TWENTY-FIFTH ANNUAL REPORT

OF THE

International Association of Milk Sanitarians

(FORMERLY INTERNATIONAL ASSOCIATION OF DAIRY AND MILK INSPECTORS)

INCLUDING PAPERS READ AT THE ANNUAL CONVENTION IN ATLANTIC CITY, N. J.
OCTOBER 14, 15 AND 16
1936

COMPILED BY

C. SIDNEY LEETE
Secretary-Treasurer
STATE DEPARTMENT OF HEALTH
ALBANY, N. Y.

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"What do we live for, if it is not to make life less difficult for others?"

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SOME OBSERVATIONS ON CHLORINE AND METALS

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THIS WORK is for the purpose of determining the corrosive action of two types of chlorine solutions on various metals. The solutions used were of a strength of 200 parts per million available chlorine, which is probably the maximum used in practical plant and farm practice. Each of these solutions was representative of its type, the first a chloramin-T compound and the second a calcium hypochlorite and sodium carbonate mixture.

The metals used were tin, black steel, Monel metal, Allegheny metal, copper, aluminum, and bronze. These were in the form of strips three inches long and approximately one inch wide. The width, however, was varied according to the gauge of the metal so that the surface exposed to the liquid was the same for each strip. Each metal strip was placed in a half-pint milk bottle of chlorine solution, so that the metal was completely covered.

Each combination of metal and chlorine solution was subjected to three methods of treatment. The first consisted of filling the bottles containing the weighed metal strips with the chlorine solution, capping the bottles and sealing them with paraffin, and leaving them unopened for two weeks. In the second system the bottles were capped but not sealed, and the chlorine solution was replaced each twenty-four hours with fresh solution. The third method of treatment consisted of placing the strips in the fresh chlorine solution for two hours daily. At the end of the two-hour period the strips were withdrawn and hung (by wooden clothespins) in the air to dry. Before re-immersing, each strip was thoroughly rinsed with distilled water.

Before starting the experiment each metal strip was thoroughly cleaned and rinsed, wiped with a clean towel, and then dried in a vacuum oven. After drying, the metals were placed in a calcium chloride dessicator overnight to cool to room temperature. The next morning each strip was weighed and returned to the dessicator until placed in the solution.

At the completion of the experiment each strip was thoroughly rinsed with distilled water, dried in a vacuum oven, and cooled in a dessicator and held there until weighed.

It will be noted that at the completion of the experiment the metals were not wiped. At the time we had developed no method which we considered satisfactory for evenly wiping each strip. It was felt that the results would be more accurate if no corrosion were removed than if the corrosion were unevenly removed and, in the case of the softer metals, some of the metal itself lost. This practice, of course, resulted in a loss of weight in some strips and a gain in weight where insoluble compounds were formed. As these insoluble corrosion compounds would be removed by physical means in dairy practice, we have considered any change in weight as a loss due to the action of the chlorine compound under discussion.

From the point of view of milk inspectors or those engaged in commercial work, the results of the first method are of little immediate interest. This method would practically never be duplicated in actual practice. However, by sealing the metals and chlorine solutions away from air and holding them in this condition for a long period of time the cumulative effect of the chlorine on the metals and of the metals on the chlorine may be studied. This method might be termed purely experimental and will require considerable time and work before any definite results can be obtained. At the end of two weeks some of the chlorine solutions used had lost 100 per cent of their available chlorine, while some others had lost less than 1 per cent. The chloramin group averaged a much smaller loss than did the hypochlorite group.

The second method of treatment, in which fresh solutions were added each day, more nearly simulates practical conditions in that the metal is subjected to fresh solutions daily. There are, however, several discrepancies, the main one being the complete and continuous immersion of the metal in the chlorine solution. Under this method we had the greatest loss in any one metal. That was a loss of practically 8 per cent of the weight of the aluminum strip treated with the hypochlorite solution. The other strips, although their losses were larger than under other treatments, did not exceed 1 per cent loss. Under this treatment the bronze and copper were affected the most by the chloramin and the least by the hypochlorite. In the latter solution they tied with Allegheny metal. Tin, Monel metal, and Allegheny metal were practically untouched by the chloramin but Monel metal and tin were mildly affected by the hypochlorite. Aluminum, as mentioned, was attacked strongly by the hypochlorite but was only mildly affected by the chloramin. The present indications are that this method of treatment causes a change in the type as well as the amount of corrosion when compared with the final method of treatment.

In the final method of treatment, that of immersion for two hours and then exposure to the air, we have tried to simulate the conditions to which metals and solutions would be subjected in actual practice and at the same time eliminate any corrosive elements other than those being studied. It may be well here to review the procedure used. The chlorine solutions were put in half-pint milk bottles, then the clean metal strips were immersed in the liquid. At the end of two hours the strips were removed and hung by wooden clothespins to dry. The pins being of wood prevented electrolytic action. After the strips had dried for twenty-two hours and just previous to their immersion in fresh solution, they were thoroughly rinsed with distilled water. Under these conditions we get the effect of fresh chlorine solutions daily but for a shorter period of time than in the second method. Added to the effect of the fresh solution we also have the oxidizing effect of the air. These two conditions working together undoubtedly reduced the amount of change in weight, for in this series there was only one strip which changed more than 0.05 per cent. The metal with the largest change in weight was aluminum, which lost 4.8 per cent of its original weight when exposed to the hypochlorite solution. Aluminum was also affected rather strongly by the chloramin solution. Monel and Allegheny metals were not affected by either solution under these conditions. Bronze and copper ranked with Monel and Allegheny in the hypochlorite solution but were among those most corroded by the chloramin. Tin, while unaffected by the chloramin, was considerably corroded by the hypochlorite. Black steel, while corroded by both solutions, was attacked more by the hypochlorite solution.

The available chlorine of the solutions used was tested whenever fresh solution was added and also at the end of the experiment. In general the chloramin solution held up much better than the hypochlorite. The average per cent loss of available chlorine from all samples of the chloramin solutions was 12.0 per cent and of the hypochlorite 26.1 per cent. Of the sealed samples four out of seven of the chloramin solutions lost less chlorine in the two weeks than in either two hours or twenty-four hours. This is explained by the chemists as being due to the accumulation of decomposition products, which slow down the reactions much the same as a fire is slowed down in a tightly closed room. Of the remaining three of the seven samples, two were copper and bronze. Copper, being an excellent catalyst for Halogen compounds, increased the reaction. The third metal was aluminum, which would form a soluble aluminum chloride, thus exposing the metal to further action and further destruction of the available chlorine. The sealed samples of hypochlorite, however, presented a different picture in that most of them showed a greater loss of available chlorine than under the two open systems. This is explained (again by the chemists) as due to the absorption of the liberated chlorine by the sodium hydroxide present, probably forming sodium chloride. This reaction served to take care of the decomposition products in a manner similar to renewing the solution or having it open to the air.

Coincident with the work on metals a test was made of the lasting power of three chlorine solutions. These solutions were the two used with the metals and a third which was a buffered hypochlorite compound sold under a trade name. Six liters of each solution were made up to approximately 200 parts per million available chlorine and were then divided equally into two four-liter flasks. One flask of each solution remained open and the other was kept tightly stoppered. A sample was taken from each flask every other day and tested for available chlorine. These tests lasted for one month. A previous test on the chloramin and hypochlorite gave comparable results. The two hypochlorite compounds lost a greater percentage of their available chlorine in the open flask than in the closed flask, but on the other hand the chloramin lost more in the closed than in the open. The open chloramin is rather an interesting case. By the end of the first week it had lost 7.04 per cent of its available chlorine; for the next two weeks it did not change a bit, each test being exactly the same as the one previous. Then in the last week it started to pick up and at the end of the month the test was only 4.23 per cent under the original test. Those are the facts. Now as to the explanation of those facts, the most logical seems to be that the water evaporated more rapidly than did the chlorine. As the amount of solution decreased in the Erlenmeyer flask, the surface exposed to the air became greater and permitted more evaporation and as it was apparently the water that was evaporating, the chlorine concentration increased. Of course that is an assumption, but, as I said, it seems logical. In comparing the three chlorine solutions we find that in the open containers chloramin lost 4.23 per cent, the buffered hypochlorite 36.06 per cent, and the plain hypochlorite 46.21 per cent. In the closed containers chloramin lost 8.92 per cent, the buffered hypochlorite 13.94 per cent, and the plain hypochlorite 24.06 per cent.

In closing let me call your attention to the fact that the material presented here is not the final result of a completed study, but is more in the nature of a collection of observations on what data we have obtained.

INVESTIGATION OF THE AMYLASE AND PHOSPHATASE TESTS AS AN INDICATION OF PASTEURIZATION*

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ACCURATE control of the temperature and time of heating is essential for the proper pasteurization of milk. In general practice the only proof of treatment is the chart of the recording thermometer on the pasteurizing equipment and the accuracy of this indication is in turn largely dependent upon the integrity of the operator. Thus the development of a laboratory test that will indicate adequate treatment is most desirable. To be of practical value, however, such a test should be not only relatively simple, rapid, accurate, and not influenced by natural variations in the product, but capable of indicating minor as well as significant differences in treatment. Changes in the colloidal character of the milk and in the separation of the fat globules as a result of heating have not proved satisfactory as a basis for such a test. The enzymes present in fresh unheated milk, particularly amylase and phosphatase, have offered the greatest promise and have been studied by several investigators. Mohler [1] (p. 82) found that although always present, amylase varied in amount in different breeds of cows, under different conditions of health and diet, and with the period of lactation. He describes a titration procedure (p. 218) in which varying quantities of soluble starch are added to a known volume of milk. After in-

* Presented also before the New York State Association of Dairy and Milk Inspectors, Schenectady, September 23, 1936.

cubation, the presence of residual starch is detected by the addition of iodine. He makes no mention of the application of this fact to check pasteurization although he states (p. 46) that amylase is destroyed by heating for thirty minutes at 68° C. Waksman and Davison [2] (p. 160) have described a similar titration in which the quantity of enzyme is varied. Leahy [3, 4] has recently proposed a method based on the destruction of amylase by heating the milk at 143° F. for thirty minutes. Kay and Graham [5] have studied the inactivation of phosphatase by pasteurization and describe a technic for its determination. The procedures described by both Leahy and Kay and Graham appear to offer possible means for the control of the pasteurization process. Therefore, a detailed study of each to determine its applicability under actual operating conditions was undertaken.

Amylase Test

The technic based on the inactivation of amylase and described by Leahy [4] has been summarized as follows:

> To 10 ml. of the milk to be tested is added 0.5 ml. of sodium-chloride-starch reagent (0.4 gm. soluble potato starch and 20 gm. NaCl in 100 ml. distilled water). After thorough mixing the solution is incubated at 30° C. for four hours. Following incubation, 2 ml. of a mixture of equal parts of acetic acid and chloroform are added to coagulate the casein and extract the fat. The strong acid also checks any further amylolytic activity. The tube is centrifugalized at high speed for 15 minutes and the clear supernatant removed and tested for residual starch by the addition of a few drops of freshly prepared dilute iodine solution (0.05N). The stage of starch hydrolysis is indicated by the color obtained. A clear yellow color denotes strong enzyme activity and thus unheated milk. A characteristic starch-iodine blue color shows the absence of amylase and therefore properly pasteurized milk. Colors ranging from red, to purple and orange denote intermediate degrees of activity and therefore inadequate heating or admixture with unheated milk.

Tables 1 and 2 give the results of our application of this technic to milk heated at 143° F. for varying times. Two

series of samples were treated in the laboratory and eight were collected from commercial pasteurizing plants. Unheated milk was detected without difficulty but determination of the degree or period of heating was not possible. It was not uncommon to obtain in samples pasteurized for longer than thirty minutes, color reactions similar to those produced in specimens heated for less than thirty minutes. Temperatures lower than 143° F. either failed to inactivate the amylase or produced a partial inactivation that yielded a reaction difficult to interpret.

Because of the increasing use in pasteurization of high temperatures (160° F. or more for not less than 15 seconds) the value of the amylase test in detecting milk pasteurized by this method was investigated. As shown in table 3, specimens heated at 163° F. for fifteen seconds gave the yellow color characteristic of unheated milk. The reaction of pasteurized milk was produced only when heating was prolonged for a minimum of three minutes.

Table 1

AMYLASE TEST

Milk heated in the laboratory at 143° F.*

Samples examined	Holding time	Color reaction	Interpretation
no.	min.		
2	0	yellow	unheated
2	10	red-blue	underpasteurized
2	20	faint blue	underpasteurized
2	25	blue	pasteurized
2	30	blue	pasteurized
2	45	faint blue	underpasteurized
2	control–raw milk	yellow	unheated

* Time of preheating, 10-15 minutes.

Table 2

Amylase Test

Milk heated at 143° F. in commercial pasteurizing plants*

Samples examined	Holding time	Color reaction	Interpretation
no.	min.		
2	0	yellow	unheated
2	0	faint blue	underpasteurized
1	0	red-blue	underpasteurized
8	15	faint blue	underpasteurized
4	15	red-blue	underpasteurized
1	15	blue	pasteurized
3	20	faint blue	underpasteurized
1	25	faint blue	underpasteurized
1	25	red-blue	underpasteurized
1	25	blue	pasteurized
2	30	blue	pasteurized
8	30	faint blue	underpasteurized
4	30	red-blue	underpasteurized
9	45	faint blue	underpasteurized
2	45	red-blue	underpasteurized
1	45	blue	pasteurized
6	unheated	yellow	unheated

* Time of preheating, 18-20 minutes.

Table 3

Amylase Test

Milk heated in the laboratory at 163° F.*

Number of samples examined	Holding Time	Color reaction	Interpretation
	sec.		
1	0	yellow	unheated
1	15	yellow	unheated
1	45	yellow	unheated
1	90	faint blue	underpasteurized
1	120	faint blue	underpasteurized
1	180	blue	pasteurized
2	Control: samples from commercial pasteurizing plant, high-temperature process; 15 seconds at 160° F.	yellow	unheated

* Time of preheating, 45 seconds.

The test was also applied to the detection of raw milk mixed in varying proportions with samples completely pasteurized (table 4). Five per cent or less raw milk affected the color reaction so slightly that it was not possible to differentiate it from that in the pasteurized sample.

Table 4

AMYLASE TEST

Pasteurized milk containing varying proportions of raw milk

Number of samples examined	Raw milk	Color Reaction	Interpretation
	%		
1	0	blue	pasteurized
1	5	blue	pasteurized
1	10	faint blue	underpasteurized
1	20	faint blue	underpasteurized
1	40	faint blue	underpasteurized
1	60	very faint blue	underpasteurized
1	100	yellow	unheated

Because of the possibility that storage of milk with or without proper refrigeration might produce changes in the amylolytic activity and thus interfere with the reading, a series of tests was made with raw milk from different sources. It was found (table 5) that with certain milks a long period of storage is possible before the amylolytic activity decreases to a point corresponding to that of heated milk. It is interesting to note in this table that of the eleven samples, there were two with insufficient amylase to react in the test and which would have been classified as pasteurized milk although neither had been heated. Souring, in causing a gradual destruction of the enzyme, also interferes with the accuracy of the test. If the pH of the sour milk is corrected to 6.2, however, the technic can be applied and the amylase detected if present.

Table 5

Amylase test applied to raw milk at varying periods of storage

Storage		Sample No.										
		1	2	3	4	5	6	7	8	9	10	11
Days	Temp. °F.											
0	40	R	R	R	UP	P	R			R		
1	40	R	R	R	UP	P	R	R	R	R	UP	R
	68	R	R	R	P	P	R			R		
2	40	R	R	R			R	R	R	P	UP	R
	68	R	R	R			P	R	R	P	UP	R
3	40	P	R	R			R	P	R		R	R
	68	P	P	P			P	P	UP		P	R
6	40	P	R	R			R	P	R		R	R
	68	P	P	P			P	P	P		P	R
8	40			P			UP		P		P	R
	68						P					
17	40											R
29	40											R

R=unheated milk; P=pasteurized milk; UP=underpasteurized milk.

The value of any laboratory test depends upon its precision in the routine examination of unknown specimens. Several series of samples which included unheated milks and those treated at different temperatures and for varying periods were prepared by the Bureau of Milk Sanitation and submitted without identification. Table 6 summarizes the results of this study. Eighty-seven samples were examined and of these the treatment of only fifty-one or 59 per cent was accurately determined.

The investigation thus indicates that the amylase method differentiates fresh unheated milk from the heated product, except when the amylase content of the raw milk is too low to give the typical color reaction: it can not be relied on to detect accurately the degree of treatment.

Phosphatase Test

The inactivation of the enzyme phosphatase by heating milk under controlled conditions of pasteurization has

Table 6

AMYLASE TEST

Summary of the results of the examination of unidentified samples of milk *

Number of samples examined	Treatment	Accuracy	
		no.	%
27	0—<30 min., 143° F.	23	82
40	30 min. and over, 143° F.	12	30
9	Varying temp., 135°-153° F. except 143° F.	7	78
11	Pasteurized + raw milk	9	82
Total 87		51	59%

* Prepared by Bureau of Milk Sanitation, New York State Department of Health

been thoroughly studied by Kay and Graham [5] who have presented two tests based on the effect of such heating on this enzyme—one a qualitative determination which distinguishes between heated and unheated milk, the other a quantitative test in which the amount of phosphatase present may be accurately determined and even minor variations in the technic of pasteurization detected. An experimental repetition of this quantitative test was therefore undertaken according to the technic of the authors, as follows:

PROCEDURE

Pipette 10 ml. of buffer substrate into each of 4 test tubes of 20-25 ml. capacity. To two tubes (controls) add 4.5 ml. of diluted Folin's reagent. To all four tubes add 0.5 ml. of the milk to be tested. Mix well. Add a few drops of chloroform to the two samples (not to controls), cover to protect from dust, warm to 37-39° C. and keep in a 37° C. incubator for 24 hours.

Remove from the incubator, add 4.5 ml. of diluted Folin's reagent to the samples, mix, let stand 3 minutes. Filter all four tubes. Transfer 5 ml. of the filtrate to 13 mm. diameter test tubes, add 1 ml. of 14 per cent Na_2CO_3, mix, place in boiling water for 5 minutes, and filter. The color of the filtrate is read in a Lovibond tintometer. Colors greater than 2.3 Lovibond units of blue indicate improper treatment.

REAGENTS

1 Buffer substrate. Dissolve 1.09 grams of disodium phenyl phosphate * and 11.54 grams of "sodium veronal" * in water saturated with chloroform and make up to 1 liter. Add a few drops of chloroform and keep in refrigerator.

2 Folin and Ciocalteu's phenol reagent.* Dissolve 100 grams of sodium tungstate $Na_2WO_4.2H_2O$ and 25 grams of sodium molybdate, $Na_2MO_4.2H_2O$ in 700 ml. water in a 1500 ml. flask connected by a ground glass joint to a reflux condenser. Add 50 ml. syrupy (85 per cent) phosphoric acid and 100 ml. of concentrated hydrochloric acid. Reflux gently for 10 hours. Cool, add 150 grams c. p. lithium sulfate, 50 ml. water and a few (4-6) drops of liquid bromine. Boil without condenser for 15 minutes to boil off excess bromine. Cool, dilute to 1 liter, filter.

The finished reagent should have a golden yellow color with no greenish tint. Any reagent with a greenish tint should be rejected. Keep well protected from dust. Dilute one volume of this stock solution with two volumes of water before use.

3 A 14 per cent solution of anhydrous sodium carbonate, Na_2CO_3 c. p. (We interpreted this as 14 grams per 100 ml.)

Our procedures were modified only in the method of reading. A comparison of the characteristic color reaction of the phenol liberated in the test with known phenol standards was found to provide a more convenient and accurate determination of treatment than the measurement of the color in a tintometer. Our results, therefore, have been expressed in milligrams of phenol per 0.5 ml. of sample.

In order to measure interference by substances possibly present in milk and which react as phenol, it is desirable to include control tubes in each examination as recommended by Kay and Graham. Our experience indicates, however, that such interferences are infrequent. The color produced by the Folin reagent with small amounts of phenol is readily duplicated and the development of per-

* British Drug Houses, Ltd. It was not possible to secure the "sodium veronal" recommended by Kay and Graham. Sodium barbital, Merck, proved a satisfactory substitute.

manent standards was undertaken. The preparation of inorganic solutions and the amounts required to produce standards corresponding to concentrations of phenol are shown in table 7. They were developed for use with natural daylight and are not suitable with artificial illumination. The deep color produced by the phenol liberated by raw milk or that heated at 143° F. for fifteen minutes or less renders impractical the preparation of corresponding permanent standards. Plate I shows the permanent standards in the colors developed by the given phenol concentrations.

Table 7

PHOSPHATASE TEST

Preparation of phenol standards

Phenol	Color solution		
	gray *	red †	blue ‡
mg./0.5 ml.	ml.	ml.	ml.
0.01	0.3	0.106	0.96
0.02	0.40	0.140	1.16
0.03	0.55	0.180	1.65
0.04	0.65	0.216	2.10
0.06	0.92	0.286	3.00
0.09	1.30	0.326	4.40
0.12	1.70	0.360	5.70
0.15	2.50	0.396	7.10

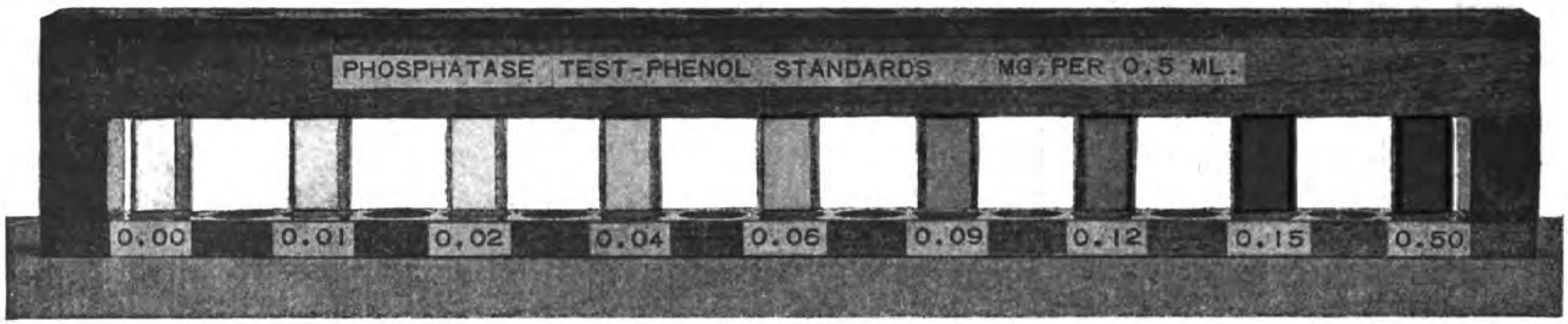
The amounts of color solutions given above are diluted to 10 ml. with distilled water.

* Cobalt chloride ($CoCl_2.6H_2O$) 31.9 grams; copper sulfate ($CuSO_4.5H_2O$) 67.5 grams; nickel sulfate ($NiSO_4.6H_2O$) 75.0 grams; concentrated hydrochloric acid, 32 ml.; concentrated sulfuric acid 45 ml.; dissolved in distilled water and diluted to 500 ml.

† Cobalt chloride ($CoCl_2.6H_2O$) 476 grams dissolved in distilled water and filtered. 100 ml. concentrated hydrochloric acid added and diluted to 1 liter.

‡ Copper sulfate crystals ($CuSO_4.5H_2O$) 300 grams and 20 ml. of concentrated sulfuric acid, dissolved in distilled water and diluted to 1 liter.

Plate I



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Phosphatase Test

Permanent Standards Equivalent to Phenol Color Reactions

To determine the concentrations of phenol which correspond to various times of holding at 143° F., several series of mixed-milk samples were pasteurized in the laboratory and examined. The work was then repeated using samples from a commercial pasteurizing plant. The results are given in table 8. Since plant practice in the time of preheating varies considerably, this period was made to cover a wide range—1 to 79 minutes—in the laboratory. Within the range, no significant difference could be observed. The average phenol values for laboratory treated milk were plotted against times of holding and the resulting curve (Diagram 1) can be used with reasonable precision to convert milligrams of phenol as determined with the standards into corresponding times of holding at this temperature.

As a result of this study a phenol value of 0.037 mg. per 0.5 ml. of sample examined, or less, was found to indicate adequate pasteurization. The method permits detection of variations in holding time as low as 5 minutes. The reaction of milk heated for ten minutes or less can not be distinguished readily from that given by unheated milk. Dilution of the resulting color solution can be made with the buffer-substrate reagent and the phenol concentration and thus the approximate time of heating may be estimated.

There are also shown in table 8 the results of the application of the technic to milk heated at 160° F. After a holding time of fifteen seconds the active phosphatase remaining liberated an amount of phenol which approximated that observed at the ordinary pasteurizing temperatures.

Table 8

PHOSPHATASE TEST

Samples heated in laboratory at 143° F.
Time of preheating 1-79 minutes

Number of samples examined	Holding time	Color reaction	Phenol value mg./0.5 ml.			Interpretation
	minutes		max.	min.	av.	
10	unheated	deep blue	>0.15	>0.15	>0.15	unheated
6	10	deep blue	>0.15	>0.15	>0.15	unheated
8	20	blue	0.15	0.045	0.099	underpasteurized
9	25	light blue	0.085	0.035	0.060	underpasteurized
20	30	faint blue	0.05	0.030	0.037	pasteurized
6	45	trace of blue	0.04	0.015	0.026	pasteurized
Samples from commercial pasteurizing plants at 143° F. Time of preheating 18-20 minutes						
4	10	deep blue	>0.15	>0.15	>0.15	unheated
3	15	deep blue	>0.15	0.15	>0.15	unheated
4	20	light blue	0.14	0.06	0.081	underpasteurized
4	25	light blue	0.053	0.045	0.049	underpasteurized
4	30	faint blue	0.038	0.025	0.030	pasteurized
4	45	trace of blue	0.015	0.010	0.012	pasteurized
Samples heated in laboratory at 160° F. Time of preheating 25 seconds						
	sec.					
1	15	faint blue			0.04	pasteurized ?
1	30	trace of blue			0.02	pasteurized
2	commercially pasteurized; 15 seconds 160° F.	faint blue	0.023	0.028	0.025	pasteurized

Table 9 gives the results of the application of this procedure to samples of pasteurized milk to which varying portions of raw milk had been added. As little as 0.1 per cent of added raw milk was detected. In routine examination it would be impossible to say whether this indicated underpasteurization or added raw milk but an improperly pasteurized product could be selected. The relation of phenol values to percentage of added raw milk is also shown in Diagram 1.

