conference or short course of the Michigan Association of Dairy and Milk Inspectors was held at the Michigan State College on July 13, 14, and 15. More than one hundred persons registered at this very successful conference. The forenoons were devoted to lectures, and the afternoons to laboratory work in which every one took an active part. The laboratory time was spent mostly in microscopic examinations, plate counts, and resazurin tests.

At the lecture sessions, the subjects were:

Milk Inspection Record-Keeping
Standardization of Ordinances, Equipment, and Specifications
Ice Cream Sanitation
Butter Problems
Licensing of Milk Inspectors
Dairy Plant Equipment
Sanitation on the Farm

The speakers were H. S. Adams, F. M. Skiver, W. D. Hasckell, F. W. Fabian, Ira A. Gould, W. D. Tiedeman, L. L. Miller, Russell R. Palmer, B. R. Franklin, and E. F. Meyer. Doctors C. S. Bryan and F. W. Fabian had charge of the laboratory work.

A delightful recreational program was held in connection with the conference. On the first afternoon a golf tournament was conducted, and on the second afternoon a baseball game was provided. This was followed by a banquet at the Michigan State Union. The new Mason Hall dormitory was turned over to every one who registered for lodging.

The membership voted unanimously to hold a Conference each year during the second week of July.

HAROLD J. BARNUM,
Secretary-Treasurer.

Chicago Dairy Technology Club

The next meeting of the Chicago Dairy Technology Club will be held on September 12. The speaker, Mr. Jesse Sampson, Department of Animal Pathology, University of Illinois, will lead a discussion on mastitis control.

P. H. TRACY, *Secretary.*

Connecticut Association of Dairy and Milk Inspectors

The fall meeting of the Connecticut Association of Dairy and Milk Inspectors will be held on Wednesday, September 27, at the Hotel Bond, Hartford. The morning session will be held jointly with the Association of Dairy, Food, and Drug Officials of the United States who are holding their annual meeting in Hartford on that date. The afternoon session will be held by the Association alone.

The program and speakers have been announced as follows:

State Laws and the Food Industries, by Dr. L. V. Burton, Editor, Food Industries.

State Laws and the Drug and Cosmetic Industries, by J. F. Hoge, of the firm of Rogers, Ramsey, and Hoge, New York City.

Standard Containers and the Consumer, by Alex Pisciotta, Director, Division of Weights and Measures of the Department of Markets, New York City.

The Advantage of Standard Methods and Procedure in Dairy Products Laboratories, by Dr. F. L. Mickle, Director, Bureau of Laboratories, Connecticut State Department of Health, Hartford, Conn.

H. C. GOSLEE, *Secretary.*

Metropolitan Dairy Technology Society

The first meeting of the Metropolitan Dairy Technology Society for the season will be held on Tuesday evening, September 19, at 6:30 P. M. at the McGraw-Hill Building, 330 West 42nd St., New York City.

O. F. GARRETT, *Secretary-Treasurer.*

Jacksonville

TWENTY-EIGHTH CONVENTION CITY OF INTERNATIONAL ASSOCIATION OF MILK SANITARIANS

On To Jacksonville

In this day of progress, we not only drink milk, but eat it, wear it, and use it for ornaments. It is used for the sick, the weak, the young, and the old. It is used not only as an article of diet but the products of milk are used for refreshment purposes, the making of bread, and the propagation of poultry. It has multiple uses, and month by month new applications and valuable constituents are found by numerous investigators.

The production of milk runs high as a product of the farms in the United States, and is a business which runs into millions of dollars per annum. While tremendous progress has been made, it lends itself to much further development. It is a business that affects the farmer, the transportation company, the merchant, the banker, and every home owner.

The milk business, however, is rather poorly organized. Producers are handicapped by the complexity of ordinances that confront them in the various municipalities. Some of these ordinances are on the verge of violating the Constitution with respect to commerce and tax clauses. There would be no excuse for these factors if a uniform or standardized program would be made effective throughout the United States.

Corner of lagoon on Ponte Vedra Country Club links near Jacksonville

The milk control officials of Oregon differ in their views from the officials in New York State, and the latter from those of California and Florida. Milk produced under the regulations of one town does not meet the requirements of the neighboring city ten miles away.