DIAGRAM 1

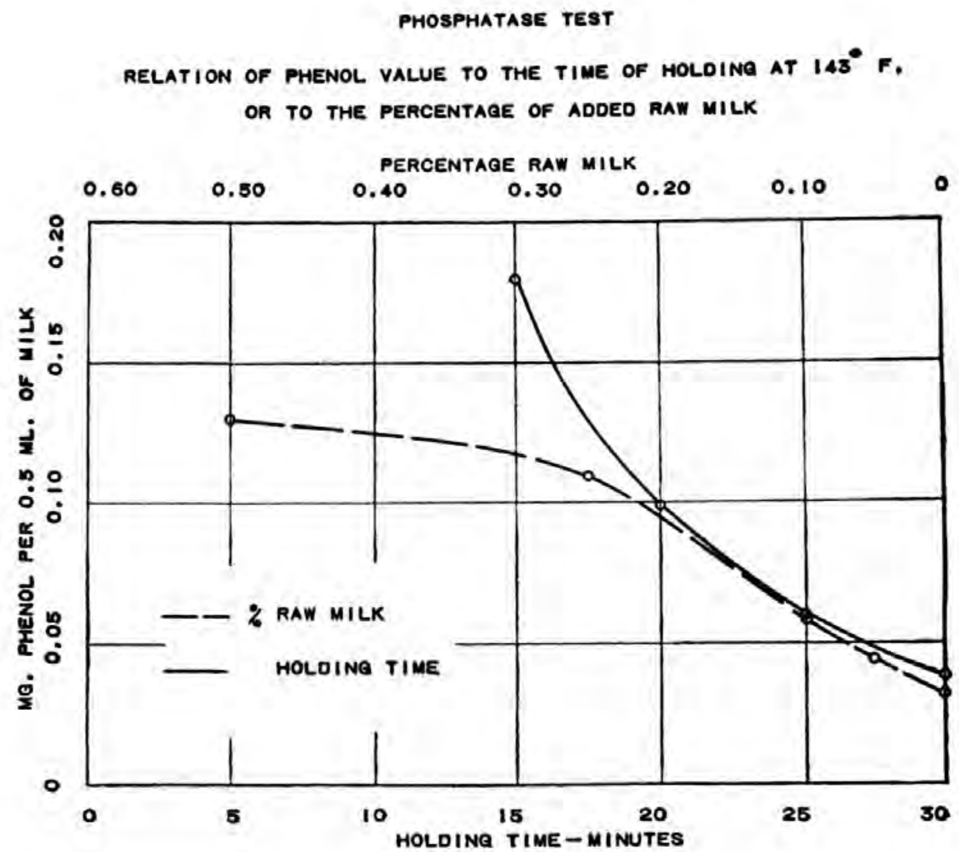

Table 9

PHOSPHATASE TEST

Pasteurized milk mixed with varying proportions of raw milk

Number of samples examined	Raw milk added	Color reaction	Phenol value mg./0.5 ml.			Interpretation
	%		max.	min.	av.	
3	0	faint blue	0.04	0.02	0.03	pasteurized
5	0.05	faint blue	0.055	0.040	0.045	underpasteurized
5	0.10	light blue	0.058	0.048	0.059	underpasteurized
3	0.25	blue	0.12	0.10	0.11	underpasteurized
3	0.50	blue	0.15	0.10	0.13	underpasteurized
2	1.00	deep blue	>0.15	>0.15	>0.15	underpasteurized or unheated

The reaction of milk heated to temperatures slightly above and below 143° F. was studied. The results are shown in table 10. It is interesting to note that heating at 141° F. for fifty minutes and at 144° F. for twenty-five minutes produced reactions comparable to that of milk pasteurized under standard conditions.

Table 10

PHOSPHATASE TEST

Effect of a varied time-temperature relation

		141° F.†	143° F.*	144° F.†
Number of samples examined	Holding time	Phenol value	Phenol value	Phenol value
	min.	mg./0.5 ml.	mg./0.5 ml.	mg./0.5 ml.
2	20	<0.15	0.099	0.046
2	25	0.15	0.06	0.033
2	30	0.13	0.037	0.028
2	40	0.053		
2	50	0.04		

† Time of preheating, 10-15 minutes.

* Taken from table 8. Covers more than two determinations. Time of preheating, 1-79 minutes.

To determine the effect of storage, several samples of both raw and pasteurized milk were kept under conditions of refrigeration and tested after increasing periods of time. Table 11 indicates the results of this study. Raw milk continued to react as raw milk even through twenty-one days of storage. Pasteurized milk reacted as pasteurized until souring started.

Kay and Graham suggest that the action of certain proteolytic bacteria in milk during the period of storage and the process of souring set free phenol, or phenol-like substances, which may be determined by the method; decreasing heat treatment is thus also indicated. The results of our investigation substantiate this statement since when pasteurized milk became sour, it reacted as

Table 11

PHOSPHATASE TEST APPLIED TO MILK AT VARYING PERIODS OF STORAGE

Storage	Sample no.							
	1	2	3	4	5	6	7	8
days								
....	R	P	R	P	R	P	R	P
7	R	P	R	P	R	P	R	P
14	R		R		R	P	R	UP
21	R		R		R	UP	R	

R=unheated milk; P=pasteurized milk; UP=underpasteurized milk.

underpasteurized. Probably a considerable period of storage would be required to produce a pasteurized milk that would give the typical reaction of raw milk. Souring does not interfere with the determination of phenol since the reagents are adequately buffered and only a small volume of milk is used.

The Bureau of Milk Sanitation again prepared several series of samples representing different periods of treatment at 143° F., and submitted them to the laboratory as undesignated test specimens. The results are summarized in table 12. These results although based on the examination of a small number of samples show that the phosphatase test will differentiate properly pasteurized from improperly pasteurized milk with a high degree of precision. It is also sufficiently accurate to detect minor variations in treatment. These determinations were made and read against the permanent standards described.

Since treatment at 143° F. for 30 minutes does not destroy the enzyme completely, it was thought that the standard for complete pasteurization might not be the same with different types of equipment embodying variations in the over-all time of heating. Therefore, several portions of milk were prepared, representing wide variations in time of preheating but all held 30 minutes at

Table 12

PHOSPHATASE TEST

Summary of the results of the examination of unidentified samples of milk * heated at 143° F.

Number of samples examined	Treatment	Properly classified	
		no.	%
10	untreated	10	100
16	held 0-10 min.	16	100
22	held 15-25 min.	21	95
38	held 30 min. and over	37	97
11	added raw milk, 0.05% and over	10	91
Total 97		94	97%

* Prepared by Bureau of Milk Sanitation, New York State Department of Health.

Note: According to the standards described, reactions in samples heated for ten minutes or less are read as "untreated."

143° F. The differences in the amount of phenol liberated by the pasteurized milk were too slight to be of significance in the examination of commercially pasteurized milk according to the tabulated values given.

SUMMARY AND CONCLUSIONS

Methods for the measurement of the progressive inactivation of enzymes naturally present in fresh milk by heating the product to the time and temperature of pasteurization have been studied with a view to establishing a simple, accurate laboratory test for the control of pasteurization.

The method based on the destruction of amylase was found in general to differentiate unheated from heated milk, but with the technic recommended it was not possible to determine even major variations in treatment. In the examination of a series of undesignated specimens, a correct evaluation of the treatment of the milk was reached in only 59 per cent of the tests.

The inactivation of the enzyme, phosphatase, also present in unheated milk, was the second method studied. During incubation the enzyme hydrolyzes an added phenyl-phosphoric ester, liberating phenol, which is readily detected quantitatively by the use of Folin's reagent. The blue color produced by small quantities of phenol lends itself readily to comparison with permanent standards prepared from inorganic solutions; this mode of reading was therefore developed. Variations of five minutes or greater in the heating time were readily distinguished and the addition of as small a quantity as 0.1 per cent of raw milk gave a result indicative of incomplete pasteurization. Variations in temperature were also easily detected. The technic proved equally satisfactory in determining pasteurization by the ordinary procedure and by the high-temperature process.

The test has been applied to the examination of approximately 100 samples of milk representing varying conditions of temperature and holding time in commercial pasteurizing plants. A correct evaluation of the character of the treatment to which the milk had been subjected was made in 97 per cent of the specimens. If this precision can be maintained in extended routine practice, the test should prove an invaluable aid in the control of pasteurization.

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Discussion

Mr. Leete: Since that paper was prepared the Bureau of Milk Sanitation sent to Mr. Gilcreas several series of samples the results of which may be of interest and practical value.

It is more or less a common practice to standardize milk and we have found in several instances in the small plants that standardization takes place after the milk was pasteurized and so we prepared several sets of samples in which was pasteurized milk at 143° for thirty minutes and then added the skim milk to bring the butter fat content down one-tenth—sometimes we used as much as 10 per cent skim—poured that cold skim milk into the pasteurized milk while it was still hot and then continued treatment for fifteen minutes more.

In every instance the laboratory reported that as unpasteurized milk or under-pasteurized milk.

In this particular case, the test had quite a practical value.

We also thought that possibly if this test became widespread samples might be sent to a laboratory by mail and so we added an excess amount of formalin to some samples, an excess amount of bichloride and also an excess amount of chlorine and in reports of those samples there was no change due to the addition of preservatives. In other words, a pasteurized sample containing those preservatives would be reported as pasteurized and a raw, or under-pasteurized one reported as raw or under-pasteurized.

In addition to that we put in an excess amount of trisodium phosphate or washing compound, believing that possibly that might have some effect upon the test. However, there was no effect on the results when a washing compound was added to the milk.

These were more or less tests which we thought might prove of interest from a practical standpoint in determining the accuracy of the test.

One point Mr. Gilcreas brought up, which possibly should be enlarged on or at least brought a little more to our attention: In control work, if this test is adopted, control officials would necessarily be obliged to give equal values to pasteurized milk at 141° for fifty minutes, to milk pasteurized at 144° for twenty-five minutes, and to milk pasteurized at 143° for twenty-five minutes with a prolonged heating period. These temperature and time combinations all give the same reaction.

In other words, in some of these small plants it might be possible or it may be practical to heat the milk very slowly in a vat. If it takes an hour and a quarter to heat that milk from 50° or 60° to 143°, it is then held twenty-five minutes, the reaction is reported as a pasteurized reaction; so in the practical application of this test we would have to consider these various time and temperature relationships as equal to 143° for thirty minutes.

If it happens that the pasteurization temperature as prescribed by ordinance, is 145°, color standards may be made up for that particular time and temperature combination.

There are two questions I would like to ask Mr. Gilcreas. One is: Is this test practical from the laboratory standpoint? In other words, would the ordinary laboratory be able to carry out the test satisfactorily? And again, what further work should be done on this test if it is to be taken into court and used as an official test?

Mr. Gilcreas: The technic of the phosphatase test is relatively simple. Anyone who has a supply of test tubes, a water bath, an accurately controlled incubator and some pipettes could readily be taught to do the test. The accurate reading of the results would depend on his ability to detect differences in color; these differences, however, are sufficiently marked so that unless one were truly blind to blue colors he should be able to detect them without difficulty.

To answer the question regarding court action: it seems to me we should first have the experience of the practical application of the test to a large number of samples, possibly those collected from pasteurizing plants and on the street, where complete data are available regarding the treatment of the milk. Our work has been entirely experimental.

Mr. Leete discussed the matter of the over-all time of heating which, of course, includes the time of preheating of the milk. In the laboratory pasteurizing experiments we endeavored to keep the time of preheating at fifteen to twenty minutes, which is approximately that required by most of the pasteurizing equipment, at least in Albany. In order to check that point we collected specimens from four or five commercial pasteurizing plants in Albany which employ different types of equipment with slight variations in the time of preheating and our results indicated that from a practical point of view the slight differences in the time of preheating made very little difference in the results and that we could still depend upon the value 0.037 milligrams per 0.5 milliliter to indicate complete pasteurization.

I think the question of preservatives needs considerably more study, though the work which we did on the samples prepared by Mr. Leete did indicate that in general the addition of the preservatives made very little difference. On the other hand, I fail to understand why the strong chemicals which he added would not affect the enzyme and destroy its activity. That the addition of those substances as preservatives does not destroy the activity of the enzyme is so contrary to theory that I am inclined to think that the results we obtained in the preserved samples may have been more or less freaks.

One point I neglected to mention, namely that Kay and Graham in their technic suggest that a control specimen be run with every milk examined. The purpose of this is to measure and therefore eliminate any interferences which might be caused by phenolic or phenol-like substances in the milk and also to rule out the action of phosphate splitting by bacteria. However, although we have run a control on every sample of milk which we have examined, our experience indicates that interference by substances naturally present in the milk or by the bacteria which may be present is infrequent and probably may be disregarded.

Mr. Holmquist: Does that control the raw milk?

Mr. Gilcreas: No, it is a control portion in another tube of the sample examined. The control is run as follows: to the sample to be examined we add the phenyl-phosphoric ester buffer solution and place it in the incubator for twenty-four hours at 37° C. With the control sample we do the same thing, except that we add Folin reagent which contains sufficient acid to destroy the enzyme. Incubation of the control is unnecessary and undesirable. The difference in color obtained with the control and the sample is a measure of the phenol which is liberated by the action of the enzyme on the added phenyl-phosphoric ester.

To date, on all the samples which we have examined we have not found that the color produced in the control tube is sufficiently great to warrant a correction of the value determined.

Secretary Brooks: I understood the gentleman from New York who spoke about the court cases to say that there they had used the modification of the Leahy test. Would not they be in a better position in court with this test than with that?

Mr. Gilcreas: The results of our experience with the two would indicate that they would be in a very much better position if they used this test. I think at the time they actually demonstrated the Leahy test before the court but perhaps they were lucky.

Mr. Tiedeman: May I add that I happen to know how that was demonstrated in court and they were fortunate in that they sent out for a bottle of certified milk and a bottle of pasteurized milk and even the amylase test will detect the difference between straight raw and pasteurized milk, whereas the case was actually one of under-pasteurization.

Mr. Scales: Mr. President, I should like to ask Mr. Gilcreas if he has found any national source where we can purchase phenyl-phosphoric ester?

Mr. Gilcreas: The main difficulty with the test at present is to obtain the reagents. We tried all of the manufacturing concerns in this country who make so-called rare organic chemicals, particularly the Eastman Kodak Company and they never had tried to prepare it. It was necessary to buy our first supply of the disodium phenyl phosphate from the British Drug Houses, Ltd. in London. Since then I have been informed that it is probably possible to purchase it from a branch of the British Drug Houses, Ltd. in Toronto. I do not know exactly how much it is, but a gentleman from New York City who recently ordered some told me it was about eight or ten dollars for one hundred grams and that of course will last a long time. The solution contains a little over one gram of the phosphoric ester in one liter of solution and 10 ml. is used for each test, so the hundred grams would make a good many tests. The buffer solution which is recommended by Kay and Graham is sodium veronal. We had some difficulty in buying that in this country but we substituted Merck's sodium barbitol which can be readily purchased.

The Folin reagent used is the Ciocaulteu modification and can be purchased from some of the laboratory supply houses ready prepared. The preparation of it requires about 10 hours and considerable laboratory apparatus.

REPORT OF COMMITTEE ON THE FOOD VALUE OF MILK AND MILK PRODUCTS

Dietary Needs

THAT milk should form a conspicuous element of the diet of all ages is emphasized in recommendations of a group of nutrition authorities from various countries to the Health Committee of the League of Nations. This Commission of twelve met in London at the request of the Health Committee to "define the nutritional needs of the human being in the course of its development from conception to the adult age, *i.e.*, the physiological bases for adequate nutrition." The Commission voiced its commendation of the tendency manifested in some countries to increase the daily intake up to one litre (slightly over one quart) per day for pregnant and nursing women, as well as to provide an abundant supply for infants, children of all ages, and adolescents.[1]

Orr's report of a study in Great Britain of families divided roughly into six groups on the basis of different income levels concludes that:[2]

1 The degree of diet adequacy for health increases as income rises.

2 To improve diets at lowest income level, to bare adequacy, involves increases of 12 to 25 per cent in milk, eggs, butter, fruit, vegetables, and meat.

3 The consumption of bread and potatoes is practically uniform throughout income levels as studied, but the amount of milk and other products above mentioned rises with income. The largest proportion of children are found in the lower income groups, showing the need for more milk to meet requirements of growth, pregnancy and lactation.

Sherman has often pointed out that present knowledge of nutrition and food values shows the way to avoid nutritional deficiencies and to attain higher levels of health than would otherwise be possible.[3] He has shown through laboratory feeding experiments not only the benefits to be derived from the selection of a diet generally agreed to be adequate, but the improved physical condition and greater vitality resulting when this adequate diet approaches the optimal by merely increasing the proportion of milk. In rat feeding experiments, enrichment of the diet, in only the calcium constituent contributed by additional milk to a diet already adequate led to better utilization of food, earlier maturity and apparently increased life expectation of the animals.

Much attention in recent years has been given to reducing diets. Experiments suggest that: (a) they may be adequate and still be low in calories and reduce weight effectively; (b) certain foods, especially dairy products, often regarded as "fattening," have an important place in the reducing diet. In other words, "It is entirely possible to lose weight and at the same time to enjoy meals that look and taste appetizing and are ample enough to prevent a feeling of dissatisfaction and hunger."[4]

A considerable amount of absenteeism in industrial plants is attributed to preventable causes. Reports have been made suggesting that absences were curtailed by use of milk—cod-liver oil supplementary feeding.[5] Comstock and Eddy, using bananas and milk for supplements, made comparisons of results in terms of absence from work. They contrasted absences of the period just before and just after supplementary feeding with those during the feeding period itself. They also contrasted absences of the feeding period with those of the same subjects in the same seasonal period the previous year. Both types of measures seemed to indicate a reduction of absence as the result of the banana-milk supplement, and a positive but less degree change with bananas alone.[6] There are obviously many factors to consider in regard to studies in this field, but results thus far seem promising.

Pasteurization

In popular and scientific literature, increasing attention has been directed to pasteurized milk, including pasteurized-certified milk. It has been emphasized that pasteurization does not affect unfavorably those nutritive constituents present most abundantly in milk and which consumers must depend upon chiefly from milk. Users of certified milk who prefer the added safety of pasteurization welcome the information that the food value of pasteurized milk is thus virtually the same as the milk before it is pasteurized. Experiments show that the growth promoting and calcifying properties of milk, and the vitamins A, G and D are unaffected by the process. There is some destruction of vitamins B and C in pasteurization, but these vitamins are supplied abundantly in certain other common foods and, therefore, the loss in milk is not regarded as important.[7]

Butter

Previous reports have discussed the value of cheese, ice cream, and other milk products. The daily use of butter in the American dietary to add flavor and food value to meals has become a habit in many families. In considering the item of butter in low cost meals, Sherman warns that "Any substitution of cheaper fat is dubious economy until there is every assurance that the dietary as a whole provides an abundance of the fat soluble vitamins.[3a]

The Processed Milks*

Evaporated, condensed, and powdered milks, collectively known as the processed milks, continue to elicit the attention of physicians and scientists, as shown by the numerous clinical and laboratory reports on these products that have appeared in medical, chemical, dairy,

* Prepared by James A. Tobey.

and other scientific literature during the past year. As in the past, considerably more material has been published on evaporated milk than on the other types of concentrated milks, and this product has likewise continued to show a substantial increase in distribution.

Evaporated Milk

Perhaps the most interesting of the reports on evaporated milk was that of Dr. Allan R. Dafoe, medical mentor of the famous Dionne quintuplets, who has described the care and feeding of these justly celebrated infants.[8] During the first few days after their birth on May 28, 1934, they were fed on mixtures of milk, water, and corn syrup, with a few drops of rum, but from the fourth day to October 19, a period of about four and one-half months, the babies were given breast milk sent from Toronto. They were then put on evaporated milk formulas for the next five months and thrived on this product, as supplemented with vitamins C and D, the customary solid foods, and *B. acidophilus*.

Much of the success of evaporated milk in infant feeding seems to be due to the ready digestibility and easy assimilability of this product. Experiments in vivo and in vitro reported by Fetter and Schlutz indicate that evaporated milk is quickly digested, is somewhat superior to powdered milk in this respect, and shows much more rapid digestion than untreated cow's milk, although digestibility of cow's milk can be increased with rennin.[9]

The advantages of evaporated milk supplemented by iron in preventing nutritional anemia have been pointed out by Stein, Radetsky, and Lewis as a result of tests with laboratory animals.[10] This action of evaporated milk is ascribed by the authors to its copper content, since the milk is in continuous contact with this metal during the manufacturing process.

In addition to the studies on irradiated evaporated milk that were reported last year, several investigations have

"When Writing Mention This Report"

revealed the value of this form of vitamin D milk as an efficacious prophylactic against infantile rickets. Thus, Drake, Tisdall, and Brown found that 103 rapidly growing infants, aged one to six months at the initial examination, were protected against rickets when irradiated milk having 9.8 U.S.P. units of vitamin D to the ounce was given daily during the winter months.[11]

Similar, although less extensive results have been described by Rapoport and Stokes, who compared the effects of feeding nineteen infants on irradiated evaporated milk containing 125 U.S.P. units of vitamin D per 14.5 ounce can and on irradiated fluid milk having 140 U.S.P. units of vitamin D to the quart.[12] In both instances, these milks proved efficacious in preventing the development of rickets, although the authors feel that these milks can not be depended on to bring about rapid healing of rickets. Peterman and Epstein have reported that evaporated milk modified with a concentrate of cod-liver oil so as to provide at least 228 U.S.P. units of vitamin D was successful in protecting 26 white infants against rickets.[13]

The value of irradiated evaporated milk in routine infant feeding has been summarized by Eichelberger,[14] while the clinical investigations on all forms of vitamin D milks, including evaporated, have been ably reviewed by Jeans in a recent article,[15] and also by Tobey.[16]

Condensed Milk

Although condensed milk has been widely used in infant feeding for many years, some pediatricians have felt that the high carbohydrate content and the apparent reduction in protein in the formula militated against the routine employment of this milk for long periods. A recent study by Harrison has shown, however, that the protein requirements of infants are satisfied when 10 per cent of the calories are provided by the protein in condensed milk.[17]

Metabolism tests carried out in this investigation proved that retentions of nitrogen on such formulas were adequate, and that retentions of calcium and phosphorus, while somewhat less than in the case of evaporated milk, were sufficient to permit normal growth. The infants in this study thrived on condensed milk formulas, supplemented with orange juice and cod-liver oil.

Successful treatment of cases of allergy to breast milk by means of condensed milk have been reported by Rice, who attributes these good results to an alteration in the protein of the condensed milk.[18]

Powdered and Malted Milks

Powdered whole milk (Klim) has been found by Wosika and Emery to be especially valuable for use in the Sippy diet which is so widely employed in the treatment of peptic ulcer.[19] When 2.5 grams of powdered milk are mixed with the usual Sippy powder containing 0.6 gram of calcium carbonate and 2.0 grams of sodium bicarbonate, and given at intervals of one hour, this mixture is more effective in neutralizing the gastric acidity than are 90 cc. of milk and cream with the same powder.

In laboratory studies on the antigoitrogenic value of foods, Remington, Coulson, and Levine discovered that the goiter-preventing properties of milk and oysters are correlated with their iodine content.[20] In their tests, these authorities used a powdered milk prepared by the roller process from milk produced by cows in a non-goitrous region. The iodine content of this powdered milk was shown on analysis to be relatively high, and its value in the prevention of goiter is brought out by these experiments.

The value of powdered skim milk as a source of the growth-promoting vitamin G has been demonstrated by Davis and Norris, who state that there is no significant destruction in this factor when skim milk is dried by the

Merrell-Soule spray process, the Gray-Jensen spray process, or the open roller process.[21]

Malted milk, a processed blend of whole wheat, barley malt, and whole milk, has been shown by Ivy, Schmidt, and Beazell to promote gastric digestion of starches, particularly in cases of a deficiency of pancreatic amylase, or an inadequate secretion of saliva due to defective ptyalin formation.[22] This property of malted milk is due to the presence of the malt enzyme, amylase. The value of malted milk in the dietary treatment of infantile diarrhea has been pointed out by Carter.[23]

Special Laboratory and Field Studies *

Flavor

The flavor of milk has continued to receive major attention. Trout and Taylor [24] report that the flavor from feeding beet tops to cows became noticeable in the milk when the feeding amounted to twenty-five pounds daily and was most objectionable in night's milk. This was enhanced if this food was spoiled. However, this flavor was not noticeable when the milk was held twenty-four hours and was largely reduced when the milk was aerated or when the cattle had received a supplemental feeding of grain or hay.

Davies [25] shows that there is a fishy flavor imparted to milk by feeding beet molasses, molassied beet pulp and beet tops. The obnoxious trimethyl amine and associated products are largely excreted in the urine but some may combine with the fat. The effect is minimized by allowing sufficient time to elapse between feeding and milking, depending on the amount fed.

Rations of green or dry alfalfa hay or corn silage were found by Roadhouse and Henderson [26] to impart undesirable flavors to milk when fed 1-2 hours before milking but withholding them from the feed five hours before

* Prepared by J. H. Shrader.

milking obviated these baneful effects. Improperly cured hay imparted a musty flavor to the milk. Wheat bran improved it. Milk from cows late in lactation or from udders previously infected with mastitis had a salty taste. The lipase in the milk caused the development of rancidity but this was prevented by pasteurization. As other authors have pointed out [27] exposure of the milk to iron and copper develops an oxidized flavor, and sunlight, a tallowy flavor, described by Tracy as burnt. These off flavors from metallic contaminations were shown by Tracy to develop when the milk is held 24-48 hours and are encountered more frequently in winter milk and milk of low bacterial content. Chilson [28] showed that the development of the oxidized flavor could be prevented by the addition of hydroquinone or ascorbic acid.

An oxidizing enzyme is stated by Chilson [29] to be the causative agent of an off flavor in milk. When milk is pasteurized at 143° C. for thirty minutes the off flavor increased but when the milk is heated at 170° F. for ten minutes the off flavor does not develop. He attributes this as evidence of the existence of an oxidizing enzyme. Copper salts enhanced its activity. These ideas are confirmed by Dahle [30] who adds that the iodine number of the fat was decreased in proportion to the degree of flavor present. This flavor was absent when the cows were in summer pasture.

Vitamin A

The vitamin A content of the milk of Ayrshire, Holstein, Jersey and Guernsey cows was shown by Sutton and Kraus [31] to bear no correlation to their carotene content. In the winter these breeds yielded respectively 1.45, 1.95, 2.05 and 3.45 milligrams of carotene per kilogram and in the summer 4.70, 8.00, 12.10 and 20.50. In general, these findings are confirmed by Meigs [32] whe reports that Jerseys and Guernseys secrete milk with a higher yellow color than that of Holsteins and Ayrshires on the same feed but that this higher carotene content is accompanied with less vitamin A. However, inasmuch as the differences in butter color which are produced by different feeds exceed greatly the differences in the butter color of the different breeds on the same feed, the natural yellow butter color does actually serve as a fairly good index of the vitamin A content.

Vitamin A in milk can be increased by the feeding of high-grade field or machine cured alfalfa and corn silage according to the investigations of Russell *et al*[33] but in decreasing percentage of the vitamin A intake. An ingestion of about 1 million U.S.P.X. 1934 units of vitamin A imparted a potency of about 2500 units per quart but at no feeding level did the percentage in the milk exceed 3.5 per cent of the vitamin A intake.

Vitamin C

The instability of vitamin C in milk was attributed by Jacobsen[34] to the loss of CO_2 and to exposure to copper. The usually small content of vitamin C is greatly reduced simply by pouring or mixing or by holding. The author states that three liters of milk are necessary to supply the vitamin C requirement of an adult. However, as a result of 502 determinations of the vitamin C content of fifty-five cows of the Holstein, Jersey, Guernsey and Ayrshire breeds, Whitnah and Riddell[35] found an average of 25.9 ± 4.3 mg. per liter which they state to be about the human protective requirement (quoting Gothlin.)[36] Whitnah, Riddell and Caulfield[37] further studied the effects of pasteurization and of copper on the vitamin C content of milk. When it was pasteurized by the short-time, high temperature process in stainless steel internal tubular pasteurizers without exposure to copper, the vitamin C content was scarcely affected. However, when the milk was pasteurized by the thirty-minute holding process in five different types of vat pasteurizers, the vitamin C content was very greatly reduced. Copper was at least twenty times more destructive than iron and about 200 times more than nickel and chromium.

When milk is subjected to excessive irradiation from carbon arcs or from mercury vapor arcs, Meckel *et al*[38] found that the off flavors were produced by energy in the wave lengths less than 2600A and between 3100 to 7000A. The range between 2600 to 3100A was less active in the development of off flavor and most active in producing the antirachitic property.

An excellent review of the methods of producing vitamin D milk and determining its potency was published by Olson and Wallis.[39]

Composition

The composition of more than 100,000 samples of milk delivered to plants in New England over a period of sixteen months was studied by Jacobsen[40] who found that the minimum requirements of the state of Massachusetts of 3.35 per cent butterfat and 12.00 per cent total solids can not be realized without artificially standardizing the milk by the illegal addition of solids-not-fat or by the legal addition of very rich milk.

The acidity of 811 samples of cows' milk was shown by Caulfield and Riddell[41] to range from 0.098 to 0.295 per cent. Breed groupings in 80 per cent of the samples differed within a range of 0.06 per cent acid. The acidity slowly declined during lactation, becoming marked at the end. Average variations from milking to milking and from day to day of a selected group of cows were not significant.

The CaO content of seventy cows' milk was shown by Burr and Witt[42] to range mostly from 1.40 to 1.59 grams per liter, and the P_2O_5 content likewise was 1.90 to 1.99. Feeds high in CaO did not influence the percentage of CaO in the milk.

The iodine content of Kentucky milk from cows on normal pasture or winter feed was found by McHargue [43] to be thirty parts per billion and that the feeding of iodine raised this figure to 400.

The total number of fat globules varies from one to five million per cu.mm. varying from 1-25 μ and 0.4 per cent are over 10 μ supplying 8.76 per cent of the fat, according to determinations by Restivo.[44] Separation results in the removal of 99 per cent of the droplets over 10 μ, about 94 per cent of the 5-10 μ and about 32 per cent of the 1-5 μ.

Soft Curd Milk

Berry [45] found that colostrum and milk for several days after freshening possessed a hard curd but it then remained uniform without seasonal variation, or change by holding. Freezing had a hardening effect upon the curd. Ordinary pasteurization showed no effect on the curd tension nor did heating at 71.1° C. but heating at 82.2° C. for fifteen minutes rendered ordinary milk a soft curd. The boiling of a milk with a curd tension of 30-80 grams usually softened it to below thirty grams. Viscolization pressures of 3000-5000 pounds per square inch rendered a milk of 50-112 grams, a soft curd milk. Rat feeding with soft curd produced no greater gains in weight than did normal hard curd milk as such or rendered soft curd by pressure or heat. Riddell, Caulfield and Whitnah [46] did not agree with some of the above results. They found that after the initial rapid decline in curd tension during the first month, the lowest values were obtained in the second and third months, followed by a gradual increase which in the tenth month was 100 per cent higher than in the second month.

Homogenization reduced curd tension on an average about 57 per cent which was not increased by a second passage through the machine, according to Caulfield and Martin.[47]

The curd tension of normal milk is reduced as the pressure of homogenization is increased up to an optimum of 2000 pounds at 115° F. Sediment in such milk is due to the settling of body cells and can be prevented entirely by clarifying the milk after homogenization. When mixed milk is homogenized under similar conditions throughout the year, the lowest readings were obtained in January and the highest in October.

Subclinical mastitis was reported by Sommer and Matsen [48] to lower the curd tension of normal milk.

The conversion of normal milk into a soft curd milk by subjecting it to sonic vibration was described by Chambers.[49] He flowed the milk in a thin layer over an electromagnetically driven diaphragm which was a source of intense sonic vibration. The percentage reduction of curd tension was greatest in the normal milks of hard curd properties and the final curd values approached a constant level in the soft curd range no matter what the original curd texture. Little or no reduction in curd tension was effected below the melting point of butter fat. No reduction was observed when the fat content was less than 0.2 per cent. The effect seems to be associated with the number of fat particles and not the actual fat concentration. In general this treatment seemed to be similar to the effects of homogenization. Inasmuch as the maximum reduction in curd tension could be effected with a fat content of less than 1 per cent, the addition of cream to a vibrated milk results in the formation of a normal cream line.

*Lactoflavin**

Studies of growth response from unit amounts of pure lactoflavin as isolated from milk are of special interest. This factor is apparently necessary for growth promo-

* These concluding summaries are based on data supplied by G. C. Supplee.

tion; the properties are determined with a suitable basal ration adequately supplemented with pure vitamin B and a third factor or group of factors necessary for the prevention and cure of dermatitis and carried by rice polish. The potency of lactoflavin may be "calculated" to be 150,000 units per gram. The "unit" designation for expressing the potency of biological substances, such as vitamins and enzymes, according to Ansbacher *et al,* may be meaningless or erroneous.[50]

Pellagra-Like Syndrome

The factor or group of factors which prevents and cures a dermatitis in rats seems to be identical with that which prevents the pellagra-like syndrome in chicks. The use of an unheated vitamin-free casein has yielded consistent evidence to show that the heated commercial casein as a constituent of the 240-H ration of Kline contains a factor or factors which accelerate the rate of growth and diminish the incidence of the pellagra-like syndrome in chicks.[51]

Concentrates prepared from milk and from rice polish contain a factor or group of factors which prevents the onset of the pellagra-like syndrome in chicks. Crystalline preparations of vitamin B and of lactoflavin do not prevent the development of the syndrome. The factor or group of factors preventing this pellagra-like syndrome may be adsorbed on fuller's earth.

Vitamin D Effectiveness

Studies of the influence of milk constituents on the effectiveness of vitamin D lead to the observation that the biological activity of a substance present in natural products as a prosthetic group of a symplex, or which might form such a system, with appropriate substances, can not be expressed in units of like value.[52] Such considerations are necessary in arriving at a sound appraisal of the true value of the empirical laboratory "unit" designation of irradiated milk and other antirachitic agents.

Irradiated Evaporated Milk

The interrelationship between the antirachitic potency of irradiated natural fluid milk and such factors as the intensity of the incident radiation, time of exposure and character of the milk film has been shown by various studies. Are there analagous interrelationships applicable to evaporated milk? Recent studies indicate that the irradiation of evaporated milk as such does not result in as high a degree of antirachitic potency as the irradiation of fluid milk when films of the same capacity are subjected to the same intensity and quality of ultra-violet radiation. Films of evaporated milk of the same capacity are thicker and more dense than those of fluid milk with the same capacity; hence the depth of penetration of the ultra-violet rays, or transmitting properties of evaporated milk films is less than that of fluid milk films. The ultra-violet transmitting property of milk is progressively decreased by pre-heating to 180° F., by concentration and by homogenization, due to physical changes in the inherent milk constituents.[53]

Greater antirachitic potency of evaporated milk irradiated as such has been produced by exposure of thinner films for longer periods of time, or by increasing the intensity of the incident radiation. The potency obtained by such means is apparently not equal to the potency obtained by the irradiation of fluid milk films treated under comparable conditions.

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NUTRITIVE VALUE OF MILKS—PLAIN VERSUS CHOCOLATE FLAVORED *

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INTRODUCTION

A NATIONWIDE survey on chocolate milk, as reported in *The Milk Dealer*, July 1935, revealed that chocolate milk is now generally recognized as an important sales item for the milk dealer. This report also showed that sales outlets for chocolate milk over the country as a whole ranked in the following order of importance: Retail routes and stores tied for first; schools, second; and restaurants, third. The greater proportion of all these outlets showed an increase in sales volume during the past year over the previous year.

The fact that some dairymen are advertising chocolate milk as a real health food for children and for convalescents and that schools rank second as chocolate milk sales outlets brings up the old debatable question of the nutritive value of cocoa and the question of whether cocoa should be included in children's dietaries. Most of the reported experimental work on this problem is controversial. The extensive use of cocoa has been criticized because it contains theobromine and, to a lesser extent, caffeine. However, pathologists generally agree that the objection to the use of chocolate milk because of the theobromine content is not fundamental. Another objection raised to chocolate milk is its sugar content which is considerably higher than that of whole milk. Although most investigators concede that the tannic acid content

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in cocoa is too small to be of any significance, they disregard the high (2.35 to 5.9 per cent) content of cacao red which resembles tannin in many of its properties.

Cocoa and chocolate are made from the nibs of cacao beans. The cacao bean is the seed of the cacao tree, and its component parts are the shell, nib and germ. Chocolate is the solid or plastic mass obtained by grinding the roasted or dried nibs; while cocoa, or powdered cocoa, is chocolate deprived of a portion of its fat and pulverized. There are U. S. federal definitions[1] and standards for cacao products. Space does not permit to give the standards in detail; however, it should be mentioned that they specify in general the minimum fat content and the maximum ash and crude fiber content of cacao products. The composition of commercial cocoas varies considerably according to the composition of the cacao bean used, the extent to which the fat has been removed, and the method of manufacture. The following figures taken from Whymper's "Cocoa and Chocolate"[2] give the main components of commercial cocoa powder.

	Per Cent
Moisture	2.25 to 5
Ash, American Process	3 " 5
Dutch Process	5 " 11
Fat	22 " 35
Extractive soluble in water	13.5 " 18.5
Theobromine	0.7 " 2.7
Starch	2 " 11
Fiber	2.5 " 6.5
Proteins	10 " 17
Oxalic acid	0.4 " 0.65
Sucrose	Trace
Cacao—red	2.35 " 5.9

Cocoa is more likely to be used in milk for its flavor than for its food value. As used in making ordinary chocolate milk, the food value of cocoa is negligible. However, there is a possibility that the small amount of cocoa added to milk may have a marked effect on the digestibility of the milk solids. Whymper[2] states that tannin decreases the solubility of milk solids. Neumann [3,4] studied the digestibility of cocoa, using himself as a subject for eighty-six days, and reports that the addition of cocoa to other articles of food seems to reduce the total amount of nitrogen absorbed. He also found that the amount of fat present in the cocoa affects the absorption of nitrogen, a reduction in fat lowering the assimilation of nitrogen.

Object of Study

In view of these reports, this study was undertaken with the hope of demonstrating by animal feeding experiments whether the addition of cocoa to milk changes the nutritive value of the milk. Also, it was hoped to secure some data which might aid health officials in setting up standards for chocolate milk. The authors are aware of only one instance where such standards have been set up. The Baltimore City Health Department [5] requires a minimum fat content of 2.5 per cent and the permissible maximum cocoa and added sugar are 5 and 6 per cent respectively. Because of the lack of information on the nutritive value of chocolate milk, it was necessary to depend upon trade practice and consumers preference when formulating these standards.

Experimental

The general plan was to feed one group of albino rats whole milk and other groups whole milk to which various percentages of cocoa had been added. Both control and the chocolate milk diets were supplemented with cane sugar and with iron, copper and manganese, according to the procedure reported by Elvehjem *et al.*[6] These investigators have made studies which suggest that the rate of growth of male rats on mineralized milk is an excellent measure of changes in the nutritive value of that milk.

The cocoa used throughout this experiment is a commercial product made by the Dutch process with the following composition.

Constituent	Per Cent
Moisture	3.00
Ash	7.11
Nitrogen	3.74
Ether soluble material	20.64
Crude fiber	5.25
N. F. E.	40.63

In the first experiments pasteurized fluid milk was (approx. 3.8 per cent b.f.) fed, while in the later experiments whole milk powder was fed. Details in the experimental procedure are given under each separate experiment.

Preliminary Experiment

Since no information was available as to whether rats would drink milk containing varying percentages of cocoa, a preliminary experiment was conducted, to determine the approximate maximum amount of cocoa that can be added to milk without retarding the rate of growth. Three animals each were placed on a whole milk and on a one per cent chocolate milk diet and one animal each was placed on chocolate milk diets containing respectively 10, 20, and 30 per cent cocoa powder. Fresh, pasteurized, mineralized milk to which seven per cent cane sugar had been added was used for all the diets. The milk was fed *ad libitum*. It was found that the daily consumption of chocolate milk by rats decreased as the percentage of cocoa was increased above one per cent. For example the average daily feed consumption during the first week of the experiment was as follows:

No cocoa	35 grams
1 per cent cocoa	35 grams
10 per cent cocoa	17 grams
20 per cent cocoa	10 grams
30 per cent cocoa	7 grams

The animals receiving the 30 per cent and 20 per cent chocolate milk died at the end of one week and six weeks respectively. The animal receiving 10 per cent

cocoa in the milk was taken off the experiment after twelve weeks with practically no gain in weight. Animals on the whole milk diet and the one per cent cocoa diet were kept on experiment for thirty weeks, with no significant difference in rate of growth. At the end of the experiment all six animals weighed approximately 400 grams and were extremely fat. The results of this preliminary experiment indicate that rats will make normal growth gains on whole milk and on chocolate milk containing 1 per cent cocoa, but show poor growth and definite injury on milk containing 10 per cent cocoa or more.

Feeding Fluid Chocolate Milk Ad Libitum

The purpose of this experiment was to continue the study on the maximum amount of cocoa which may be added to milk without retarding the rate of growth. Twelve male rats, weighing approximately forty-three grams each, were used in this experiment. The animals were divided into three groups of four rats each. Each group received one of the following four diets: whole milk without cocoa, and whole milk to which 4, 7 and 10 per cent cocoa was added. The rats were placed in individual cages, which were equipped with Fisher porcelain feed cups. All of the diets were mineralized and contained seven per cent cane sugar, and were fed *ad libitum*. The experiment lasted for twelve weeks.

Table 1
Summary of Results for First Six Weeks of Experiment

	Rations			
	Control	4 per cent cocoa	7 per cent cocoa	10 per cent cocoa
	gm.	gm.	gm.	gm.
Average daily gain	3.45	2.07	0.85	0.04
Average daily feed consumption	53.2	37.3	23.5	16.7
Average daily total solids intake	9.89	8.22	5.75	4.5
Average daily cocoa intake	0	1.49	1.64	1.67

The results obtained in this experiment are given in Table 1, and Figures 1 and 2. Table 1 shows that when chocolate milk varying in cocoa content from 4 to 10 per cent is fed *ad libitum*, the average daily gain in weight decreases as the percentage of cocoa in the diet increases. Figure 1 shows graphically these marked differences in weight. An idea of the physical condition of the animals may be gained from Figure 2. The rats had been on experiment for seven weeks at the time the pic-

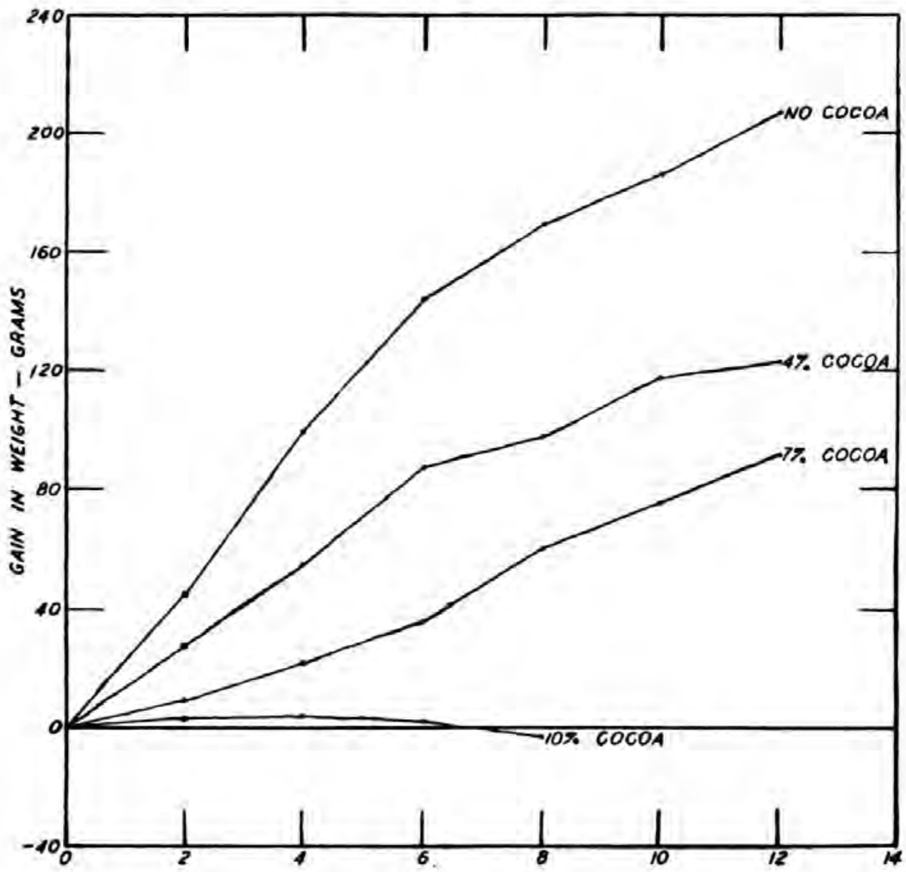

FIGURE 1

COMPARATIVE GROWTH OF RATS FED AD LIBITUM MILK CONTAINING VARYING PERCENTAGES OF COCOA

ture was taken. The photograph shows the marked differences in weight and in the appearance of the coats of the animals.

Table 1 also shows that the daily chocolate milk intake decreases as the percentage of cocoa is increased in the diet. This no doubt is mostly responsible for the inferior growth when cocoa was fed. However it does not seem to account for all of the observed decreases in growth. It should also be noted in the table that the average daily cocoa intake was practically the same for the three concentrations of cocoa. This will be referred to in the discussion of the data.

Two rats on the 10 per cent cocoa ration and one rat on the 7 per cent cocoa ration died after seven weeks.

FIGURE 2

PHOTOGRAPH OF RATS FED AD LIBITUM MILK CONTAINING DIFFERENT PERCENTAGES OF COCOA

No. 1, received no cocoa, weight 224 grams.
No. 2, received 4 per cent cocoa, weight 185 grams.
No. 3, received 7 per cent cocoa, weight 102 grams.
No. 4, received 10 per cent cocoa, weight 51 grams.

The other animals made the following average total gains during the twelve-week experimental period: control, 208 gm.; 4 per cent cocoa, 120 gm.; 7 per cent cocoa, 92 gm.; and 10 per cent cocoa, no gain.

All animals were autopsied at the close of the experiment or after they had died. In all of the animals the lungs, liver, spleen and the kidneys appeared to be normal. However, the rats receiving the 7 and 10 per cent cocoa diets had large masses of what appeared to be undigested cocoa in the ceca. In one case it appeared to be obstructing the whole tract. Furthermore, the feces in the intestinal tract were hard. Gas was found in the stomach, intestinal tract, and cecum. These abnormalities were more pronounced as the cocoa was increased from 7 to 10 per cent. One rat on the 10 per cent cocoa diet showed a possible petechial hemorrhage in gastric mucosa.

Feeding Cocoa with Whole Milk Powder

In this study the cocoa was added to whole milk powder instead of to fluid milk as in the previous experiments. This feeding procedure has the advantage that enough feed can be mixed at one time for the entire experiment. Another advantage for the dried milk plus cocoa is that the cocoa does not settle out as in fluid milk, thus making possible a closer check on the daily consumption of cocoa.

Two experiments were conducted with the dehydrated diet, using a total of forty-eight young rats as subject. In the first experiment twelve males and twelve females were used, while in the second experiment eight males and sixteen females were used. In each experiment twenty-four young rats were divided into six groups.

Table 2
Formulae for Rat Rations

Ration No.	Per Cent Cocoa	Per Cent Milk Powder	Per Cent Cane Sugar	Per Cent Cocoa on Fluid Milk Basis
I	0	62.6	37.4	No cocoa-control
II	5.0	59.4	35.6	1
III	11.9	54.5	33.6	2.5
IV	17.8	50.6	31.6	4

Each group of four animals consisted of litter mates of the same sex, and as nearly as possible of the same weight. Up to the time of being placed on the experiment, the rats had received the stock ration of the breeding colony.

Four diets were compounded as shown in Table 2, and fed one to each rat in the groups of four individuals, thus in each experiment were six individuals on each of the four treatments. The rats were fed in accord with the principle of paired feeding, however, in this case quadruplets instead of pairs. The four diets were compounded to contain none, 1, 2.5, and 4 per cent of cocoa respectively and 7 per cent cane sugar, on a fluid milk basis. Each rat in a group of four received the same amount of milk powder and cane sugar but had a different cocoa intake. In other words, the only variable in the ration was the percentage of cocoa which was added as an accessory food. The quantity of food given to each group of four rats was determined by the quantity consumed by the individual eating the least within the group. In most instances, the 4 per cent cocoa diet determined the food intake in all groups.

The rats were individually caged and placed on the experimental diets shortly after weaning. The first experiment was continued for six weeks and the second for nine weeks. The animals were fed once each day and the feed was weighed daily to determine the amount consumed, care being taken to prevent losses. The food container was a Fisher porcelain feed cup of approximately 75 cc. capacity, which was set in a metal cup and held in place by a metal cover. This arrangement reduced the average spillage per rat during six weeks to approximately two grams. The iron, copper and manganese were fed daily as recommended by Elvehjem *et al.*[6]

The rats were weighed weekly. Bacterial flora studies were made during the latter part of the experiments. At close of both experiments some of the rats on each diet were autopsied.

The essential data are given in Table 3 and Figure 3. Since the rate of growth varies with the sex of the animals, the data were analyzed separately. It was found, as expected, that the females grew more slowly than the males. It was also found that the trend in the rate of growth, both for the control rats and for those receiving varying percentages of cocoa, was practically the same

Table 3
AVERAGE DAILY GAIN IN WEIGHT AND DAILY FEED CONSUMPTION DURING THE EXPERIMENTS

EXPERIMENT No. 1*

Ration	Gain in Weight gm.	Gain or loss over control gm.	Basic ration intake gm.	Cocoa intake gm.
No cocoa	2.21	....	6.80	0
1% cocoa	2.15	—.06	6.80	0.36
2.5% cocoa	2.02	—.19	6.80	0.92
4% cocoa	1.86	—.35	6.80	1.49

EXPERIMENT No. 2**

Ration	Gain in Weight gm.	Gain or loss over control gm.	Basic ration intake gm.	Cocoa intake gm.
No cocoa	1.85	....	8.57	0
1% cocoa	1.90	—.05	8.57	0.46
2.5% cocoa	1.74	—.11	8.57	1.16
4% cocoa	1.49	—.36	8.57	1.86

* Experiment No. 1 lasted for six weeks and each datum is an average value for six animals, three males and three females.

** Experiment No. 2 lasted for nine weeks and each datum is an average value for six animals, four females and two males, except for the one male group in which the rat on the 4 per cent cocoa ration died during the fifth week apparently from some respiratory trouble.

for both sexes. Since the sexes were equally distributed for all rations, the data are presented as averages for male and female.

The growth curves in Figure 3 and the data in Table 3 for the first experiment show a progressive decrease in rate of growth as the percentage of cocoa is increased up to 4 per cent. However, decrease in rate of growth is probably not significant until the amount of cocoa is increased to 4 per cent.