The theme of the Jacksonville meeting is for unity of purpose, and while no City of Tomorrow will be portrayed, we promise palm trees, moonlight teas, and a quiet and restful climate at Jacksonville, Florida. Then, too, you will have the privilege of listening to and discussing your problems with a cosmopolitan group, a Pan-American group, or may we go further and say an international group. The program calls for papers on the diseases of the cow, motion pictures of milk plants on the plateau of Mexico, papers on milk production in the Pan-American countries, papers on Cuba's popular drink, a paper on the new standard methods of milk analyses, and helpful hints on enforcement procedures. Colorful entertainment features are scheduled. It is a rare opportunity to visit a tropical country with its beauties and water resorts, to benefit educationally, and at the same time to mix and mingle with the leading authorities in the milk field.

Write Mr. H. N. Parker, Jacksonville, requesting him to make your reservations for the dates of October 26-28, 1939.

V. M. E.

Members of the Entertainment Committee

P. J. LANIER, *Chairman*
J. C. HOLLOWAY
A. E. JOHNSON
B. S. JOHNSTON
WELLINGTON PAUL

Lady Guests

Southern hospitality at its best will be an attraction of the Jacksonville meeting. The local committee has planned special entertainment for the ladies. We sincerely hope that as many as possible will be in attendance and lend their charm to the occasion. In order to provide for all, it is requested that those who are bringing guests with them will notify Mr. Horatio N. Parker, Engineer Building, Main and Orange Streets, Jacksonville, Florida, concerning the number of ladies in their parties.

Hotel Mayflower—Convention Headquarters. See rates in July issue, This Journal, p. 208.

The Jacksonville which welcomes the Milk Sanitarians to their 28th Annual Convention is a city of 155,000 inhabitants which is located on the beautiful St. Johns River eighteen miles from the ocean, in the land of sunshine. The site in pioneer days was known as the "cow ford" because here it was that the Indians swam their stock across the St. Johns. From the city to the sea is replete with historical associations for the land was occupied successively by the Spanish, French and English, each of whom fought fiercely for possession. St. Johns Bluff and Fort George, one of the Golden Islands, are of particular historical significance.

The first family settled at the cow ford in 1816; others followed and the town was laid out in 1822; in 1832 it was incorporated. The saw mill industry was the first to become established in a large way; boat building, the naval stores, fertilizer and other large businesses followed. In the late 90's the city became an important railroad center and flourished accordingly. All of these are thriving and besides there is an important produce business, the largest cigar factory in the world, and there are many other successful enterprises of various sorts. The dairy industry is flourishing. All of the milk used in Jacksonville is produced in Duval

County within wagon-haul of the city. An inspection of these Duval County dairies will give a good idea of Southern dairying.

The city has the commission form of government. It owns and operates the electric light plant, water works and municipal docks. The port is an important one for both ocean going and coastwise traffic; both the Clyde Line and the Merchants and Miners maintain regular passenger and freight service from northern ports to the city. Railroad connections to the principal cities of the country are excellent and the train service is of the best. First-rate highways radiate in all directions from Jacksonville so that those who prefer to may make the trip to the city by bus lines or in automobiles pleasurably.

The city has excellent hotels and restaurants where accommodations and food are to be had at reasonable prices.

The visitor who has the time to spare will be well repaid by trips to Jacksonville Beach and to St. Augustine. One who has never seen Jacksonville's matchless beach has a thrill coming. It is 600 feet wide at low tide, smooth as a billiard table and so firm it is used as a motor boulevard. "The Ancient City" will richly repay those who visit Old Fort Marion and the Marine Studio. Those planning a longer stay will find driving to Miami, Tampa, Key West, and other places of interest, enjoyable and worthwhile.

You who play golf should, by all means, bring your equipment for Jacksonville boasts some exceptionally fine golf links. One of these courses is ranked by "Golf" magazine as one of the six best links in America. Here the next Ryder Cup match will be played.

Jacksonville welcomes you to the convention and to Florida.

Index to Advertisers