The second experiment was started with two males and four females on each diet. During the fifth week one male on the 4 per cent cocoa diet died, presumably from a respiratory trouble, thus reducing the male group to one animal on the 4 per cent diet during the latter part of the experiment. Both males and females grew a little more slowly in the second experiment than they did in the first. The only known difference in the diets of the two experiments was that the whole milk powder was obtained from a different lot in the second experiment. The results obtained in the second experiment are similar to those obtained in the first; namely, that the cocoa must be in-

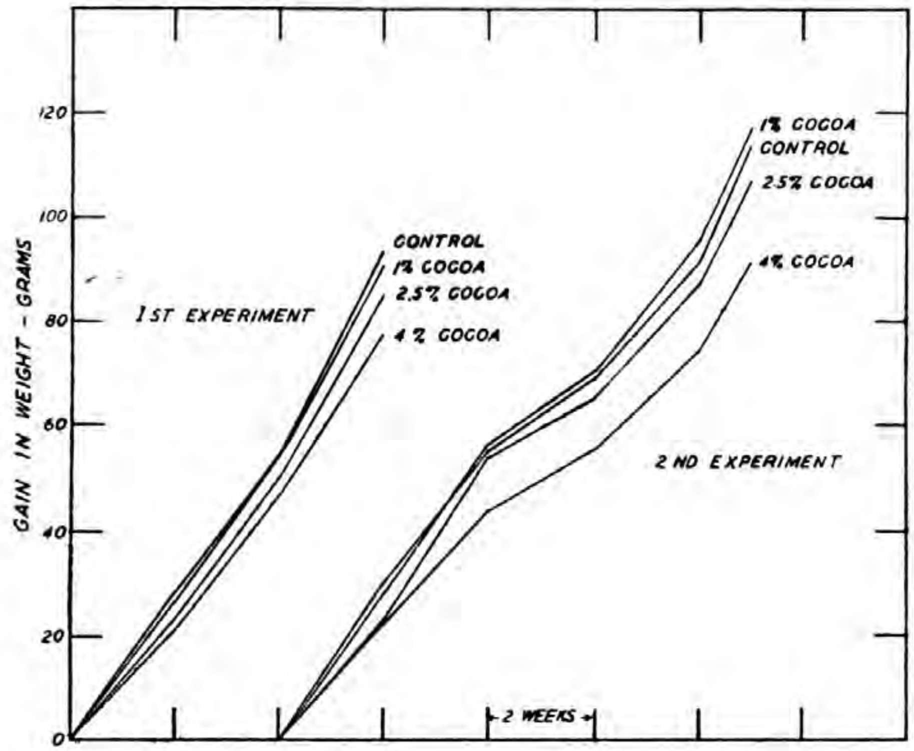

Figure 3

Comparative Growth of Rats Fed Equal Amounts of the Basic Ration but Varying Amounts of Cocoa

creased to 4 per cent before a significant decrease in the rate of growth is obtained. The 1 per cent cocoa group made slightly better gains than the control, while in the first experiment the reverse was true. However, the difference between the control, 1 per cent and 2.5 per cent cocoa diets is not great enough to be of any significance. The autopsies showed no pathological condition in any of the experimental animals.

Effect of Cocoa on the Intestinal Flora of Albino Rats

A study was made of the intestinal flora of three rats on each of the following diets: Powdered whole milk, powdered whole milk plus 4 per cent cocoa, fluid whole milk, and fluid whole milk plus 1 per cent cocoa. All of the diets were mineralized and 7 per cent cane sugar was added. These animals had been on the powdered milk diet for eight weeks and on the fluid milk diet for thirty weeks, when this study was made. A detailed description of the feeding procedure has already been given. Serial dilutions of the feces were plated out on nutrient agar, aerobic and anaerobic, MacConkey's agar, and tomato agar in an atmosphere of carbon dioxide. Egg meat tubes were used to determine the degree of hydrogen sulphide production and putrefaction.

The results obtained indicate that there was no significant difference in the intestinal flora of the rats on the different milk diets. From the differential plate counts it was found that aciduric bacteria strongly predominated over the *B. coli*, anaerobes, and other fecal bacteria. The data obtained from the egg meat tubes showed the presence of putrefactive bacteria in all of the rats. It is probable that the putrefactive bacteria present were *cl. Welchii*, a common intestinal anaerobe. It is well known that diet has a marked influence on the type of bacteria present in the intestinal tract. As all of the experimental rats were on straight milk diets, it was to be expected that they would all have a similar intestinal flora. Although some of the animals received 1 and 4 per cent cocoa in the milk, this amount of cocoa is not enough to make a marked change in the composition of the milk diet, so far as its influence upon the intestinal flora is concerned.

pH determinations were made on the feces of three animals on whole milk diet and three animals on whole milk diet to which 1 per cent cocoa was added. It was found that the average pH for the cocoa-free diet was 7.32 and for the 1 per cent cocoa diet was 7.40. It is evident from these fecal pH values that the addition of 1 per cent cocoa to a straight milk diet has no significant effect on the fecal pH.

Discussion

When chocolate milk was fed *ad libitum* to rats, the daily consumption decreased as the percentage of cocoa was increased above one per cent. It was noted that when feeding *ad libitum* chocolate milk which contained 4, 7, and 10 per cent cocoa, the daily cocoa intake was nearly the same, being 1.5, 1.6 and 1.7 grams respectively. In the controlled feeding experiments in which all animals within a group received equal quantities of the basic ration but varying amounts of cocoa, that the diet containing the highest percentage of cocoa determined the food intake for all the animals in the group. These results indicate that cocoa limits the consumption of chocolate milk by rats. Two possible reasons for this are first, the cocoa may decrease the palatability of the milk; second, the cocoa may be toxic to rats.

This study has shown that there is a narrow range of cocoa tolerance in rats. One per cent cocoa in milk had no noticeable effect, 2.5 per cent cocoa had a questionable effect, while 4 per cent cocoa retarded the growth of rats. It is difficult from our present results to determine what specific factors may be responsible for this retardation in growth. The feces in the intestinal tract were very hard when the concentration of cocoa was increased to 7 or 10 per cent in the diet. Therefore, the effect of cocoa may be mostly a physical one in that the indigestible cocoa fiber tends to block the intestinal tract. Neumann[3] has shown that the protein in cocoa is more digestible in the presence of larger quantities of cacao fat. This suggests that chocolate milk made from whole milk may be more easily digested than that made from skim milk.

Further study is being made to determine what specific factors are responsible for the observed retardation in growth when four per cent cocoa is added to milk.

Summary and Conclusions

The effect of the addition of varying percentages of cocoa to mineralized whole milk was studied by means of growth experiments on a total of seventy-two albino rats. When fluid chocolate milk containing more than 1 per cent of cocoa was fed *ad libitum*, the rate of consumption decreased as the percentage of cocoa increased.

When cocoa was added to whole milk powder and the amount fed was controlled, the 1 per cent cocoa diet was equal to the whole milk diet; the 2.5 per cent cocoa diet gave a questionable retardation rate of growth; and the 4 per cent cocoa diet definitely retarded growth.

When the rats received the 7 and 10 per cent cocoa diets, the feces in the intestinal tract were very hard and there was a greater accumulation of food material in the ceca than was the case in the control group.

Studies of intestinal flora showed no distinctive changes for the whole milk, 1, and 4 per cent cocoa diets. The addition of 1 per cent cocoa to a straight milk diet had no significant effect on the fecal pH.

Assuming that these results may have some application to human nutrition, we may conclude that the cocoa in average commercial chocolate milk which contains a trifle over 1 per cent cocoa does no harm nor does it enhance the nutritional value of the milk.

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Discussion

Mr. Holmquist: May I ask if that was fluid milk that was supplied and what other food was fed to the animals?

Mr. Mueller: It was a straight milk diet.

Mr. Holmquist: Fluid milk?

Mr. Mueller: We used fluid milk in one experiment and in the other experiments we used powdered whole milk.

Mr. Holmquist: No other diet?

Mr. Mueller: The milk was mineralized and cane sugar was added.

Mr. Scales: I would like to ask Mr. Mueller if any consideration was given as to a possible lead content in that Dutch process cocoa. The Government has found that the Dutch process frequently does have a lead content and it might account for some of the digestive abnormalities that you spoke of.

Mr. Mueller: Yes, we have considered it in thought but we have not made any determinations to check up on that particular point. We are continuing the work and the purpose of the work from now on is to find out why we got a retardation in growth, so that will be one of the things that will be considered.

Mr. Jennings: What do you find the per cent of cocoa in the average chocolate milk being sold by milk dealers? Did you make an investigation of the variations in percentage?

Mr. Mueller: We did not make an extensive investigation of the variations in percentage of cocoa in commercial chocolate milk. As near as we can tell it will probably be a little below 1 per cent and maybe as high as a little over 2 per cent and those figures were determined by picking up various formulas and calculating the percentage of cocoa in the milk.

Mr. Holmquist: I understood from a research chemist that rats fed on milk alone do not thrive; they soon die, the theory being that although there is enough food value in the milk they can not consume enough milk to sustain them properly. On the other hand, if fed powdered milk you do not have to feed such large quantities and they do thrive and increase in weight.

Mr. Mueller: Our experiments and others have shown that rats will thrive and make normal gains on liquid whole milk providing you mineralize the milk.

Mr. Maughan: I find milk dealers all very anxious to sell chocolate drinks or chocolate milk, but the problem seems to be, is it sound nutritionally and what is going to be the attitude of the Health Department toward it?

It seems to me that the percentage of butter fat runs all the way from that found in whole milk, as required in the state of Michigan, down to zero. In other words, skim milk, which is very noticeable in a good many markets, possibly the average market, would be 1 or 2 per cent butter fat.

Dr. Campbell, of the U. S. Food and Drug Department, recently told me that he considered that there was just as much theobromine in chocolate milk as there was caffeine in coffee and each was equally harmful. If that is the case it presents a serious problem to the dairy industry. I am wondering if the gentleman here has any information or if the association has any recommendations.

Mr. Mueller: Neumann, a German investigator, has shown that the protein in cocoa is more digestible in the presence of larger quantities of cocoa fat. This suggests that chocolate milk made from whole milk may be more easily digested than that made from skim milk. To our knowledge there is no experimental data available which shows that we should make chocolate milk out of whole milk rather than skim milk. Consumers' preference, I believe, determines that point now.

Mr. Tiedeman: I would like to ask Mr. Mueller about how many animals were used to determine, first of all, that 7 per cent cocoa and 10 per cent cocoa in the diet caused diminution of growth.

Mr. Mueller: We had six animals on those particular diets.

Mr. Tiedeman: Was there very much variation among the animals?

Mr. Mueller: The variations among the animals were no more than the expected.

Mr. Tiedeman: When the fluid milk diet was fed how did you feed the cocoa?

Mr. Mueller: The cocoa was added to the milk in the form of a cocoa syrup. The chocolate milk was placed in a porcelain feed cup and the amount which the rats would clean up each day was fed. The animals had to clean up all of the cocoa before we considered all of the chocolate milk being consumed.

Mr. Tiedeman: You expressed the theory that the reason for the differences might be due to the indigestibility of the cocoa. Do you think that a conclusion of that type can be warranted on the basis of these experiments?

Mr. Mueller: These experiments do not warrant definite conclusions on what specific factors are responsible for the observed retardation in growth when 4 per cent cocoa is added to milk. Further study is being made to determine that point.

Mr. Tiedeman: What is the correlation amount of cocoa between that found in a half pint of chocolate milk and that in a candy bar?

Mr. Mueller: We have not figured that out and I could not say offhand.

Mr. Tiedeman: We speak of advocating candy bars for energy in the afternoon and I do not know if there is any reason for condemning chocolate milk at the present time in lieu of candy bars that are advocated so highly.

Mr. Mueller: This study is confined to chocolate milk. We have not condemned chocolate milk as ordinarily used. Our results show that 1 per cent cocoa added to milk has no noticeable detrimental effect, but when you increase the cocoa to 4 per cent it has detrimental effects. Since ordinarily chocolate milk does not contain 4 per cent cocoa, we are not condemning chocolate milk.

Dr. Robertson: In answer to one question from the floor, relative to Mr. W. G. Campbell's attitude on chocolate drinks containing skim milk, perhaps I can add a clarifying statement. In New York State, the policy is to require that chocolate milk be made from a mixture of chocolate syrup (or its equivalent) and whole milk. Chocolate drink may be a product possessing a characteristic chocolate flavor and composed of a mixture of wholesome ingredients, a list of which is declared on the label. I believe this policy would coincide with the Food and Drug Administration's rulings.

PROBLEMS CONCERNING INTERSTATE SHIPMENTS OF CREAM *

UP UNTIL the year 1930, the city of Newark made no inspection of cream other than that coming from fluid milk supplies that separated their surplus milk. The department of health had concentrated all its effort on fluid milk supplies, which was all that could be done with the number of inspectors who could be spared for this type of work. The department has since added several inspectors to our division, which has enabled the food and drug division to put more inspectors on dairy work.

In the year 1930, which we all recognize as the start of the depression, it was found that the market was being flooded with cream. This cream was coming from all parts of the country. Until this time, the only means for procuring information regarding the various plants and dairies outside of the milkshed, that were shipping cream into Newark, was through some health official in the vicinity of these particular plants and dairies. Invariably the reports were favorable. Upon taking samples of this cream, however, it was found that the chemical analyses showed adulteration, and the bacterial analyses showed very high counts. These laboratory reports indicated that this cream was being produced and handled under insanitary conditions.

It was decided then that the only way to secure a good quality and safe can of cream was to put cream under the same inspection as fluid milk. Inasmuch as a great portion of manufactured ice cream is consumed by our children, it was very important that this cream be produced under the same sanitary conditions as fluid milk. Immediate steps were taken to change the ordinance to this effect.

The department notified all dealers, brokers, etc. that they would have to send a list of their cream supplies,

* Committee Report

whether or not this cream be for fluid or manufacturing use. Records showed that cream from approximately twenty-three states was entering Newark. The department wrote to the various companies sending them a copy of the ordinance and requesting that they carefully read it and let the department know whether they could comply with the regulations required in this ordinance. Practically every company answered that they could comply and meet Newark's inspection.

The first trip of one inspector took him into five states. He spent all of his time just inspecting plants. So many things were wrong that he did not make any attempt to inspect the dairies supplying these plants. However, he got all the information possible from the field men and plant managers concerning these dairies. The information received showed that in most cases there never had been any sanitary inspections. The field men employed were not used as inspectors of sanitary conditions, but as buyers of milk. It was not uncommon to find two weigh cans in these plants, one for sweet milk and the other for sour, or milk containing odors. It was also found that a good many of the plants were taking in hand-separated cream. After completing this initial trip the data was studied and the conclusion reached that if the ordinance on cream was to be enforced the same as fluid milk it would be necessary to exclude all of these plants because there were none that could come anywhere near complying with our ordinance. Another inspector's report was identical.

However, it was decided to finish making the inspections of all the plants listed, make the recommendations that were necessary to have these plants comply with our regulations, and give all plants a reasonable amount of time to complete these recommendations. Any plants that could not meet the requirements, such as cheese plants and butter plants (and you would be surprised as to how many of these are shipping cream) or any plants that were found to be in filthy condition were to be excluded.

After completing the original inspections, reinspections were made of the plants which had been given recommendations to see if a reasonable amount of progress was being made. It was found that most of the companies or organizations had figured that reinspections would not be made and consequently had done nothing to comply with the recommendations. The heads of these plants were immediately contacted and told that the recommendations suggested would have to be complied with and a reinspection made before they could ship any more cream into our market. This really started the ball rolling. The first reinspection trip had not been completed before any number of these plants that had been excluded on this trip were writing to the department saying that they were under construction, or had complied with the recommendations and wanted to be reinstated. These plants were again reinspected and if the recommendations were completed they were put on the approved list. There were cases where the heads of organizations said that they could not comply with the recommendations, because the changes which would be necessary would cost a great deal and they could not afford to make them, inasmuch as they shipped cream only two or three months a year. Then there were other companies that took this inspection seriously and went right ahead with the recommendations made. There were very few of these companies and they are the companies that have permanent permits today.

After getting the plants up to the point where it was felt that clean handling, processing, pasteurizing, cooling and shipping of cream were being carried out the dairy program was inaugurated. At the beginning, most of the companies were very enthusiastic about it. They were


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very much pleased with the results attained from fixing up their plants to meet the requirements, and felt that the dairy program would also help to improve the quality of their cream. They believed that they would be able to go ahead with this dairy program, but did not realize the tremendous amount of work that would have to be done on the dairies; the average farmer's attitude for doing this work; or the drive the competitive company's buyers of milk were going to make, once a program of this kind was started. Today only four states are shipping cream to Newark. You will readily see, therefore, what a problem the plants that were trying to meet inspection were up against. The plants that have gone ahead with this dairy program worked out a financial program, loaning the farmers the money to build milkhouses, to lay cement floors in the barn, and to make whatever other improvements were necessary. They have also paid a premium of anywhere from ten to thirty cents a hundred more for the milk of the dairies which had met sanitary requirements of our department.

The competitive companies have done everything to hinder the program instead of feeling that this was a good time also to inaugurate a quality program. These same companies are in most cases shipping cream into our neighboring markets. Dairymen have told the inspector that if he did not want the milk as it was being produced in the dairy there would be another truck to pick it up the next morning. When it was explained to be the benefits derived from inspection the dairyman stated that some competitive company's field man had been there and told him that the competitive company would take the milk without any inspection, and if he stayed under inspection the department would be around hounding him all the time; therefore, it would be better for him to change to his company immediately. Sure enough, when these dairies were excluded, the next morning these competitive trucks would pick up the milk. This was really an every day occurrence.

The above point has been brought out, not to hurt the dairy industry, but to try and help it. If it were possible for our health officers and the heads of our food and drug and milk divisions to make a survey of all cream shipping supplies, taking the dairy routes at random so as to see the actual conditions of these dairies, they would all undoubtedly feel that a great deal of work should be done immediately and that all cream should be put under the same inspection as fluid milk. The chairman of this committee, who has had an active part in the Newark program, offers what is believied to be a good program for the various states and cities that receive interstate shipments of cream in order that they may be sure of production under sanitary conditions.

The first suggestion would be that any city or state receiving interstate shipments of cream should make a check of the amount of milk taken into the plants under their supervision in their immediate milksheds, and the disposition of the same milk. This check should show by months. Then they should ask the buyers or dealers to supply the amount of cream they buy, by months. By buyers and dealers it is meant all manufacturers of ice cream who are selling in the city or state. The reason for these figures by months is because milk production varies a good deal, as does the consumption, and by using the figures over a monthly period the flush and short months and the amount of cream that it would be necessary to get from sources outside of our inspected milkshed may be judged. It is believed that the dairies and plants in the milksheds that are willing to comply with the requirements should have their products taken care of first, whether it be in the flush or short season.

The next suggestion after these figures have been gone over carefully (and, of course, it is understood that these figures are approximate) is that inspection of enough plants desiring to ship to these markets to take care of the demand should be made. Pick out plants that would be able to ship cream fifty-two weeks in the year. The reason for choosing plants that can ship fifty-two weeks a year is this: there will be requests from a good many plants that want to ship only in the flush season when the markets are already amply supplied. If plants are taken that can ship fifty-two weeks a year and reasonable assurance can be given that there will be no temporary permits granted in the short seasons unless those producers applying for temporary permits have been proved to be on a par, so far as sanitary and construction requirements are concerned, with all accepted plants, it is believed that such plants will be glad to work on a program to meet inspection. The plan by which these plants would be taken care of during the year would be to freeze their surplus cream in the surplus season to take care of the market in short productive seasons. This system of supply and demand could be worked out very simply and with very little clerical work.

The next suggestion would be to have the plants comply with the requirements of the city or state making the inspections. Then start on a dairy program. This dairy program should be carried over a period of from three to five years. The reason for this is as follows: it will be found that the average plant desiring to ship cream will have from two hundred to fifteen hundred dairies supplying milk. When these dairies are inspected it will be found that inasmuch as most of them have never been under any inspection they will have no milk-houses, no sanitary pails or strainers, their barns will be just general barns housing cows, hogs, horses, sheep, chickens and anything else they might have on the farm. There may be no cement floors, windows, tight ceilings, or anything else along the lines that are required by

inspection. Their toilet facilities may be bad and in a good many cases their water supplies will not meet inspection. They may have no idea of the sanitary and clean production of milk and will need education along these lines. It is readily seen that a start from scratch is necessary in order to build these supplies up to the prescribed standards. It should be understood that the conditions as described are not exaggerated. Such conditions can be seen any day when out on dairy inspection. Some may doubt that such supplies can be built up, in a practical way, so that they do meet recognized standards. The results of the plan adopted by Newark indicate that it is possible to do this, by working with the companies and the dairymen. Also it is believed that the dairyman who has met the requirements would never want to go back to the old way of producing and caring for his milk. With the health department inspector and company cooperating, any of these supplies can be made to meet the requirements over a five-year period.

It is interesting to note that the state of New Jersey, the state of Pennsylvania and the territory supervised by our good president, Dr. Grim, are working on a program very much the same as the city of Newark, and their cooperation has been very helpful in getting the Newark supply to the point where it meets inspection.

Richard Powell, *Chairman*

Paul F. Krueger
H. N. Parker
H. E. Bremer
C. Sidney Leete
John M. Scott
C. L. Witham
Clyde Beardslee
L. C. Bulmer
John M. Lescure
Walter Scofield

Discussion

Mr. Harris: I would like to ask Mr. Powell what would happen after these cream shippers met the requirements of cream. Would they not automatically want to come in and produce more surplus milk?

Mr. Powell: We are talking here chiefly of plants that are all represented by milksheds. These plants are located through Ohio, Michigan, in fact, so far away that it would not be economical to ship fluid milk, but if it were economical, if this milk were produced—I am talking from the health standpoint—under the same conditions and met the same requirements as our fluid milk there would be no reason or any way of stopping it including bacteriological requirements. There should not be anyway.

Mr. Harris: Your inspections, then, for your manufactured cream are the same as your fluid milk?

Mr. Powell: The same for manufactured cream, with the exception of butter and cheese. We have not attempted to make any inspection of creams for butter and cheese manufacturers. It is cream for ice cream or cream for baked goods or other goods that are manufactured in the city. We have not made any inspection for butter or cheese.

Question: Do you permit the ice cream to be made out of sweet butter?

Mr. Powell: I believe that New Jersey and the City of Newark allow butter in the manufacture of ice cream.

Miss Harrington: May I ask a question? I am a guest but there is a point I would like to make or understand. Did I understand you to say it is recommended in flush times that they freeze their cream and then use it when they get short?

Mr. Powell: That is right.

President Grim: The question of interstate shipment of cream is one that ought to interest all of us. We are here from many states and we all have many problems about the cream situation.

Personally I do not agree with any ordinance that would accept butter without inspection and at the same time require inspection of cream for ice cream manufacture. You have only to go out and look at conditions under which cream is produced and gathered for butter manufacture to demonstrate the folly of any program that included inspection of cream and excludes inspection of butter used in ice cream. However, this is the situation generally. The failure to supervise the manufacture of butter is a thing you will find almost everywhere.

As Mr. Powell says, they do not take into consideration butter in ice cream manufacture. Nobody seems to take butter into consideration. The same thing is true in New York City and in many other cities. We know that last summer butter from Russia and New Zealand was used in ice cream manufacture here in New Jersey, in Pennsylvania and in New York.

You know that will never do. The milk is frequently produced under very bad conditions. Separation is carried on under very bad conditions and the butter is usually not good enough to be marketed as butter for table use. Butter of this grade finds its way into ice cream and sometimes it is put into ice cream mix and sent forth to small manufacturers.

The whole question of inspection of cream and its shipment is one that needs considerable thought and deliberation. Mr. Powell's suggestion for freezing is a sound one. The demand for cream going into ice cream manufacture is great during certain peak weeks when the weather is hot. During these brief emergency periods you can not get large volumes of inspected cream. The creameries are not willing to pay the farmers the high premium necessary to induce them to do the things we require unless there is a market for the products all the time. The ice cream industry however can not use their products all the time; so the only answer is to have under inspection a few supplies that will ship all the year round. They should be a little bit better than the ordinary cream supplies for fluid purposes, because much of this cream must be frozen and placed in storage. It is only the best kind of cream that can be put away and remain in storage frozen for long periods until it is taken out for ice cream manufacture.

On the other hand the successful ice cream manufacturer claims he can not use all frozen cream; that there are difficulties in the quality of ice cream were ice cream to be made from frozen cream alone and that some fresh cream is always necessary to make a good product. So far as I can find there is very little objection to frozen cream. Nevertheless I know of some places where they discriminate against high quality frozen cream and permit the use of butter of inferior grades.

By the all year round purchase of inspected cream, freezing and storing when flushes appear or demands lessen, will be found a means of providing a constant supply of high quality cream for ice cream manufacture the year round.

One trouble with cream supplies, is that many creameries in the West expect to buy their milk at butter prices. As Mr. Powell has stated, when we attempt to enforce our sanitary requirements, the farmer does not respond because the buyer fails to pay him for the additional effort required. When the butter factory or the cheese factory down the road pay the same price as the eastern cream shippers, there is just one answer. The cream shipper pays the farmer for meeting the requirements or the farmer refuses and without further ado the milk henceforth goes to the cheese factory.

Mr. Lewis: I want to know what provision is made where you have to pay the expense of this inspection. Is it paid by taxes or a permanent fee?

Mr. Powell: The inspection is paid today by the companies requiring inspection; that is, anything outside.

Mr. Lewis: Is that considered satisfactory to the company?

Mr. Powell: As far as I know we have never had any objections.

Mr. Lewis: What objections do you have from the public?

Mr. Powell: We have not had any objections that I have heard of. Of course, it is understood that when we started this work it was before our city and many other cities were in their present economic condition. Our Department thought that inasmuch as these plants which were shipping cream were located all over the country and were not paying taxes to our city they should pay for inspection service.

It was believed further that if they were asked to pay for inspection many of them would not want it, but it was surprising how the checks flowed in for this inspection work.

Mr. Lewis: Does that cost seem to anyone concerned to be a policy of racketeering?

Mr. Powell: I believe that if an inspector does his work conscientiously it could not be construed as racketeering. A real service is being rendered to these people. They are paying the expense of their own field men and we should be able to leave enough constructive work behind us to take care of the expense. There has never been any criticism that we know of, as far as our Department is concerned.

Mr. Lewis: The reason I brought that up is that I read an article in one of our leading magazines in which the editor took exception to such levies on the industry. He ended his editorial by saying that it smacked too much of racketeering, and that there was too much opportunity for graft on the part of the inspectors. I wondered if that entered at all.

Mr. Powell: We have never heard anything of that nature entering into any part of our work. Personally, this is the first time I have heard the subject brought up that way. It seems to me there would be little chance for racketeering or graft with companies paying the expense of the inspector. They certainly would not like anyone piling graft on them, whether paying the expense or not. Since we are taking this work on and since our cities are in their present financial condition, we have to take the financial program into consideration. These companies are not like companies located in our city or state who are paying local taxes. They are just shipping their product into our city.

I would like to clarify the question in regard to butter being used in ice cream in Newark. We did not permit the use of butter in the manufacture of ice cream for a long time. However, a study of our ordinance revealed that there were no grounds to prohibit such practice. Nevertheless, we are not in sympathy with butter going into ice cream unless this butter is inspected the same as cream.

President Grim: I do not like the use of butter under any conditions if churned from uninspected cream. Neither do I like the plan of labeling ice cream to indicate butter was used in its manufacture. The difficulty is that if we are going to take the easy way we are just going to postpone our improvement work in the country. If we start right in, "grab the bull by the nose" and demand an inspected supply of cream and keep hewing at it we may accomplish something, but so long as you permit the use of uninspected fat in the form of butter, the ice cream manufacture is never going to be short of inspected cream. Without a shortage of inspected cream there will never be a time when the market will be good enough to warrant the cream shipper paying the farmer five or six cents more a pound for fat in order that his dairy farm may be improved or the creamery placed in shape so it can supply an inspected market.

Inspection of cream supplies in the West is a good thing. It is a good thing anywhere. I did not see the article referred to by Mr. Powell about graft or about the payment of fees; but why should a municipality, for instance, take the money of its taxpayers and go out and look over a supply of cream in the West because A, B or C wants to buy from a particular source in the West merely because the price quoted is a dollar or two less than the prevailing quotation at home?

That is all there is to our importation of cream from the West—just a question of price. There is plenty of cream around. We do not have to go far for it. Right up in New York State, the northern part, there is almost enough cream to take care of the excess requirements of the whole area around here. There is a good bit at present going into cheese and butter. There are vast areas ready for development in Pennsylvania but wherever the product is produced it must be inspected; certainly we are not going to exhaust our funds employing inspectors and paying their transportation and other expenses in traveling hundreds and hundreds of miles to look over sources of supply. If for some commercial reason a buyer elects to make his purchases hundreds or thousands of miles from home, he should expect to pay not only the increased transportation of the product but in addition to that the cost of inspecting it. We follow this practice right along. Our municipalities send bills for the amount of money it costs to make the inspections. That is all there is to that, and I can not see how any graft could be committed that way, because no direct payments are made to the inspector. We, of course, require the creameries to have their own field men, but the reason municipalities find it ncessary to inspect supplies is because we have states, our own and our neighbors, that stick their heads into the sand, close their eyes and let the supply ride on without attempting to make any inspection at all beyond their boundary lines.

They say "No, they have no permit," "We won't let them ship," but when it comes to stopping the shipment, they often fail to function. Circumstances such as these usually result in the municipality going beyond its state lines for the purpose of conducting dairy inspections.

If the state would take the position of actually stopping the uninspected shipments our out-of-state inspections could be largely curtailed. Past history, however, is otherwise, and for this reason it has been necessary for us to inspect them. I think if more of us would go out and insist on higher quality products in ice cream, carrying the program on into the powdered room, into the condensing pan and into the butter churn we would find a solution to many of our difficulties.

Of course there is very little butter churned from inspected cream and qualified for use in ice cream. I know of only one or two small supplies and here the price of the butter would be almost prohibitive. Some day we may get our butter supply in shape for use in ice cream manufacturing, but the day is not here yet.

Mr. Trimble: I would like to ask Mr. Zimmerman a question. Does labeling require selling at a lower price?

Mr. Zimmerman: Yes, it practically does and that is the reason for it. The higher quality ice cream brings a better price, as they are able to use the fluid product.

Miss Harrington: What do your eastern producers think of the inspectors going off to the West some place to get milk? Do they make a big hue and cry and say: "Here we are with plenty of milk and still they are going off some place else to get milk"? Is there a big fuss and is that a source of unrest?

Mr. Powell: I believe our immediate milksheds should be taken care of first, providing they want to meet the requirements. As far as we are concerned any plant that is willing to meet our requirements will never be turned down for inspection, but we have the same or better conditions in our milksheds in New York or Pennsylvania than we have any other place in the country. We have certain groups of plants that have been in the manufacturing end of the game who have no desire or have shown no desire to go under inspection, for several reasons, one being the possibility of losing milk. These plants have never wanted or asked for inspection. We, personally, would be glad if this work could be confined to all nearby states, and would like it much better if we did not have to go to Wisconsin, Minnesota and down South to make inspections for cream. We do realize, however, that while in certain seasons of the year there is enough milk produced in our milksheds amply to take care of our market, there is at other seasons of the year not enough, consequently we do have to go outside of our milksheds for these supplies.

Mr. Jennings: There is another question that arises. What about evaporated milk that may be, as many of us know, produced under very filthy conditions, and then goes into ice cream? Are we going to say, "You can not make ice cream from evaporated milk?" If we were put on the stand and the attorney for the defense would say: "This evaporated milk is used for the feeding of babies. It is sterile, isn't it? The finest babies in town are raised on evaporated milk, yet you say we can not use it in the manufacture of ice cream. You let it go for feeding babies, and so forth. You are letting this butter go to be used as a spread on bread for children to eat, yet you say it can not be used in ice cream."

Some of those are problems that arise. You would certainly be whipped in a minute in court on your evaporated milk. It seems to me that it is a problem that can not very well be handled by a local city government but must come from a cooperative program between the state and federal governments.

President Grim: I think there is an answer to that. Evaporated milk, as such, is not used by the large ice cream manufacturers to any extent in the eastern part of the United States. They claim it is not suitable. They use bulk condensed milk which is not sterilized and the bulk condensed milk which is not sterilized certainly ought to be supervised.

The fact that babies thrive well on sterilized evaporated milk is not any argument, as I see it, for using milk which we know contains all kinds of dirt and filth for ice cream manufacture. The Government has done extensive work on butter. Their results show definitely what might be expected on some of these supplies. Our laws in Pennsylvania provide that all milk, the condensed milk, the evaporated milk, the butter and the milk powder all come under supervision and must be handled in accordance with standards identical with milk. We do not have any evaporated milk in our ice cream that is not from inspected sources. We do not have any butter used in our ice cream that is not from inspected sources. That is the prevailing condition in the city of Philadelphia, with some of the largest ice cream plants in the world. They get along without using butter; they get along without using condensed milk that does not meet our standards, and I know the same thing can be done elsewhere.

In this connection I attempted this summer to make some kind of a survey to determine whether or not sanitary conditions on dairy farms in the East were better or worse than in the West.

We inspected about 1,765 farms in the West and we attempted to rate them on a percentage basis of compliance with major items of sanitation. Toilets were deemed acceptable or not acceptable, depending on whether they were tight and had self-closing lids. We did the same thing with the milk house, with the utensils, the barn, the cows, the cow yards, milking stools and the methods in use.

As a result of this survey we found that if anything our milk, a good bit of it, right in Pennsylvania and New Jersey and New York, was not as good as some of our better inspected supplies in the West. The best supply we found from the standpoint of compliance with sanitary requirements was one that was a thousand miles or more away from our market. Our conclusion was that a big job should be undertaken right at home.

With reference to dairy products other than cream I think it is our job to supervise them.

TUBERCULIN TESTING AND THE COURTS

James A. Tobey, Dr. P.H.

Director of Health Service, The Borden Company, N. Y.
Member of the New York Bar

Mr. Chairman, I might preface my remarks by stating that this matter of the admissibility of tests in evidence arose forty years ago in the question of tuberculin testing. The general rule of evidence is that if a test or process is accepted by the consensus of scientific opinion it will be admissible, but whether it is accepted or not must be shown by testimony in the courts. Of course, officials and others who are upholding a certain procedure will present their evidence, and those who consider themselves aggrieved will present conflicting evidence, and the judge, being completely bewildered by it all, will then use his best judgment in admitting or refusing to admit the evidence.

LEGAL requirements by states and their political subdivisions that all dairy cattle shall be tested for tuberculosis, that milk from diseased cattle shall not be sold for human consumption, and that tubercular cattle shall be destroyed, have been before the courts of last resort in this country on numerous occasions during the past forty years.[1] A review of the legal principles set forth in these decisions should be of value to all milk inspectors, whose duties require the enforcement of legal provisions of this nature.

The first court decision upholding the tuberculin test was an opinion handed down by the Supreme Court of Minnesota in 1896.[2] In this case, an ordinance of the city of Minneapolis requiring that every herd whose milk was sold in the city should be subjected to the tuberculin test was held not to be oppressive, since the provision had a reasonable tendency to prevent the sale of unwholesome milk within the city. Not only was this decision reaffirmed by the same court in 1910, but it was held in this later decision that an ordinance authorizing the summary seizure and destruction by the health department of milk from cows that had not been inspected or tuberculin tested was not violative of the constitutional rights of the citizens nor a taking of property without due process of law.[3]

Since the first decision on tuberculin testing in 1896, the United States Supreme Court,[4] and the courts of last resort in a number of states have sustained the validity of municipal ordinances,[5] or board of health regulations,[6] requiring the tuberculin testing of cattle and the freedom of cows from tuberculosis, as conditions precedent to the sale of milk within a municipality. In two instances, however, such municipal ordinances have been held invalid but only because they were in direct conflict with state laws then in existence.[7] In these cases the courts did not pass upon the merit of the tuberculin test, which was stated to be primarily a matter for legislative and not judicial determination.

The writ of mandamus will not be granted by a court to compel the issuance of a license to a milk dealer who had not complied with an ordinance requiring pasteurization of milk or tuberculin testing of cattle, effective when the mandamus proceedings were heard, but not yet effective when the permit was denied, since neither the license nor the writ would authorize the sale of milk contrary to the ordinance after its effective date, according to the opinion in a Connecticut decision.[8]

A city has the power to require that persons producing milk outside the city for sale in the city shall have the cows from which such milk is drawn tuberculin tested, and may empower the health officer to confiscate and destroy milk that is not produced in compliance with the terms of the ordinance, even when the rules applying to cows outside the city are different from those applicable to cows and dairies within the city.[9] "But even if the necessity of the tests be not demonstrated," said the

United States Supreme Court in this case, "and the beliefs which induced them may be disputed, they can not be pronounced illegal."

In a leading New Jersey case, decided in 1911, the rule was laid down that a board of health is empowered to prohibit the sale of milk from diseased cows and to this end may adopt recognized and reliable procedures, such as the requirement that the cows be tuberculin tested.[10] "The evidence," said the court, "justified a finding that the subjection of cows from which a supply of milk is derived to the tuberculin test is a reasonable method of determining not only whether they are diseased, but also whether their milk may carry the germs of tuberculosis."

The Eradication of Bovine Tuberculosis

Requirements in state legislation that all dairymen should register their herds or cattle with a state livestock board, which was empowered to make and enforce rules for dairy sanitation and the prevention of disease in cattle;[11] and prohibition of entry of cattle into a state unless accompanied by a certificate showing them to be free from tuberculosis,[12] were upheld by the courts as early as 1899.

Since 1917, when the federal government inaugurated its campaign of cooperation with the states in the eradication of bovine tuberculosis, many state laws have provided for the so-called "area plan" for the control of this disease. These statutes generally authorize boards of county commissioners to appropriate certain sums of money for tuberculin testing by qualified veterinarians when a majority of the cattle owners in the county petition the board for this service. Provision is usually made in the laws for the slaughtering of cattle found to be diseased and the payment of reasonable indemnities for reactors. Part of the fund for indemnities is derived from federal, and part from state, sources.

The constitutionality of a state law of this character was sustained by the Supreme Court of Minnesota in 1925.[13] In an able opinion, this court held that the law was clearly a measure for the protection of the people of the state against disease; that the state could designate counties as the agencies to perform this governmental function, just as it might have designated municipalities or other appropriate areas; that the statute did not violate the principle of equal protection of the laws, even though the total tax imposed was determined by the number of cattle in a county; that the law might have been compulsory rather than permissive and lost nothing in effect by being permissive; and that the petition required was not a delegation of legislative power to cattle owners, since the final decision rested with the county board, a governmental body.

"That tuberculosis is a dangerous, contagious or infectious disease which attacks both human beings and domestic animals," said the court, "that it is prevalent throughout the state among both human beings and domestic animals; and that it is communicated to human beings, especially to children, by milk and other food products from infected animals stands undisputed. The object of the statute is to promote and preserve the public health by providing a means for the control and suppression of this disease among cattle. That it is for a public purpose is beyond question."

These principles were affirmed in a comprehensive decision of the Supreme Court of Iowa in the following year.[14] This court likewise upheld the appraisement of cattle before testing, denied that control of tuberculin by the state department of agriculture created an unlawful monopoly, and sustained a provision of the law making it a misdemeanor for owners in accredited areas to fail to have breeding cattle tested, and authorizing the department in such instances to make the examinations on its own motion.

This opinion, which presents an excellent review of prior decisions on tuberculin testing, was followed in several subsequent cases in this same state,[15] in one of which the rule was stated that even if no provision was made for notice and opportunity to be heard by owners of cattle who had not filed agreements with the secretary of agriculture, the statute was still valid and not in contravention of the constitutional requirements for due process of law.[16] The statute was further construed and upheld by this court in 1930[17] and again in 1932, when it was stated that appraisement of cattle is not a condition precedent to tuberculin testing, and that notice of the day and hour of the proposed testing need not be given.[18]

"Manifestly, from all that has been said and cited," said the court in the Loftus case,[19] "it is evident that a statute permitting the tuberculin test for dairy and beef cattle is within the police power of the state. Such test is not so arbitrary or unreasonable as to permit the courts, under the circumstances, to interfere with the Legislature's prerogative in that regard. Under those circumstances, the legislation can not be declared unconstitutional unless the enforcement of the act is so arbitrary and unreasonable as to deny the appellees due process of law."

Similar legislation was sustained as valid by the Supreme Court of Nebraska in 1927, although one section of the law, providing that where the area plan had already been adopted the work might be continued without further petition if 60 per cent or more of the herds already had been tested, was held void on the technical grounds that the subject matter was not covered in the title of the act, as required by the state constitution.[20] In the following year, however, this court decided that a provision of a later act authorizing continuance of the area plan without petition where more than 5,000 cattle had been tested, was valid and constitutional;[21] and in 1930 it adjudged that there was no unlawful discrimination because a distinction was made between breeding and feeding cattle, with exemption for the latter.[22] These opinions were affirmed in 1931.[23]

An order issued by the state commissioner of farms and markets pursuant to law, quarantining a dairyman's premises for refusal to submit his cattle to the tuberculin test, was found to be constitutional by the New York Court of Appeals in 1928.[24] Here, a township had been designated as the area for tuberculosis eradication, and 90 per cent of the herds in the township had been tested. "Small use," said the then Chief Justice Cardozo, now a member of the United States Supreme Court, "would there be in stimulating the many within a township to a care of the public health, if one or a few wiseacres or obstructionists could make the labor vain."

A statute authorizing county commissioners to make appropriations for the eradication of tuberculosis has been sustained as valid by the Supreme Court of Ohio,[25] which has also upheld the validity of the tuberculin test.[26] A Federal Circuit Court of Appeals in Ohio refused, however, to affirm the conviction of a dairyman for forcibly resisting the tuberculin testing of his cattle by an inspector of the United States Bureau of Animal Industry when it was not shown that his cattle were involved in interstate commerce.[27] The making of the test in this instance was solely a matter within the domain of the police power of the state, and the federal officer had no authority or right to interfere.

The Bovine Tuberculosis Eradication Act of Illinois has been upheld in its entirety in several recent cases.[28]

Destruction of Diseased Cattle

Cattle afflicted with a dangerous and contagious disease were and are public nuisances under the common law. Under the police power of the states, such cattle are nuisances and may be summarily seized and destroyed by health officials or other public authorities, without compensation to their owners. The police power, the United States Supreme Court has declared, "is universally conceded to include everything essential to the public safety, health and morals, and to justify the destruction or abatement, by summary proceedings, of whatever may be a public nuisance. Under this power it has been held that the state may order the destruction of a house falling to decay or otherwise endangering the lives of passers-by; the demolition of such as are in the path of a conflagration; the slaughter of diseased cattle; the destruction of decayed or unwholesome food; . . ." [29]

Cattle shown by the tuberculin test or by physical examination to be afflicted with tuberculosis may be destroyed or ordered destroyed as a public health measure.[30] The state may, under the police power, require such destruction of diseased cattle without payment, but where statutes provide, as is customary, for compensation to the owners of cattle slaughtered in accordance with the terms of tuberculosis eradication laws, such payment is valid.[31] Where a county pays one-half of the indemnity value of a cow and the owner later sells the carcass to a packing company, the county can not collect this latter amount from the owner.[32]

"In providing measures for the protection of public health," asserted the Supreme Court of Ohio in a recent case, "the destruction or summary abatement of public nuisances inimical to the public health may be ordered. Unwholesome food may be destroyed; diseased cattle may be slaughtered. Such action is not a taking of private property for public use. If the state were to requisition cattle for the use of its armies in the field, that would constitute a taking of private property for public use; but the destruction of diseased cattle is merely the abatement of a public nuisance. Hence statutes providing for summary destruction of diseased animals are not unconstitutional." [33]

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Discussion

Dr. Tobey: That happens to be the end of my oration, but in the course of this fairly brief paper there are some thirty-five references to court decisions, fully documented, which you will find in the printed report, and also in my newest book, "The Legal Aspects of Milk Control."

And let me add as a word of warning to health officials and milk inspectors, that while these principles that I have set forth are all good law, any inspector or health official who destroys property acts at his peril, that is, he must be able to prove in court if necessary that the destruction was a reasonable action on his part. If he has made a serious mistake of judgment or has acted in an arbitrary, oppressive or unreasonable manner, or in a malicious or imperious manner, and has destroyed property which is not a public nuisance, he may find himself liable for damages and he may find a judgment ordered against him. In view of the huge salaries customarily paid to milk inspectors, health officials, veterinarians in public health and others, such a judgment might be something of a hardship. This legal principle is, therefore, one that it is well to bear in mind.

In the actions of health officials that have been invalidated by the courts the judgments that have been awarded amount to a very considerable sum of money. All of your legitimate activities will always be upheld by the courts, and they will be liberal in doing it; they will, in fact, lean over backward in doing it, but arbitrary and oppressive and improper actions are certain to cause trouble.

Secretary Brooks: I would like, first, to commend Dr. Tobey on the work that he has been doing for many years in keeping us in touch with court decisions and legal principles, and then I would like to emphasize the importance of health officials keeping within their jurisdiction. We have in our Public Health Law in New York State a provision, the essence of which is that a health officer can not be sued for damages for any act in the performance of his duty. There are certain reservations which I do not recall. Since that was put in there we have been advised by our legal counsel that it really does not change the principle of the law at all. The fact is that a health officer, as Dr. Tobey said, may be sued if he is unreasonable or arbitrary, but more than that he may be sued if he exceeds his jurisdiction and anyone is damaged by his action. That is true of any government agent, and it is important to keep in mind, because I find health officers—and sometimes milk inspectors—are not always clear as to just where their jurisdiction stops and they are all the time doing things that are in excess of their jurisdiction. Usually they are lucky and nothing happens.

Dr. Hardenbergh: Mr. President, Dr. Tobey's able summary dovetails quite nicely with a part of the report on communicable diseases that will be given tonight. In speaking of the area testing it may be well to mention at this time that the extent of that work covers, up to date, forty-one states that are modified accredited areas. I believe the forty-second state will be accredited tomorrow and that will leave only six states in the Union in which the extent of bovine tuberculosis has not been reduced to one-half of one per cent or below. I think it is quite a commentary on the work that has been done in the last twenty years under the area plan.

BACTERICIDAL PROPERTY OF MILK

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YOUR President asked me to tell you something about the normal inhibitory or bacteriostatic substance present in milk. Since so little is really known about the nature of this complex mechanism, I shall confine my remarks to a review of the literature and cite certain experiments which illustrate without question that such a substance does exist in normal freshly drawn milk.

In this communication I have gathered my data from papers published either jointly or individually by Jones, Simms, and Little.[1, 2, 3, 4, 5, 6] The experiments and portions of the discussion are submitted as originally published.

In 1890 Fokker[7] reported that when freshly drawn goat's milk was inoculated with ordinary milk-souring organisms, it failed to curdle for long periods. If a sterilized sample was inoculated in a similar manner the milk soured promptly. Later Hesse[8] and Heineman[9] found that raw milk was capable of inhibiting the growth of certain bacteria for varying periods. Following these original observations which indicated that freshly drawn milk possessed an inhibitory principle, many investigators attempted to learn more about the true nature of this peculiar substance. Stocking[10] was of the opinion that the inhibition resulted from the failure of the organism to utilize milk as a food. Rosenau and McCoy[11] reported that the inhibitory substance in milk was comparable to a weakly bactericidal blood serum, since the bacteria were clumped thus reducing the count. The results of their experiments indicated that phagocytosis was not associated with the reaction. The results of the studies of Chambers[12] and Jones and Little[1] failed to show any correlation between agglutination and inhibition. Hanssen[13] later suggested that the inhibitory effect was due to oxidizing enzymes in the milk which probably reached the udder through the blood stream. When the milk from the same cows was examined during the pasture season it was found to be more effective than in the winter. This theory was not accepted by Drewes,[14] for he found that there existed no correlation between the inhibitory action and peroxidase. Brundy[15] did not agree with the interpretation of Rosenau and McCoy,[11] but regarded the reaction as a complement amboceptor complex,—a natural immune substance. Meier[16] was of the opinion that the inhibitory substance originated in the udder and that its function was primarily protective. Jones and Little,[1] in their studies, arrived at the same conclusion, suggesting that the function of this special mechanism in the udder was to inhibit the growth of bacteria within the gland. They found that the bactericidal substance of aseptically drawn fresh milk, when tested against a non-hemolytic udder streptococcus, curtailed the multiplication of streptococci from 4 to 8 hours. The inhibitory effect was the same for skim as for whole milk. The bactericidal substance resisted heating to 62°C., whereas heating to 80°C. for 20 minutes or boiling for 5 minutes completely destroyed the inhibitory principle. Their results indicated that the bactericidal substance in the blood was more thermolable and thus differed from the bactericidal substance in milk. In contradistinction to the findings of Rosenau and McCoy, the absence of clumping on microscopic examination of incubated samples showed that the inhibitory principle was not similar to a bactericidal blood serum. In the examination of the milk from various cows it was found that the amount of the inhibi-

tory substance varied in its concentration in the udders of different individuals and occasionally a marked quarter variation of the same udder was recognized. The bactericidal substance was not associated with fat or casein.

Later Jones [4] reported that the scarlet fever streptococcus was more susceptible to the inhibitory action of milk than the mastitis streptococcus. When the same culture was inoculated in boiled milk the streptococci grew with undiminished vigor. With a 1:20 or 1:25 dilution of milk the growth of the organisms was completely suppressed or only a small number of non-hemolytic colonies developed. However, as the amount of milk is decreased the colonies become larger and their hemolytic zones appear but never approach the same size as when plated in milk-free medium. In 1929 Jones and Simms [5] stated that the sudden beginning of growth at the end of the lag phase (4 to 8 hours) resulted from the adaptation of the streptococci to the inhibitory substance. Bacteria surviving the lag phase when placed in fresh milk grew rapidly. Samples of the incubated milk with the addition of the original culture inhibited the growth for about four hours, indicating that the inhibitory factor had not been completely utilized during the first incubation period. In another paper [6] they called the inhibitory principle "Lactenin" and found that it was not associated with salts and carbohydrates. Agents which precipitated the proteins of whey also removed the bacteriostatic substance from the milk. Following dialysis, the material could be completely desiccated and kept three months without loss of activity. Christiansen [17] was of the opinion that the growth inhibitory factor was closely associated with milk fat. When milk under sterile conditions was added to agar or serum agar, streptococci generally failed to multiply rapidly. If portions of the same milk were heated to 80-100°C. before inoculation no inhibition was manifested. In experiments where skim milk was used no inhibition was demonstrable. The centrifuged fat, however, from this same milk dispersed in physiological saline had a marked inhibitory action. This conception of Christiansen's was contrary to the findings of Jones and Little[1] who had already reported that skim milk was as effective as whole milk. Steck[18] in 1930 carefully reviewed the literature concerning the inhibitory principle in milk, and concluded that the nature of the bactericidal substance was not clearly understood. His experiments showed that the inhibitory substance in milk was more potent against its own homologous organisms than against similar foreign varieties.

Experimental

Methods

In nearly all experiments the same technique was used in determining the presence of the inhibitory substance in milk. Generally the middle milk was used. It was collected aseptically into sterile bottles and chilled immediately. The chilled milk was next centrifuged and a portion between the cream line and sediment withdrawn and heated at 58°C. for twenty minutes to destroy any saprophytic bacteria. Occasionally unheated milk was used, with the same result. The milk was then distributed in one cc. amounts into sterile agglutination tubes containing a glass bead. For control purposes a sample of boiled milk was handled in the same way. Each tube received a standardized loop of an eighteen-hour broth culture of mastitis streptococcus diluted 100 or 200 times in broth. Throughout the experiment each tube was immediately shaken and agitated each half hour thereafter. At various intervals the contents of the tubes were removed and plated with 12 cc. veal infusion agar. After twenty-four hours incubation the plate colonies were counted.

In the first experiment as illustrated in Table 1 the results of the bactericidal activity of both milk from a resistant cow, No. 1, and from a young cow, No. 9, early in the first lactation are given.

Table 1

THE BACTERICIDAL ACTIVITY OF THE MILK OF A RESISTANT COW AND OF A YOUNG COW EARLY IN ITS FIRST LACTATION PERIOD

	STREPTOCOCCI PRESENT				
	At once	After 2 hours	After 4 hours	After 6 hours	After 8 hours
Milk of resistant Cow 1	5,200	4,392	4,928	4,608	12,608
Boiled milk of Cow 1	5,000	48,900	Innumerable	Innumerable	Innumerable
Milk of young Cow 9, early in first lactation period	5,356	4,492	4,262	6,220	22,464
Boiled milk of Cow 9	5,068	36,990	Innumerable	Innumerable	Innumerable

From Table 1 it is clear that the inhibitory substance may be about as active in the milk of a young cow early in her first lactation period as it is in the secretions of an old cow which has passed through several lactation periods.

It seems logical to assume that the amount of the inhibitory principle would be relatively uniform in the secretion from the various quarters. That this is not altogether true is evident from the next experiment.

Experiment 2

The milk from each quarter of two cows was drawn into separate bottles. It was chilled, centrifuged to free it from fat, and heated at 60°C. for twenty minutes, then distributed and inoculated with 1:200 dilution of broth culture. Plate cultures were prepared as usual and the colonies counted after suitable inoculation. The results are given in Table 2.

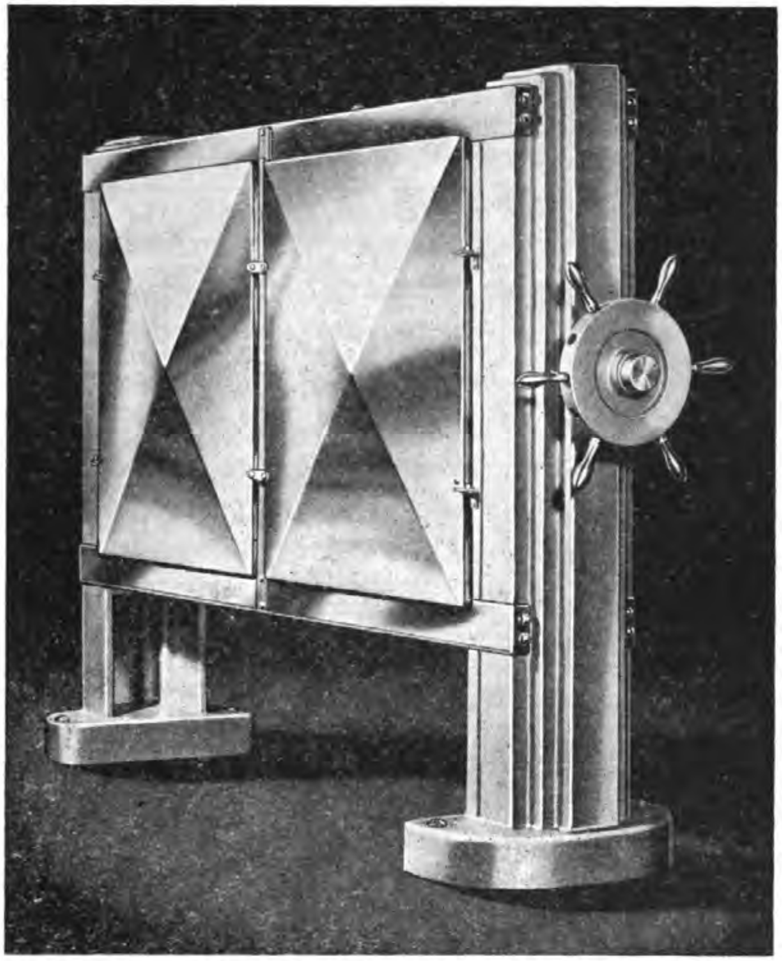

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Table 2

THE EFFECT OF MILK FROM VARIOUS QUARTERS ON THE GROWTH OF THE MASTITIS STREPTOCOCCUS

	STREPTOCOCCI PRESENT				
	At once	After 2 hours	After 4 hours	After 6 hours	After 8 hours
Cow 82 Right fore quarter	576	704	704	1,152	37,440
Left " "	704	768	640	1,792	57,600
Right hind "	640	512	768	576	15,552
Left " "	640	640	5,632	Innumer-able	Innumer-able
" 07 Right fore "	704	704	768	1,600	72,000
Left " "	576	704	2,112	14,400	Innumer-able
Right hind "	704	576	1,088	3,136	86,400
Left " "	576	576	2,048	57,600	Innumer-able
All samples combined and boiled	640	5,312	115,200	Innumer-able	Innumer-able

From the evidence submitted in Table 2 it is clear that the concentration of the inhibitory substance in the secretion from various quarters varies considerably. In the right hind quarter of Cow 82 the milk completely inhibited growth during the first six hours and considerable inhibition was noted during eight hours. The milk from the left hind quarter inhibited during the first two hours but not thereafter. That from the other quarters was more efficient in this regard but not equal to that obtained from the right hind quarter. Much the same reaction was encountered in the milk from Cow 07. The milk from the right fore quarter of this cow inhibited growth much better than the secretions from the other three.

In an experiment by Jones [4] it was shown that fresh milk heated at 58°C. for twenty minutes actually prevented multiplication of scarlet fever streptococci during incubation periods ranging from two to forty-eight hours.

Experiment 3

Milk from five cows chosen at random was mixed and freed of fat by centrifugation. A portion was heated at 58°C. for twenty minutes and the remainder boiled for five minutes. Both lots were distributed into sterile agglutination tubes in amounts of one cc. The tubes were then separated into two groups each containing an equal number of tubes of the pasteurized and the boiled milk. Each tube of one group was inoculated with one loop of Strain F.C. diluted 500 times in broth. Those of the other group received a similar inoculation from scarlet fever 55. Plate cultures were made by adding 0.25 cc. of milk to uniform amounts of blood and agar. Initial plates were poured and others after various intervals of incubation. The results of this experiment are recorded in Table 3.

While there is some irregularity in the results recorded in Table 3 the influence of the milk is evident. It would appear that the milk probably destroyed both strains of streptococci after an interval of four to six hours. Here again the same cultures grew with great vigor in the boiled milk.

The presence of inflammatory products in the secretion frequently eliminates the protective influence of the milk. A comparison of the effect of the inhibitory substance in normal and mastitis milk from the quarters of the same cow is presented in cut on page ——. A cow suffered from staphylococcus infection of the left hind quarter. The milk from the other quarters did not contain the organism. When milk from the left hind quarter was heated at 58°C. for twenty minutes and three cc. of it plated with ten cc. of melted veal-infusion agar inoculated with about 1,000 staphylococci, optimum growth after suitable incubation was obtained (Fig. 1). When three cc. of the milk from the other three quarters was plated in veal-infusion agar inoculated with a similar

Table 3

THE EFFECT OF UNDILUTED MILK ON THE SCARLET FEVER STREPTOCOCCUS

Culture	Milk	COLONIES DEVELOPING IN PLATE CULTURES CONTAINING 0.25 CC. MILK						
		At once	After 2 hours	After 4 hours	After 6 hours	After 8 hours	After 24 hours	After 48 hours
F. C.	Heated 58° C.	No growth	243 Visible X 12	256 Visible X 12	No growth	No growth	No growth	No growth. Reaction pH 6.6
F. C.	Boiled	409	4,708 Whole plate hemo-lyzed	72,000	Innum-erable	Innum-erable	Innum-erable	Coagu-lates on boiling. pH 5.2
Scarlet Fever 55	Heated 58° C.	384	154 Visible X 12, non-he-molytic	No growth	No growth	No growth	No growth	No growth pH 6.6
Scarlet Fever 55	Boiled	512	7,488	86,400	Innum-erable	Innum-erable	Innum-erable	Coagu-lates on boiling pH 5.4

number of staphylococci, complete inhibition resulted (Fig. 2). When one cc. of milk from the infected quarter was mixed with two or three cc. of the other milk and then plated, no inhibition occurred (Fig. 3). In another series of experiments, when the milk from normal quarters was mixed with cow's blood (serum one cc., milk three cc.), it lost its inhibitory property (Fig. 4).

From the evidence submitted on the cut it is clear that the milk from the normal quarters completely inhibited growth, while the secretion from the infected quarter was ineffective. When the altered secretion from the left hind quarter was mixed with the normal milk no inhibition occurred. The milk lost its inhibitory action with the addition of normal cow serum.

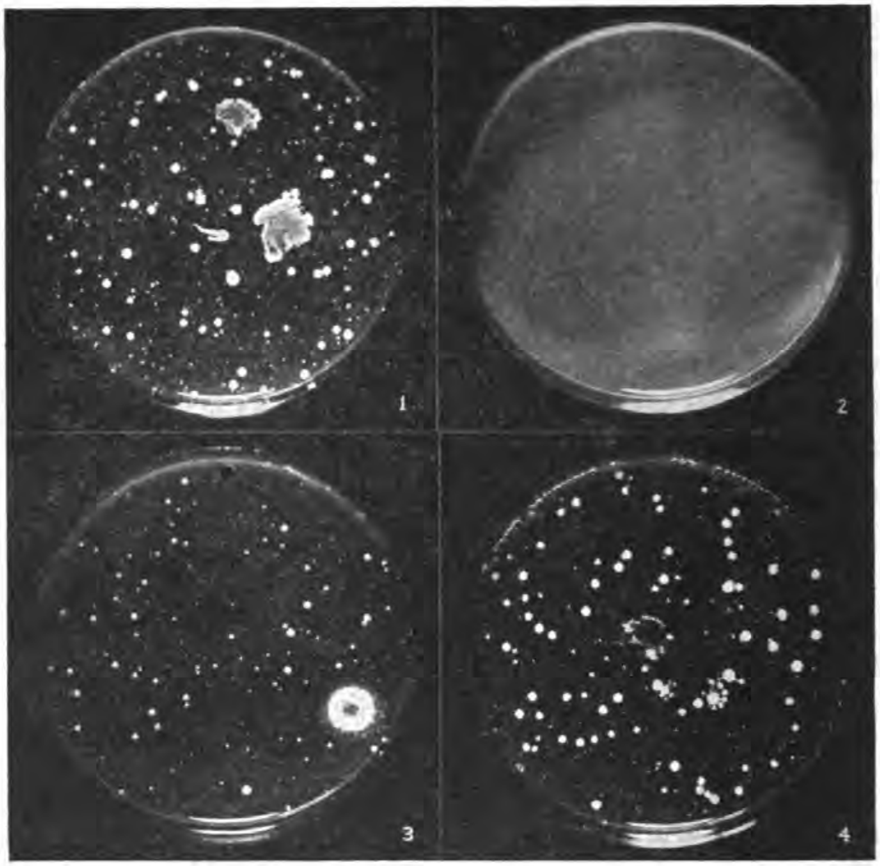
Summary

It is apparent that there is present in the milk of all cows examined by us a substance which will inhibit the growth of mastitis streptococci for a definite period. It is an inherent factor, for the milk from young cows early in their first lactation period contains about the same amount of the substance as the milk from older cows. The concentration of the inhibitory principle varies in the secretions of different animals and occasionally in the quarters of the same udder.

Although we have no data bearing directly on the origin of the substance, by inference it seems possible to localize its course. Rosenau's contention that the diminution is due to agglutination is probably true for the organisms he tested. Our technique seems to rule out agglutinin, especially in view of the microorganisms employed. The blood contains only weak agglutinin for the streptococcus which is not easily agglutinated, and clumps could not be detected on microscopic examination of the milk.

If the substance is of blood origin the inhibitory substance should be greatly increased in the whey since with

A COMPARISON OF THE EFFECT OF THE INHIBITORY SUBSTANCE IN NORMAL AND MASTITIS MILK FROM THE QUARTERS OF THE SAME COW



EXPLANATION

Fig. 1. Petri dish containing three cc. of mastitis milk, heated at 58°C. for twenty minutes, and incubated for twenty-four hours with ten cc. of veal-infusion agar to which approximately 1,000 staphylococci had been added.

Fig. 2. Petri dish containing three cc. of mixed milk from three normal quarters, heated at 58°C. for twenty minutes, and incubated for twenty-four hours with ten cc. of veal-infusion agar to which approximately 1,000 staphylococci had been added.

Fig. 3. Petri dish containing one cc. of mastitis milk mixed with two or three cc. of milk from normal quarters, heated at 58°C. for twenty minutes, and incubated for twenty-four hours with ten cc. of veal-infusion agar to which approximately 1,000 staphylococci had been added.

Fig. 4. Petri dish containing one cc. of fresh, normal cow serum mixed with three cc. of milk from normal quarters, heated at 58°C. for twenty minutes, and incubated for twenty-four hours with ten cc. of veal-infusion agar to which approximately 1,000 staphylococci had been added.

rennet coagulation there is considerable concentration of the blood proteins, as shown by serum precipitin tests of the whey.

The view that the substance is alexin from the blood is not supported by our observations. In the normal udder there is only a slight interchange of blood proteins from the circulation to the milk and the concentration is too low to be a deciding factor. Furthermore, the bactericidal substance in milk is more thermostabile than alexin and, unlike alexin, when once its activity is impaired by heat it can not be reactivated by active milk. The chemical analysis of milk indicates that the bacterial growth inhibiting substance is removed by agents which precipitate the proteins of whey. Following tryptic digestion the resulting split products may be removed with the salts and sugar by dialysis. When such a solution is completely desiccated the dried material still possesses a marked activity.

The reaction of the inhibitory substance in milk is very effective when streptococci of the scarlet fever type are used to test its potency. When the streptococci are plated in veal-infusion blood agar with undiluted milk a complete inhibition of growth is shown. As the milk is diluted with the addition of approximately the same number of organisms colonies appear which resemble colonies of non-hemolytic streptococci. In the higher dilutions small hemolytic zones develop comparable in size to the zones produced in blood agar by hemolytic mastitis streptococci of the udder variety.

From the results of our observations, as well as the reports of other workers, it appears that the inhibitory substance is produced in the udder and that its function is primarily a natural means of restraining the growth of bacteria in the udder. Whether or not such a substance under the present conditions of dairying may be regarded as of much value in protecting the udder against the rapid multiplication of bacteria which have gained entrance to the gland is open to question. However, under the most favorable conditions, it is possible that a few organisms which have recently gained access to the udder might be prevented from multiplying until they are flushed out at the next milking. It may be that the substance is more potent than we suspect, since many opportunities are available for the entrance of bacteria into the teat canal although, in the main, the flora of the udder is limited to relatively few species and these species have become well adapted to the environment and to the inhibitory influence of this substance.

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Discussion

Dr. Harding: Did I correctly understand that Dr. Little's conclusion was that there was a general bacterial inhibiting substance present in the udder which operated against bacteria of all kinds?

Dr. Little: In our studies we have employed nonhemolytic mastitis streptococci and known cultural strains of scarlet fever streptococci. Therefore we have no data in regard to the potency of the inhibitory substance for other bacteria. As I have already mentioned, we know very little about the complex nature of this mechanism, present in the udder. However, we do have sufficient experimental evidence to indicate that such a substance is present in normal freshly drawn milk. From the results of our experiments we assume that the function of the inhibitory principle in milk is primarily for the protection of the gland from bacterial invasion.

Dr. Harding: I gathered from your data, as I saw it, that there were two different cultures tested on the milk of two different cows or four different cows.

Dr. Little: In our hands the most satisfactory method in determining the potency of the inhibitory substance is to inoculate properly prepared freshly drawn milk with a given number of scarlet fever streptococci. In Table 3 one culture, designated as F.C., was obtained from the New Jersey State Board of Health. The strain was isolated from the throat of a milk handler during a scarlet fever outbreak in which milk was responsible for the infection. The other culture was obtained from Dr. Park.

You may recall that previously I reviewed the experimental work of Steck in which he reported that milk was more potent against its own homologous organisms.

In the examination of the milk from a hundred cows one would be apt to find a great variation in the concentration of the inhibitory principle in the secretions from the udders of different individuals. It may be possible that cows with a low concentration of the inhibitory substance in their milk are more susceptible to mastitis. On the other hand, in experimental mastitis, if one could measure quantitatively the concentration of the bacteriostatic substance in the milk, it might be possible to determine with some degree of accuracy the susceptibility of each quarter of the udder.

Dr. Harding: About 1916 Dr. W. H. Chambers, who is now connected with Cornell Medical School at New York City, was my assistant and made a study bearing on this question of germicidal action of cows. We had about a hundred milch cows. We did not work with all of these cows, but with a good many of them the work went on about a year. The gist of the thing, if you put it simply, seemed to be this:

Individual cows gave milk which was inhibitory to the growth of individual organisms or strains present in their own udders. Some of the organisms which we isolated from certain udders were sharply inhibited by the milk from the udders from whence they came but were not so checked by the milk from udders in which they were not found. If there is any rule to be deduced from this, it was that cows acquire an immunity toward the growth of certain strains which occur in their own udders. Lactic germs rarely, if ever, are found in udders and I think no students have recognized germicidal action toward such germs.

THE PRESENT STATUS OF MILKBORNE DISEASES *

I

IN 1935, health officers in the United States and Canada reported forty-five epidemics of disease carried by milk and dairy products.[1, 2]

Table 1
MILKBORNE EPIDEMICS, 1935

	No. of Epidemics	No. of Cases	No. of Deaths
United States:			
Typhoid fever	16	172	14
Paratyphoid fever	2	50	0
Scarlet fever	2	65	0
Septic sore throat	9	1000	7
Food poisoning	6	139	0
Gastroenteritis	7	272	0
Dysentery	1	131	0
Total—United States	43	1829	21
Canada:			
Typhoid fever	1	13	0
Undulant fever	1	4	0
Total—Canada	2	17	0
Grand total—United States and Canada	45	1846	21

Typhoid fever and septic sore throat were responsible for 58 per cent of the epidemics, 64 per cent of the cases reported and all of the deaths.

The following dairy products were reported to be involved:

The communities in which milkborne diseases were reported in 1935 were, for the most part, small. Twenty-seven outbreaks were in towns of less than 5,000 population; ten in communities of from 5,000 to 25,000; four in cities of 25,000 to 50,000 and two in cities of more than 100,000 population.

* Report of Committee on Communicable Diseases Affecting Man.

In addition to the foregoing, there were 1936 cases of undulant fever reported in the United States; the number of these that were milkborne is undetermined. In Canada, an additional 124 cases of undulant fever were

Table 2

TYPES OF MILK SUPPLY INVOLVED

United States:	
Raw milk	32 times
Pasteurized milk (*)	4 "
Both raw and pasteurized milk	1 "
Ice cream "raw"	2 "
Cheese	2 "
Cream cheese	1 "
Sweet milk and ice cream	1 "
	43 times
Canada:	
Raw milk	2 times
Total	45 times

reported, a large percentage of which were traced to ingestion of milk from herds containing animals affected with Bang's disease, others to direct contact with infected cattle and a few to "camp butter."

II

THE TREND OF MILKBORNE DISEASES

The figures on milkborne outbreaks of disease in recent years show no definite trend. No significant or consistent change in the number of epidemics and number of cases reported is discernible in the data for the United States on milkborne disease since 1923 as given in Table 3. However, since 1928 when deaths reached a high point of 120, the number of deaths reported each year have tended to decline and for the past five years have averaged less than one per epidemic whereas prior to that time, the ratio of deaths to epidemics was 1.3 to 1.

* In connection with these four outbreaks associated with pasteurized milk supplies, it may be noted that, in two instances, the state health departments reported that some of the milk was consumed raw and, in two instances, that the supplies were improperly pasteurized.

In the consideration of these data, which by themselves seem, and are indeed, important, reflecting a condition in which there is much need for improvement, it should be borne in mind, nevertheless, that cases of disease and deaths due to milkborne infections represent an extremely

Table 3

SUMMARY OF MILKBORNE EPIDEMICS—UNITED STATES

1923—1935

Year	Epidemics	Cases	Deaths
1923	23	834	37
1924	44	1,552	67
1925	44	1,739	56
1926	68	3,364	94
1927	36	954	41
1928	47	2,196	120
1929	51	2,332	53
1930	48	1,968	56
1931	34	1,398	24
1932	33	642	28
1933	48	1,426	40
1934	45	1,787	42
1935	43	1,829	21

small percentage of the total morbidity and mortality traceable to any given disease. Therefore, this phase of milk in relation to the public health should not receive disproportionate emphasis.

III

SAFEGUARDING MILK SUPPLIES DURING FLOODS

Disasters such as the floods that occurred in some parts of the country early this year throw a tremendous burden on health officers, inspectors and milk producers and distributors in maintaining milk supplies that are adequate and safe. During the devastating floods of last spring, all these agencies performed noteworthy services in the affected areas and the steps taken to safeguard those milk supplies should be recorded. Accordingly, the procedures adopted in two of the badly affected states are summarized below.

From Ralph E. Irwin, Dairy Plant Engineer, Bureau of Milk Sanitation, Harrisburg, Pennsylvania[3]:

"The Johnstown section of Pennsylvania had practically its entire pasteurized milk supply cut off by the flood. Johnstown and vicinity is supplied by six pasteurizing plants and seven raw milk distributors. Three of the pasteurizing plants are located in the downtown section of Johnstown and the entire first floor of each was under water. These three plants furnished about 95% of the pasteurized milk, the other three plants being small suburban plants. The City Health authorities prohibited the sale of raw milk in Johnstown during the period that the district was under relief supervision.

"Two plants did not start operating for about ten days after the flood. As soon as the flood occurred these two plants transferred their bottles and cases to a plant in Somerset of sufficient size to take care of their entire milk supply. The raw milk supply for these two plants was transferred to the Somerset plant. The distributing equipment of these two plants was only slightly damaged by the flood and thus distribution was carried on as usual so far as these two plants were concerned.

"The third plant had pasteurizing equipment on the second floor and was able to operate within 24 hours after the flood. The three small plants outside of the city continued as usual.

"I give an outline of existing conditions to explain the action taken by this Department. When I was ordered to Johnstown to supervise the public milk supply in the flooded area, I was given sufficient assistance to cover the plants. Since the raw milk was not allowed to be sold, it was diverted to the small pasteurizing plants and sold as pasteurized milk. One man was placed in charge of the three small plants. He so arranged his schedule of milk treatment that he was present when bottles were washed, when the pasteurizing equipment was placed in service and during the treatment of milk. An officer of this Department was placed in each downtown plant and an officer in the plant treating milk in Somerset. We centered our supervision upon the sterilization of bottles, the sterilization of equipment before milk was treated and the treatment of the milk. In this way we could guarantee a safe bottle of milk. In the meantime, the plants were being placed in condition. All machinery had to be taken apart, including motors; walls and floors were repaired and everything in general thoroughly cleansed. Motor driven compressors were difficult to place in service and this delayed the operation of the plants.

"The basic requirements for safety in a pasteurized milk supply are few and simple, as indicated above, and it is possible for one Health Official to supervise these operations in a large plant. We required a recording thermometer on the bottle washer, each pasteurizing vat, the cooler outlet and one filler valve in order to show the temperature used in sterilization. For this purpose hot water was used. Of course, we had the usual record of pasteurization. Other milk supplies throughout flooded areas were handled in a similar manner and apparently our procedure was satisfactory as no milkborne outbreaks occurred."

From E. G. Woodward, State Dairy and Food Commissioner, Hartford, Connecticut[4]:

"During the recent flood the Dairy and Food Commission did its best to safeguard the healthfulness of the milk supply in the flood area by concentrating the work of the milk inspectors on the flood area. These inspectors took lists of all producers who retailed their milk and visited their premises. Provisions were promptly made for the chlorination of all water supplies used in the washing of bottles and utensils and, in those cases where the premises were in such condition as to warrant the pasteurization of the milk supply, provisions were made by the inspectors for the pasteurization of these supplies by pasteurization plants nearest.

"In the case of milk pasteurization plants, the inspectors kept in close touch with the work of each, and gave assistance in arranging for plants outside of the flood area to take over the pasteurization of supplies for those plants in the flood area which had to close on account of lack of power or flooded conditions. Complete cooperation was evidenced by pasteurization plants outside of the flooded area in this work.

"Unpasteurized milk under pasteurized labels was put out for one day by two dairies which had found it impossible to operate their pasteurization equipment. This fact required a blanket request by radio and through the press to the people of Hartford to boil their milk for that particular day.

"No outbreak of disease of any sort was traceable to milk contamination."

It is notable that in neither of these states did any disease develop traceable to contaminated milk, in spite of the very serious effects of the flood on milk plants. This is an excellent demonstration of effective supervision, and of cooperation between the health departments and milk distributors concerned.

IV

Bacterial Spores in Milk

Interest in the subject of bacterial spores in milk revives periodically. There is much difference of opinion whether these spore-formers, to the extent to which they commonly occur in milk, are harmful or not to infants and children and to other milk consumers.

Spore-bearing bacteria are frequently, perhaps even constantly, present in milk and are either aerobic or anaerobic. The aerobic spore-bearers are of the proteus, hay bacillus and similar groups. Bacilli of the hay bacillus group are common on hay, fodder and in manure. Their entrance into milk is, therefore, readily explained. It is also probable, as suggested by one member of the Committee, that there may be building-up of spore formers when sterilization of dairy equipment is not as complete and thorough as it should be.

Some anaerobic spore-formers are usually present in milk also; these include some types which cause abnormal fermentations in milk while the action of others is to digest the casein. In addition, such anaerobes as *Cl. welchii* and *Cl. sporogenes* are not infrequently encountered. Under suitable conditions, many of the spore-formers, especially anaerobes, may form toxins that are definitely injurious especially to the digestive tracts of infants. The question arises, however, do such conditions, favorable to the propagation of anaerobic spore-formers with subsequent toxin production, ever occur in milk as it is commonly handled for fluid consumption? It seems extremely unlikely that such could be the case.

However, the sources of spore-formers either aerobic or anaerobic are in such materials as dirt, dust, stable bedding, manure, feeds and dirty dairy equipment and, therefore, their presence in milk in appreciable numbers indicates faulty methods of production and handling. Seldom, if ever, are they found in the cow's udder. Tests for anaerobic spore-formers or fermenters causing "stormy fermentation" are employed in a few milk control laboratories but these procedures are seldom routine. On the basis of our present knowledge, and in view of the way in which fluid milk supplies are handled with little opportunity for growth and toxin production by spore-formers, it would seem unwise to attribute diarrheas, dysenteries and other intestinal upsets of infants to spore-contaminated milk until more data are available. It is hoped that further research work will be done that will serve to throw more light on this subject.

V

Bovine Tuberculosis Eradication

Once again it is appropriate to call attention to the extent of tuberculosis eradication in cattle. During the past two years, much greater progress has been made in the tuberculin-testing of cattle in the United States than in any other similar period. This was made possible by additional emergency funds used both for operating and indemnity purposes, the project being administered by the Federal Bureau of Animal Industry working in cooperation with the various state livestock sanitary officials.

Twenty years will have elapsed next July since the cooperative, nation-wide campaign was undertaken against bovine tuberculosis and in the interests of the health of humans and the lower animals. In these twenty years, forty of the forty-eight states of the Union have been freed of bovine tubercle infection to the extent that they are "modified accredited areas," areas in which bovine tuberculosis exists in less than ½ per cent of the cattle population. By the time this is presented, one more state—Rhode Island—will have been added to the list, and it is expected that Vermont will be accredited by November 1, 1936.

Of the six remaining states—California, Maryland, New Jersey, New York, Pennsylvania and South Dakota—it is expected that at least two and perhaps more will be added to the list of "clean" areas by the time the twenty years is completed.

According to the most recent data at hand,[5] the approximate degree of tuberculosis among cattle in the whole United States has been reduced to 0.5 per cent. This is to be compared with about 4.0 per cent infection which existed in 1917. The resulting lower incidence of and mortality from bovine tubercle infection in humans has been stated repeatedly and was discussed at some length in this committee's report two years ago.

That another chapter is about to be added to the story of man's fight against the origins of disease is evidenced by the characteristic statement in a recent Health Bulletin of the New Jersey Tuberculosis League, which says,[6] "Cases of tuberculosis traceable to bovine sources have become a rarity in the state's institutions and clinics."

VI

Great progress has been made toward the goal in which we are primarily interested—the development of milk supplies with the greatest possible factors of wholesomeness, safety and nutritional worth. In the continuation of this program, our efforts should be directed to:

1 *Education of the consuming public* to the importance of clean and healthful milk in the diets of individuals of all ages

2 *Education of dairymen* to their responsibility and the importance of their part in producing wholesome milk

3 *Promotion of pasteurization* wherever feasible in order to bring the "greatest protection to the greatest number" of fluid milk consumers. At the same time, we should not be blind to the faults of pasteurization but should work for their correction

4 *Greater attention* to the problem of safeguarding milk supplies in small communities and rural sections

5 *Recognition and encouragement* of the efforts of the dairy industry in building desirable qualities into milk.

such as greater nutritional values, qualities which are influenced by factors that go beyond the strict limits of hygiene and sanitation.

J. G. Hardenbergh, *Chairman*

Paul B. Brooks	F. L. Mickle
Leslie C. Frank	W. D. Dotterrer
Horatio N. Parker	Russell Palmer
A. R. B. Richmond	W. W. Scofield
Ira V. Hiscock	W. A. Shoults

Discussion

Dr. Brooks: An interesting question on which we can only speculate is that as to the possible effect that this eradication of bovine tuberculosis might have, theoretically, on our human tuberculosis death rate. We know that the pulmonary tuberculosis death rate all over the country—and I guess more or less generally over the world—has been declining in the past several years and apparently it has declined just about as much in sections of this country where very little is done systematically to combat it as in the places where they have been doing the most. Nobody has very satisfactorily explained just why that is so. We also know that people who suffer from tubercular infections of bovine origin rarely die from pulmonary tuberculosis.

I came across some interesting data among which was the record of two European cities: in one the milk came from cattle among which the prevalence of bovine tuberculosis was very high, but the pulmonary tuberculosis death rate was relatively very low. That was compared with another city where the milk supply came from cattle in which there was very little tuberculosis and there the pulmonary tuberculosis death rate was relatively very high. That is cited in one of the recognized textbooks, but I can not tell at the moment which one. Anyway, there seems to be considerable evidence suggesting the possibility that the decline in our human death rate from pulmonary tuberculosis may be due in some part to immunity which has arisen from our more or less continuous infection with bovine tubercle organisms.

I feel that that is no argument against the eradication of bovine tuberculosis, because if there is anything in it, eventually somebody will find a way to induce artificial immunity before the time comes when we get so free from bovine tuberculosis that we lose that source of possible immunity—but it is at least interesting.

AN OUTBREAK OF SEPTIC SORE THROAT IN BERGEN COUNTY

William H. MacDonald

Chief, Bureau of Local Health Administration
New Jersey State Department of Health

IN the period of twenty-seven years from 1909 to date, epidemiologists of the New Jersey State Department of Health have investigated fifty-eight disease outbreaks in which the vector of infection was shown to be contaminated milk. Fifty-seven of these were traced to raw milk. The one exception was a typhoid fever outbreak in which a mild case filled and capped bottles of pasteurized milk by hand. This exception occurred twenty years ago before mechanical capping was required.

Typhoid fever, scarlet fever, diphtheria, gastrointestinal disturbances and undulant fever were the diseases ordinarily spread by milk during the first twenty-five years of this period. Not until 1934 did septic sore throat occur as a recognized outbreak in New Jersey and since then we have had three such milkborne epidemics, totaling 325 or more cases and nine deaths. Two of these outbreaks occurred in Flemington in 1934 and 1935 and the third, of which I am to speak, developed in Fairlawn and vicinity, in Bergen county, in April and May of this year.

Lack of Reports Delays Investigation

Septic sore throat is not reportable in New Jersey. For this reason cases in the recent epidemic did not come to official notice until some four weeks had elapsed after the first case became ill. About the middle of May unofficial reports of a number of cases of severe sore throat in western Bergen county began to reach local boards of health and the district office of the State Health Department. At this time also a few deaths occurred and physicians, alarmed over the severity of the cases, called the situation to the attention of health officials.

Investigation was started at once and so extensive did the study become that within a few days, the State Department of Health put six specialists in the field to assist local health officers and to correlate the assembled data and take suitable action. This study revealed that 175 cases or more had occurred in the seven adjacent municipalities of Fairlawn, East Paterson, Garfield, Rochelle Park, Paramus and Saddle River township. Seven of the patients died. Practically all the cases had used raw milk, produced and distributed by a local dairy, which proved to be the only common vector of infection.

The first known case began on April 9 and during the month of April, 29 cases developed. In May, cases increased rapidly with peaks on the following days: May 1, ten cases; May 4, twelve cases; May 8 and 10, eleven cases each; and May 15 and 16, nine cases each. These numbers are approximate, you will understand, because undoubtedly some cases occurred of which we have no knowledge. Few cases became ill on May 3, six or twelve. A possible reason for these peaks and valleys will be mentioned later.

The disease in many instances was severe and was marked by enlargement of the lymphatic glands of the neck which became extremely painful. This characteristic made it relatively easy to distinguish the typical cases from other types of sore throat existing in the vicinity. This glandular enlargement usually took place promptly with the first symptom, was present even when the throat was not very sore and was the symptom best remembered by recovered cases. The complications usually found in septic sore throat epidemics were present also, including erysipelas, middle ear disease, rheumatism and suppurating glands.

Adults were affected in greater proportion than children. This is no unusual experience in milkborne outbreaks of septic sore throat and scarlet fever. Cases under ten years old numbered twenty-two; from ten to nineteen years of age, twenty-eight cases, and twenty years and over, 119 cases. The age period from twenty to twenty-nine years led with thirty-six cases, followed by the 40-49 year period with twenty-six cases and the 30-39 year group with twenty-five cases.

Many cases received no medical attention. Consequently, lists of patients furnished by local doctors could be used only as starting points in the investigation. When a case history had been obtained, the family was asked if other cases had occurred in the neighborhood or among relatives or friends. In this way the lists grew rapidly. To show how effective this method may be in finding cases, the original list of about twenty cases was increased to forty-five by two men in one afternoon. The following day it increased to ninety and the third day, with more men in the field, 160 cases were on record.

Doubtless the investigation would have been more rapid and might have been more complete if a list of the milk customers had been secured and these families canvassed after it was established that milk was at fault. This method is open to many objections, however, and was not followed.

As soon as milk was definitely established as the vector of infection, an order prohibiting the further sale of raw milk was served on the distributor. This order is still in effect inasmuch as the State Department of Health is not yet assured that the milk from the herd may be sold with safety in an unpasteurized state.

Relation of Milk to the Outbreak

You will be most interested in the part played by milk, milk handlers and dairy cattle in this serious epidemic. As far as we know, septic sore throat results from an infection of cows' udders with *streptococcus epidemicus*, a hemolytic streptococcus of the human type. Such in-infection probably reaches the cow from the hands of an infected milker. The streptococci, growing in the lower milk ducts, cause a heavy seeding of the milk with these organisms which are pathogenic to man.

If this be true, we would expect to find (1) milkers on the dairy in question suffering from septic sore throat prior to the milkborne outbreak among milk consumers; (2) one or more cows in the herd with evidence of streptococcus infection of the udder; (3) rapid termination of the epidemic as soon as such cows are removed or all the milk from the herd is pasteurized.

Milkers Affected

This is just what the study revealed. Early in April, one of the milkers at the dairy developed septic sore throat. The exact date could not be fixed but on April 12 another milker who roomed with this man and had contracted the disease, became too ill to work and did not milk until April 20. Presumably one or both of these men infected cows in the herd. On May 17, cultures taken from the dairy workers showed the presence of hemolytic streptococci in the throat of a third milker, who gave no history of recent illness. There is no doubt, therefore, that infection existed among milkers prior to the time the epidemic began and continued for some time thereafter.

The Dairy Herd

The herd comprised thirty-five cows, tuberculin tested and of various breeds. The stable and milk room met the requirements of our milk law. Milking was done by hand. This herd produced about 450 quarts of milk a day at the time of the investigation. Of this amount, 275 quarts were distributed raw and the balance was pasteurized at the farm, with equipment and methods approved by the State Health Department.

Under the system followed at the dairy, milk from any cow might be sold raw or might be in the batch to be pasteurized, according to chance. This may account for the slow development of the outbreak and for the fact that on some days many cases were evidently infected and on others, few.

The outbreak subsided suddenly on May 16, before pasteurization of the entire milk supply had been required. From eight or nine cases a day, the prevalence dropped to one case a day. On May 15, the day before this sudden change, a cow with abnormal udder which had been giving milk from two quarters only, was sold to the butcher. Circumstantial evidence points to this cow as the chief source of infection of the milk. Examination of her udder and milk was impossible as she was slaughtered before our investigation began.

The facts just stated should not be taken to mean that this was the only infected cow in the herd. As a matter of fact, physical examinations of the herd by veterinarians of the State Health Department in May, June and August showed four other cows affected with mastitis. Samples of milk taken from each cow in the herd late in June and early in August revealed the presence of hemolytic streptococci in the milk of many of them. The organisms isolated from two of these cows late in June were of the human type.

Pasteurization of the entire supply was demanded on May 21, the day after the intensive study began. Only one case developing after this date, is on record.

Diseases of animals in New Jersey are under the supervision of the State Department of Agriculture. Accordingly, that Department was advised promptly of the existence of the outbreak and of the findings of our veterinarians. It arranged for supervision of the herd by its local representative.

To appreciate the effect of an outbreak of this kind on a community, try to visualize this record of death, suffering, expense of many kinds, an injured milk business, public excitement and fear of milk in general. Is not this added evidence that market milk should be pasteurized as a health measure? Here was a milk supply of 450 quarts a day, alike except that about one-third was pasteurized. The raw portion caused the tragic epidemic described. The 175 quarts that had been pasteurized proved to be harmless. This was not so on one day only, but for a period of a month and a half. What better evidence could one ask of the value of pasteurization of milk as a means of health protection?

"When Writing Mention This Report"

REPORT OF COMMITTEE ON MILK PLANT EQUIPMENT

IN previous reports the committee has stressed the importance of reaching an understanding as to the essential public health requirements for the construction of milk plant equipment and has suggested the preparation of a manual. It appears to be rather difficult for a volunteer committee of this kind with membership scattered geographically, especially when attempting to work in cooperation with similar committees of volunteers from the manufacturers and the dealers organizations similarly scattered, to carry on this work satisfactorily. It remains to be seen whether or not this can be accomplished.

The need for such work is indicated by the growing tendency for municipalities and states to extend requirements for the approval of milk plant equipment.

For this year the committee has decided to discuss recent developments in milk plant equipment because it is believed that the association looks to this committee for information on this subject. In a report of this kind we can only hope to touch the "high spots."

It is interesting to note that the milk receiving room has gained some well deserved attention. There has been a tendency toward modernization of both equipment and layout. Yard space has been increased and dual unloading points provided to facilitate rapid unloading. Automatic can cover looseners have been provided which are adjustable to prevent interference with the odor test. Automatic washing and air drying of the exterior of the cans before dumping is an added feature. Of particular importance to inspectors is the provision of a space of about ten feet alongside the conveyor for inspection of the milk. The can is dumped automatically. This machine handling of cans and covers apparently tends to keep them in better condition. The appearance of seamless milk cans promises improvement for the future in the matter of milk can construction. Dump tanks are being built better, some of stainless steel with welded construction. Most of the new quick emptying valves are of more sanitary construction than the old "molasses gate" valves. Strainers are being made of perforated stainless steel or white metal. These strainers are stronger and otherwise more satisfactory than the socalled Dutch weave wire in older types. However, the perforations must be cleanly cut as evidenced by examination under magnification. The spacing of holes and diameter in proportion to thickness of plate, are considerations in cleaning. Strainer sheets should be perforated to size with selvage edges for soldering. Strainers in modern weigh tanks are being so installed as not to be submerged in the milk with a view to securing more representative samples for butter fat tests.

Cold milk filters are being more generally used. Tests on comparative samples have shown the removal of much more dirt at 50° F. than at 120° or 150° F. One firm has had on the market for several years a cold milk filter using a special filter block made up of alternate strips of paper grating and of cotton. Recently there has been placed on the market a cold milk filter of special design containing a rather large number of cotton flannel filter bags. Observations at one plant indicate that good results are being obtained with this filter using new bags but the use of laundered bags has not been successful and has not been accepted generally. Some dealers have reported success for three or four years in using the ordinary hot milk filter as a cold milk filter by operating at about one-half its rated capacity. One committee member, however, reports unsatisfactory results where this method was used. A cold milk clarifier of improved de-

sign is also being used for the removal of dirt from cold milk.

In the field of milk cooling there has been considerable development. Cabinet or wing type coolers of various types are being rather extensively used. They offer considerable cooling capacity for the space occupied and have the decided advantage over some of the large surface coolers and over the internal tubular cooler in that the milk contact surfaces are readily accessible for cleaning. Some users report trouble with brine leaks in some forms of cabinet coolers.

The plate type cooler offers advantages similar to those of the cabinet cooler from the standpoint of conservation of floor space as well as efficiency in the transfer of heat. It has the advantage of keeping the milk in a closed system. This type of cooler or heater, however, is more difficult to clean and considerable pressure is sometimes necessary to cause the milk to pass through the convolutions. A later type of plate regenerator makes use of single service paper gaskets which have distinct advantages from a sanitary point of view over the rubber gaskets in common use.

Considerable improvement in the cooling of milk through the prevention of freezing has been accomplished by improved automatic control of the temperature of the refrigerant both in circulating ammonia and brine. The use of sweet water in cooling milk guarantees against the freezing of milk without dependence on automatic valves.

In connection with cooling equipment the question arises as to how smooth milk surfaces should be. It is only necessary to observe different metal surfaces under magnification to appreciate the variation in smoothness. Rough surfaces are naturally more efficient in the transfer of heat. Apparently some standardization as to degree of smoothness is desirable, certainly a coarser finish than the standard No. 4 A furnished usually in storage tanks or pasteurizers should not be supplied for the cooling or heating of milk.

There has been considerable development and there is room for further development in milk pipes and fittings. The elimination of crevices within the pipe line in which milk solids may lodge is highly desirable. Too frequently these crevices are not completely filled with solder. A type of union connection in which the pipe extends clear through the joint fitting securing such fitting by expansion of the metal, eliminating the use of solder is a step in advance in the sanitation of milk pipe lines.

Although homogenizers have been in quite general use for cream, most officials have felt that the construction of these machines was not satisfactory. Considerable interest has been shown in the recent introduction of viscolizers which can be readily taken apart daily for cleaning.

Recent developments in bottles and caps may aid health officials in settling that perplexing problem of whether the pouring lip of the bottle shall or shall not be covered. A new bottle with 25 mm. (approximately 1 inch) neck opening instead of the present 34 mm. (approximately 1 5/16 inch) opening has been in use for some time in a New York State city and perhaps in other places in the United States. The aluminium cover cap on this bottle is only 38 mm. in diameter and costs little, if any, more than the paper plug cap which is 41 mm. in diameter. The bottles can be readily washed but it may be that soaker type washers must be used. One of our members reports that this bottle has come into quite general use in London. One dairy there is putting out ten million of these bottles per week in its various branches. A member of the committee reports improvement in the efficiency of bottle washers as a result of using automatic temperature controls on the solutions in the washer.

The boiler room has also come in for its share of development. The use of oil burners and automatic control has tended to increase the efficiency of milk plant operations. Many failures in one or another of the various milk plant operations have been traced to low steam pressure, the direct result of steam boilers of insufficient capacity. Coal stokers are also being used successfully with similar advantages, except the handling of coal and ashes. The time an operator ordinarily spends firing a boiler can well be spent in other operations.

At the Dairy Industries Exposition here in Atlantic City there are many things worth seeing. A thing that will impress anyone who has been a regular attendant for the past eight or ten years is the absence of "trick" pasteurizers. In former years it seemed as if each company developed a new type of pasteurizer for each exposition. Many of these were atrocious to the sanitarian. It is encouraging to note that the tendency is to simplify and standardize pasteurizers and to improve materials, workmanship, and ease of operation and cleaning.

There have been many other developments in milk plant equipment which are worthy of mention but our comments must be necessarily limited. Although there is considerable room for further development, progress has been quite rapid.

W. D. Tiedeman, *Chairman*

Loomis Burrell	G. W. Grim
W. D. Dotterer	R. E. Irwin
V. M. Ehlers	C. S. Leete
L. C. Frank	G. W. Butnam
N. M. Fuller	W. E. Ward

Discussion

Mr. Tiedeman: We have been asked to add some comments on what we have seen here in Atlantic City at the Dairy Show. In the past, almost every year you saw some new development in pasteurizers. We have been impressed by the absence of new-fangled types this year, and particularly of the pocket types. It seems that the development

has been along the line, as it should be, of perfecting the material and workmanship of the existing types of pasteurizers. The tendency seems to be back to normal in equipment generally.

Dr. Harding: There is one feature of the machine development which has seemed to me quite important, which was inadvertantly omitted from this summary which has just been given, excellent as it was.

I think we are all conscious of the relation between the accumulation of the growth of thermophiles in the pasteurizing apparatus, the growth attached to the machinery at various parts, and the building up of that troublesome germ life during the continuation of the operation. That difficulty is so pronounced that in the larger plants their custom of stopping operation to scrub up some of the apparatus is a regular part of the dairy routine.

A hopeful development in connection with the equipment during the last year or two is the studying of the design of machinery so that the milk itself, in passing through, will largely prevent the deposition of the thermophile growth.

Those of you who have been at the exhibits have noted one of the plate type coolers where the surface of the cooler is indented with semicircular indents, the design being to bring a turbulence in the flow, a whirling motion going over the plate, so that they would be mechanically freed of this possible accumulation.

I cite that merely as an illustration of a mechanical principle which I think is being applied so far as it may be to various steps in the handling of the milk.

This is a matter of some little importance, though it has not as yet received general recognition. As you think of it, I think you will see that it may have quite an important influence in keeping down this accumulation of growth which marks the continuation of the pasteurizing process as we know it now.

Mr. Jennings: I noticed that many of these high temperature short-time pieces of equipment have the thermometers a considerable distance from the heating element. When the automatic cut-out stops the flow of milk, there appears to be no way of starting except by manual control. I noticed two in particular at the Exposition. The representatives of the equipment told me that this was satisfactory and acceptable to the New York State Health Department.

I would like to ask what that situation is.

Mr. Tiedeman: I might say that I have not looked at that feature of this particular equipment as shown here. I do not know whether there has been any change since I last saw it. However New York State requires that all the water-heating equipment be so arranged that the milk flow will start automatically without manual control; and the same is true of the electrically heated now. There have been some installations in the past in which that has not been true, but on all present and future installations it is required.

A STUDY OF MILK FROM APPARENTLY NORMAL UDDERS *

C. K. Johns

Central Experimental Farm
Ottawa, Canada

IT has been shown by numerous workers that the fore-milk from animals afflicted with chronic contagious mastitis is generally high in catalase, chlorides and pH. Not infrequently, however, high values are encountered without any sign of the presence of *Str. agalactiae* (or other causative organism) even on repeated examinations. Many workers have been inclined to class such quarters as infected, believing that the organism has been missed on account of the intermittent manner in which it is frequently shed in the milk.

While there are undoubtedly many instances where this assumption is correct, undue reliance upon these indirect tests may lead to the classification of streptococcus-free † animals as infected. Steck [10] in his extensive studies of so-called "latent infection" has reported cases in which no streptococci were found; Seelemann [8] refers to "non-specific disturbances" of the udder function when streptococci were absent; Rudolf [7] reports 154 out of 1258 cows examined as being in this class, while similar findings have been reported by other workers. Hastings and Beach at Wisconsin [2] have found fourteen animals in a "streptococcus free" herd of thirty-one heifers yielding abnormal milk, and similar cases have been encountered in the main university herd as well as in a number of others tested. In the hope of adding to our knowledge of this phase of the mastitis problem, the work reported in this paper was undertaken at the Central Experi-

* Contribution No. 39. (Journal Series) from the Division of Bacteriology, Dominion Experimental Farms, Ottawa.

† In this paper infection with streptococci refers specifically to *Str. agalactiae*, the organism associated with chronic contagious mastitis.

mental Farm, Ottawa, Ontario, at the suggestion of Professor Hastings.

As in the case of the Wisconsin studies, routine testing for the purpose of segregating animals infected with *Str. agalactiae* revealed a considerable percentage of quarters giving abnormal reactions, yet free from the streptococcus on repeated tests. One such animal, Heifer No. 12, was selected for more intensive study and over 400 samples of her milk have been analysed. In order to obtain a more comprehensive picture, foremilk samples were taken daily at first, later at each milking and during one period supplemented by strippings samples. Catalase was determined by Hastings' tube method, pH * with the quinhydrone electrode and chlorides by direct titration (undiluted) using dichlorofluorescein as indicator. Samples were plated out without delay, at first on veal infusion agar, but later nutrient agar plus 0.5 per cent tryptone was substituted since better growth was obtained. In the earlier work plates were counted after forty-eight hours at 37°C. but in the most recent studies (September) recounts were made after four to eight days at room temperature. Further tests for the presence of streptococci included inoculation of Burri slants of various media from cream or sediment of refrigerated or incubated portions of samples, and microscopic examination of stained films prepared from incubated portions. Colonies resembling streptococci were fished from plates and slants to dextrose-tryptone broth and further examined.

The general picture presented by this heifer appears to be in line with that found by Hastings. On ten intermittent samplings prior to February 18, only the two front quarters yielded abnormal milk; at this time the left hind quarter commenced to give high values. Counts on these three quarters were reasonably low (maximum 9,000) yet considerably higher than on the right hind

* Grateful acknowledgment is made of the assistance of Mr. A. H. Jones, B.S.A., who made the pH determinations in these studies.

Table 1

RANGE OF COUNTS AND CHLORIDE CONTENT OF FOREMILK SAMPLES
HEIFER No. 12.

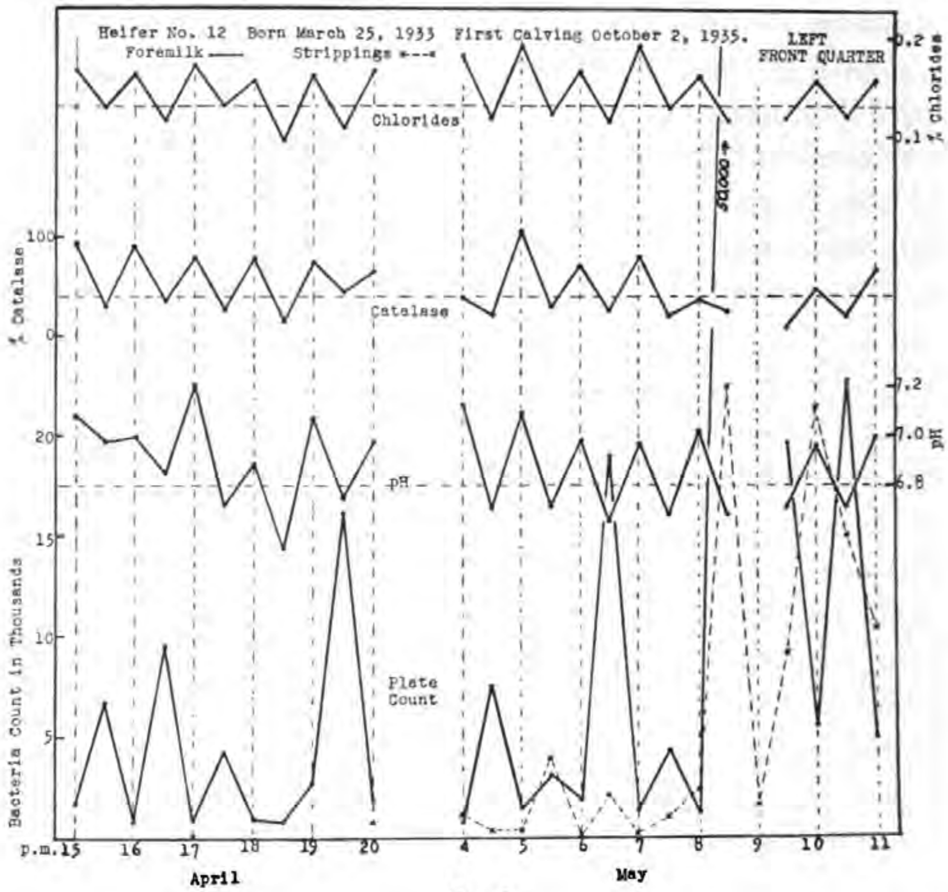
(Bracketed values represent arithmetic mean)

Period		March 24-April 2 (9 samplings, p.m. only)	April 7-20 (19 samplings, a.m. and p.m.)	May 4-11 (14 samplings, a.m. and p.m.)	June 9-19 (7 samplings, a.m. and p.m.)	Aug. 11-19 (4 samplings, a.m. and p.m.)
Counts	LF	410—5,390 (2,052)	780—26,000 (5,859)	750—50,300 (10,291)	10—5,800 (2,637)	370—2,360 (1,158)
	RF	420—2,980 (2,013)	420—19,720 (5,117)	1,750—47,800 (10,280)	10—5,400 (2,373)	240—1,500 (825)
	LH	930—6,500 (2,980)	530—80,000 (11,206)	3,140—25,300 (12,503)	4,900—130,000 (47,114)	2,360—6,700 (4,390)
	RH	20—730 (187)	30—18,380 (4,457)	200—21,900 (7,028)	5,900—250,000 (55,357)	7,300—36,800 (16,275)
Chlorides	LF	0.155—0.182 (0.167)	0.096—0.198 (0.154)	0.114—0.190 (0.145)	0.119—0.193 (0.143)	0.175—0.235 (0.210)
	RF	0.107—0.255 (0.179)	0.087—0.257 (0.177)	0.193—0.315 (0.246)	0.157—0.206 (0.181)	0.250—0.265 (0.258)
	LH	0.122—0.225 (0.162)	0.101—0.304 (0.155)	0.120—0.245 (0.190)	0.120—0.225 (0.161)	0.178—0.300 (0.238)
	RH	0.087—0.115 (0.099)	0.082—0.125 (0.097)	0.090—0.120 (0.106)	0.128—0.177 (0.154)	0.210—0.255 (0.237)

quarter. Consecutive sampling during the periods April 7 to 20 and May 4 to 11 revealed a distinct rise in the general level of counts (table 1), being most marked from the right hind quarter. It should be noted that in spite of this increase in bacterial numbers, the biochemical values for this quarter did not increase at this time. However, when another series of samples was examined a month later (June 9 to 19) the milk from this quarter gave definitely abnormal reactions, while both hind quarters showed a further increase in count. The final series of samplings in August, just before this heifer was dried up, showed much higher bacteria counts for the right hind quarter than for the other three. At no time during the lactation period was any evidence of udder trouble noted by the herdsman or milker, although on rare occasions a tiny flake could be seen on the strip cup. Samples representative of the entire milking were almost invariably normal on the basis of the biochemical values. Physical examination for fibrosis made by Dr. R. V. L. Walker of the Dominion Animal Diseases Research Institute, Hull, Quebec, on August 12, revealed two tiny nodules at the base of the teat in the right hind quarter, no induration being detected in the other three quarters. At no time have streptococci been found, the predominant types of flora being micrococci and corynebacteria. Attempts to establish the presence of types of organisms not showing up under the cultural conditions employed have met with no success.

A more detailed picture of the condition of this heifer's udder is furnished in Charts 1 to 4, where the results of consecutive samplings during the periods April 15 to 20 and May 4 to 11, 1936, are portrayed. During the latter period samples of strippings were analysed in the same manner but to avoid overloading the charts, only data for the counts have been included. In general, the biochemical values showed less violent fluctuations and were on a lower level than those for the foremilk.

Perhaps the most striking thing about these curves is the marked fluctuation in values from one milking to the next. In general there is excellent agreement between the values for chlorides, pH and catalase, all three tending

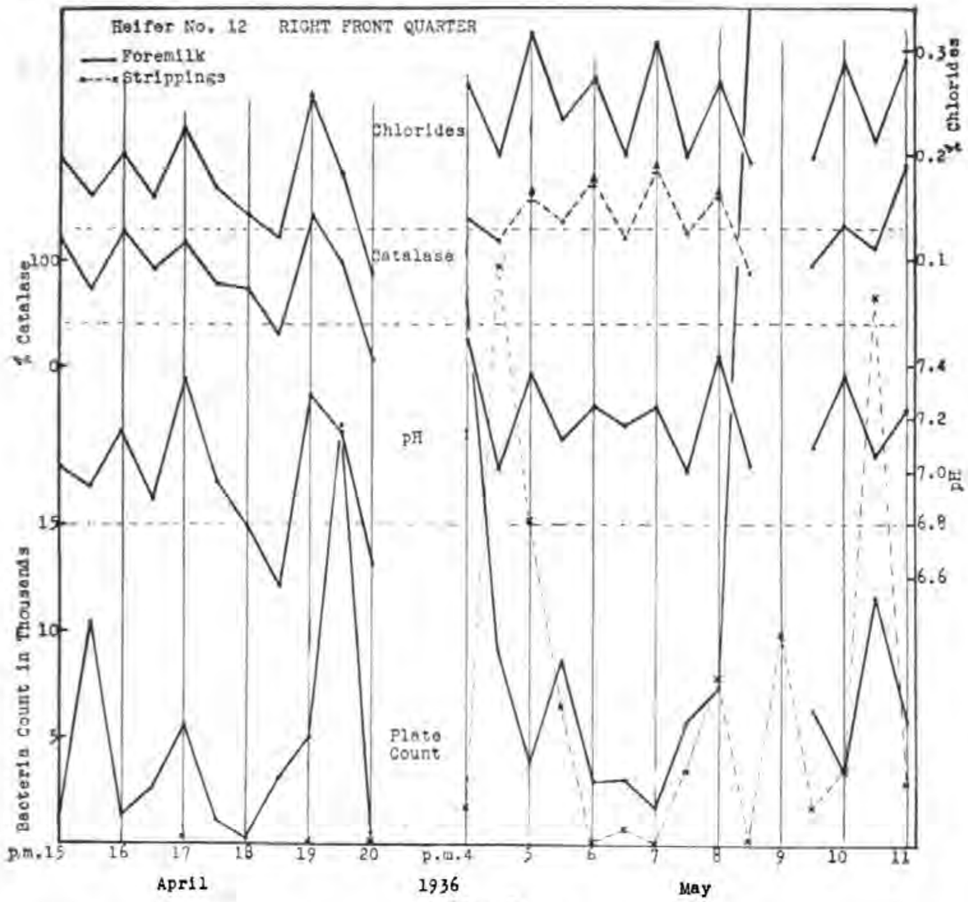


No. 1

to fluctuate in unison.* Both front quarters show a regular rhythmic fluctuation in biochemical values, the values for the evening's milkings being almost always higher than for the preceding and succeeding morning's milkings. The left hind quarter also shows marked fluctuations but these lack the regular rhythmic character of those of the two front quarters. The values for

* On the basis of these data, tentative normal limits of 0.13 per cent chlorides, pH 6.8 and catalase 40 per cent were established (see dotted lines on charts).

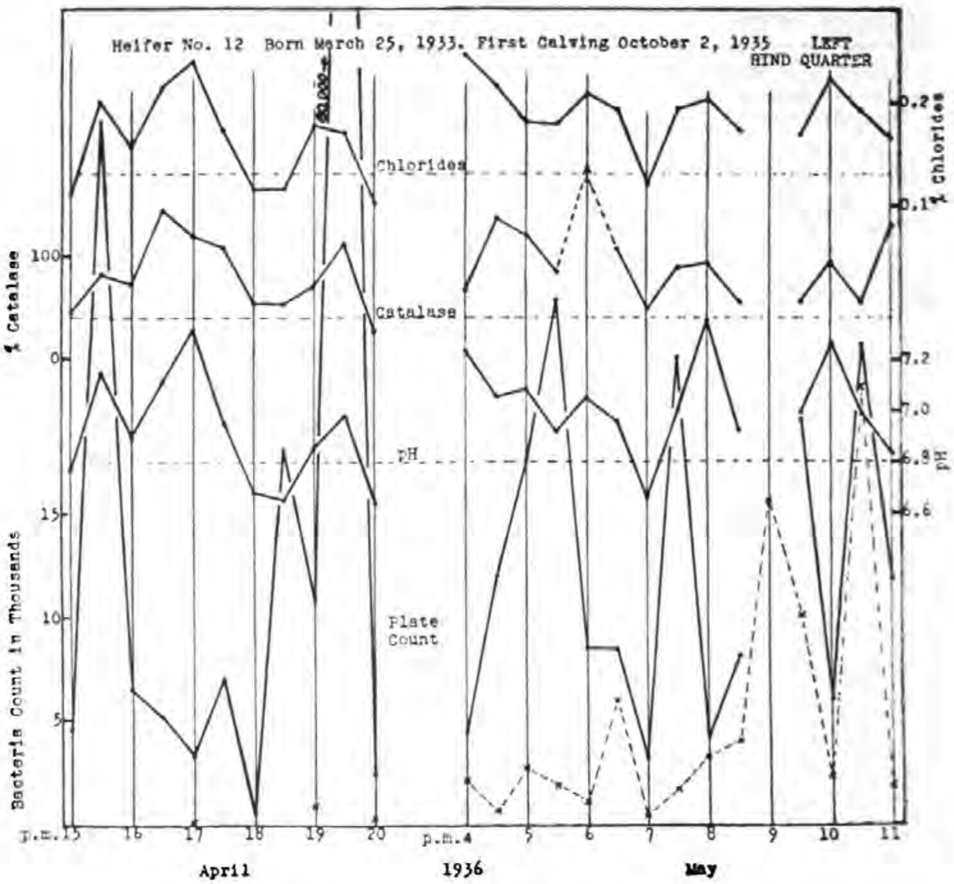
the right hind quarter are distinctly lower than for the other three quarters, and such fluctuations as exist are insignificant. In the face of these striking differences in behavior, it seems difficult to believe that some general factor outside of the individual quarter is responsible for the increased biochemical values, although the regular



No. 2

rhythmic character of the fluctuations for the two front quarters certainly suggests a physiological basis.

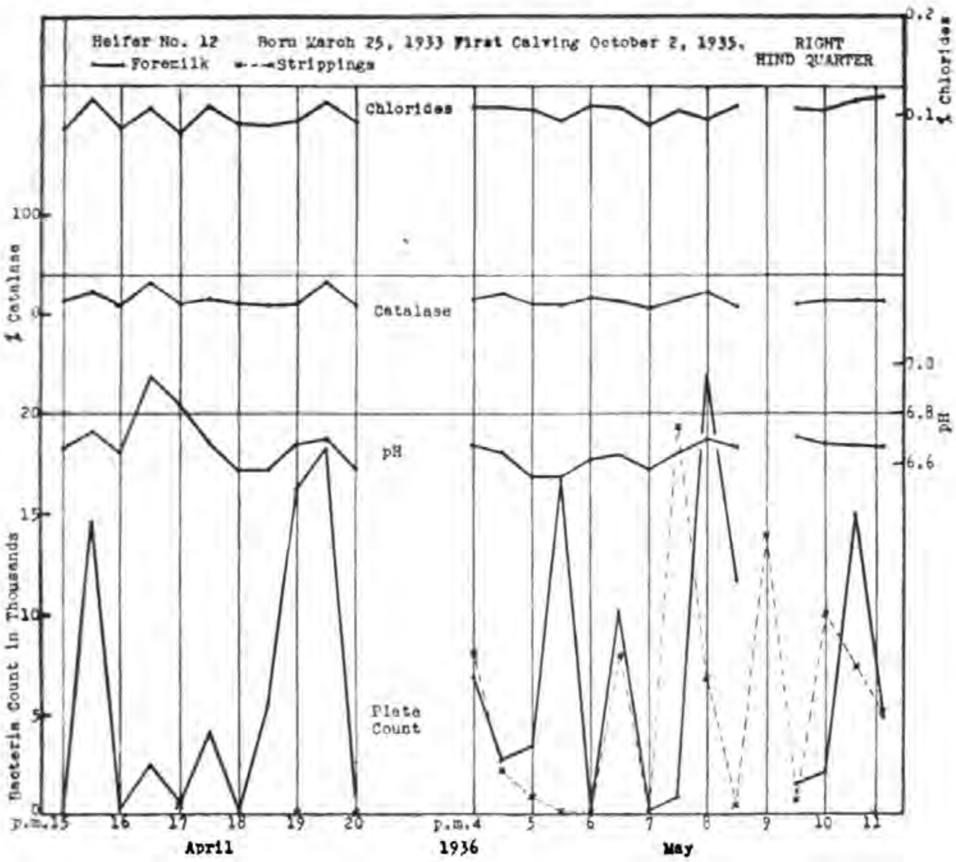
Seeking some explanation for these marked rhythmic fluctuations in biochemical values, attention was directed to the correlation between bacterial numbers and these values. Here the value of studying a series of consecutive samplings is evident. For the left front quarter there is an excellent correlation, high counts on the morning's milk being followed by high biochemical values on the evening's milk. The right front and left hind quarters show a less satisfactory correlation, while the "normal" right hind quarter shows enormous fluctuations in count without any apparent influence on the biochemical values.



No. 3

The fact that an increase in biochemical values may not coincide with the higher count, but may follow after a lag of one or two milkings has been noted by Steck [10] who believes the increase in bacteria in the udder induces the appearance of bacteriostatic substances in the milk from the blood or lymph. When the bacterial numbers are lowered, the reaction of the udder tissue ceases, and the bacteria are again free to multiply calling forth a further reaction on the part of the udder tissue.

Since it has been shown that certain types of udder flora, such as corynebacteria, exert no influence on the composition of the milk [3, 6, 10] while presumably others which do change the secretion may not show up under the cultural conditions employed, it would be strange



No. 4

indeed to find a perfect correlation between total counts and biochemical values. Furthermore, where infection is confined to the teat canal, it seems unlikely that the composition of the milk would be affected to any extent.[5] Therefore, despite the discrepancies in the data presented, it is difficult to escape the conclusion that bacterial activity is at least one of the factors concerned, although it seems likely that some physiological change must occur to reduce the bacteriostatic character of the milk in the udder before bacterial growth could progress to the extent noted. The marked rise in the counts for the right hind quarter during this period followed some weeks later by the appearance of high biochemical values, is in agreement with the findings reported by Burkey, Sanders and Cone [1] in streptococcic infection.

Little and Foley [5] have reported fairly high counts of typical staphylococci in the foremilk of three young cows on daily examination, with very few organisms in the remainder of the milk. The biochemical values were normal. These workers believe that the growth of staphylococci under normal conditions is confined to the teat canal by the action of the lactenin. Such would not appear to be the case with Heifer No. 12, as counts from strippings were frequently as high as those from foremilk. Again, the bacterial counts and biochemical values for this heifer are on a much higher level than in cases of "latent infection" described by Steck.[10] Furthermore, Holm [4] has reported that the chloride content is not increased in staphylococcic mastitis. It would seem then that this heifer presents a picture differing in various particulars from the cases reported by the investigators mentioned above.

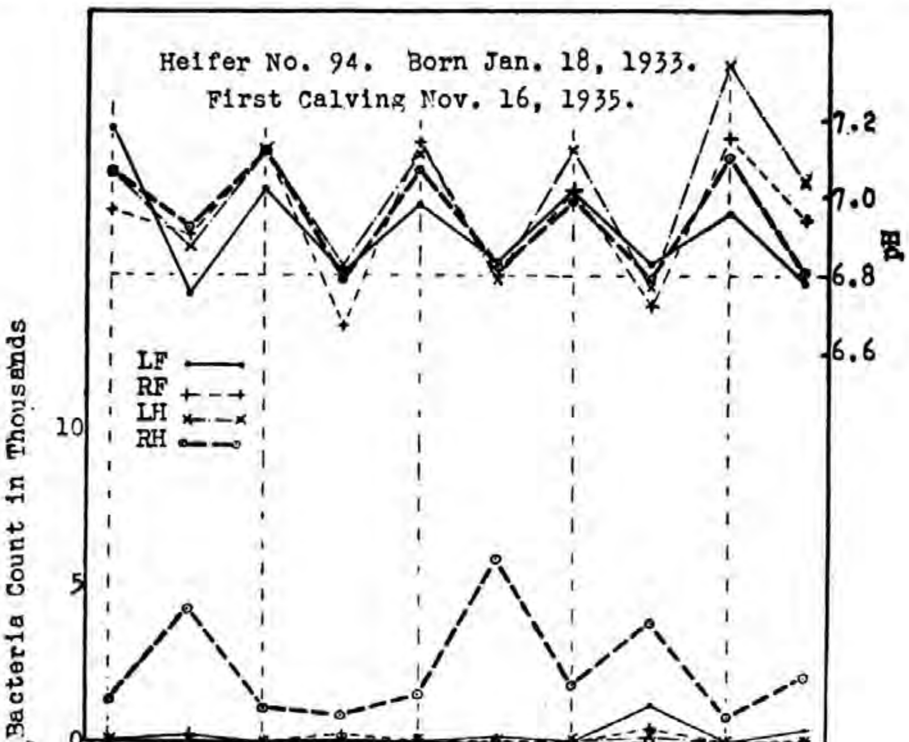
On various occasions an attempt was made to discover some predominant type of organism which might be correlated with peak biochemical values, but without success. During the earlier series a mixed flora was generally encountered, with striking fluctuations from milking to milking. However, in the later series a micrococcus similar to *M. epidermidis* was frequently found making up a fair proportion of the total count on both hind quarters, while another resembling *M. albus* occurred on plates from both front quarters.

It is hoped that further studies on this heifer during her second lactation period may throw more light on the reasons for the abnormalities described above.

Similar studies have recently been commenced on the milk from three other first-calf heifers, and the data from each of these will now be considered.

Heifer No. 94

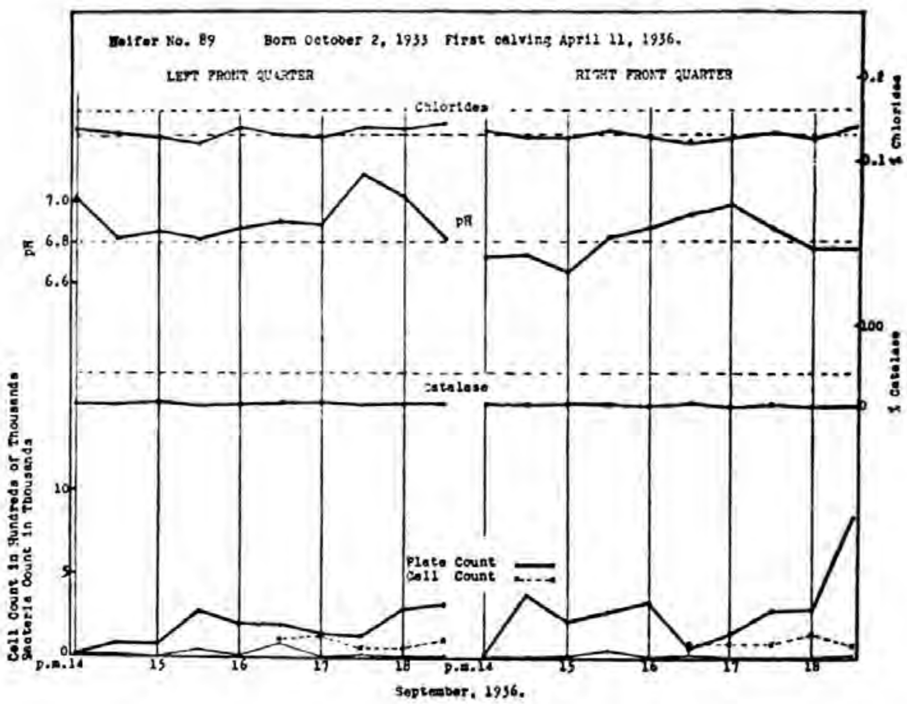
This heifer dropped her first calf November 16, 1935, and is due to freshen in February, 1937. Six previous routine tests had revealed a high catalase value for the left front quarter on one occasion, outside of which the



No. 5

picture was normal. A series of ten samples taken between September 8 and 13, showed a regular rhythmic fluctuation of biochemical values similar to those for the front quarter of Heifer No. 12, with the majority of the values in excess of the normal limits. Just why these values should be on a higher plane than normally encountered is not clear. While this heifer was in the tenth month of her lactation period when studied, she was still giving over twenty-five pounds of milk a day, the point at which Sharp and Struble [9] report that a marked increase in chloride content sets in for Holsteins.

Since there was good agreement between the values for chlorides, pH and catalase, only the pH values were plotted along with the plate counts in Chart 5. Furthermore, since corynebacteria made up the bulk of the flora



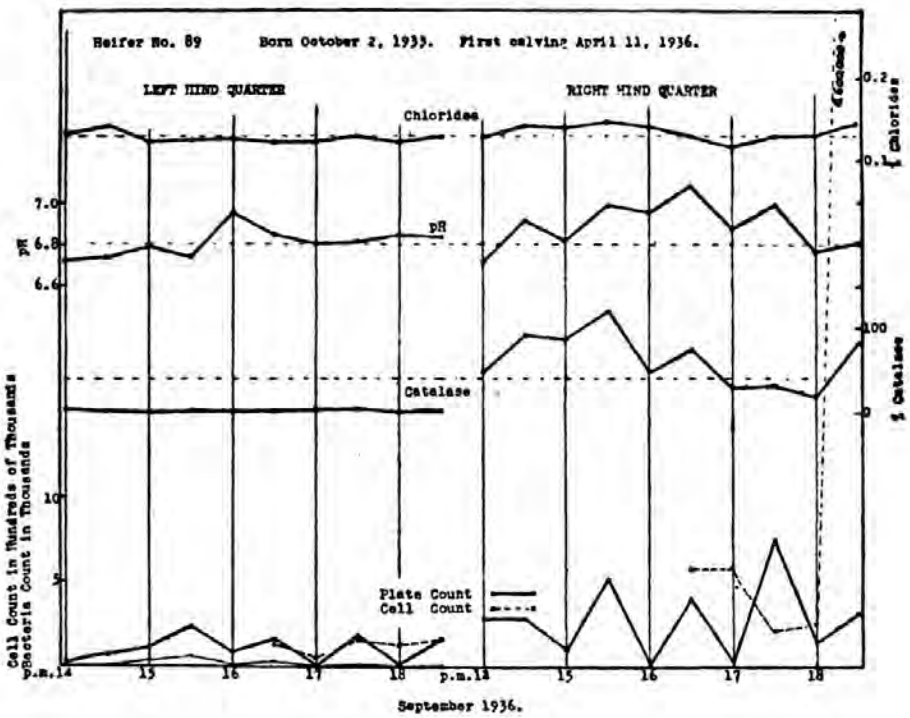
No. 6

from all but the right hind quarter, these were disregarded and only the remaining types included in the count as plotted. A regular rhythmic fluctuation in the counts of all four quarters will be observed, the peak counts occurring one milking ahead of the peak pH values.

Samples from the right hind quarter consistently showed practically a pure culture of a beige-coloured micrococcus, and the general level of counts was distinctly in excess of that for the other three quarters. (This held true even when the corynebacteria were included in the counts of the other three quarters.) The higher general level of counts however was not reflected in the biochemical values for this quarter, but may show up in future examinations.

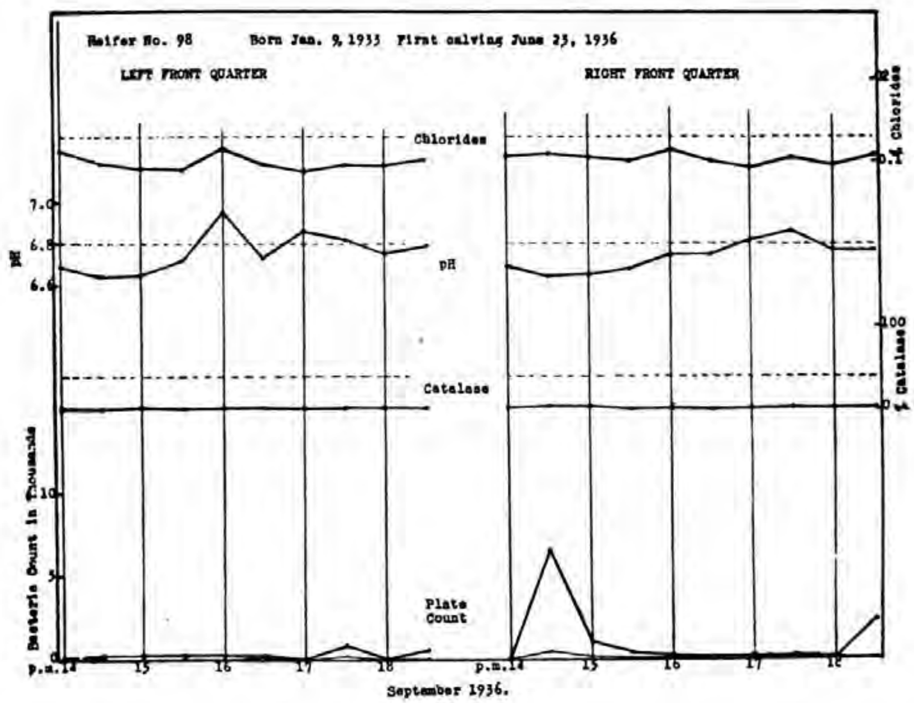
HEIFER No. 89

This heifer freshened April 11, 1936. Two routine tests failed to disclose any abnormality although the catalase content of the right hind quarter was somewhat higher



No. 7

than for the other three. Ten samples were analysed from September 14 to 19 and the data plotted in Charts 6 and 7. The outstanding feature here is the high level of catalase values for the right hind quarter as compared with the other three quarters. No such clear-cut difference is to be observed in the data for pH and chlorides. This is the first time in these studies that there has been a serious lack of agreement between the values for catalase and those for the other two tests. Cell counts made on the last five samplings show a somewhat higher level for the right hind quarter, particularly on the last sampling nineteenth, a.m.). Plates from this quarter carried a practically pure culture of *Str. agalactiae,* while on the other three quarters corynebacteria predominated. Possibly this streptococcus attracts leucocytes to a greater degree than do the organisms present in the other three quarters without an appreciably greater percentage of chlorides, etc. entering the milk. Physical examination

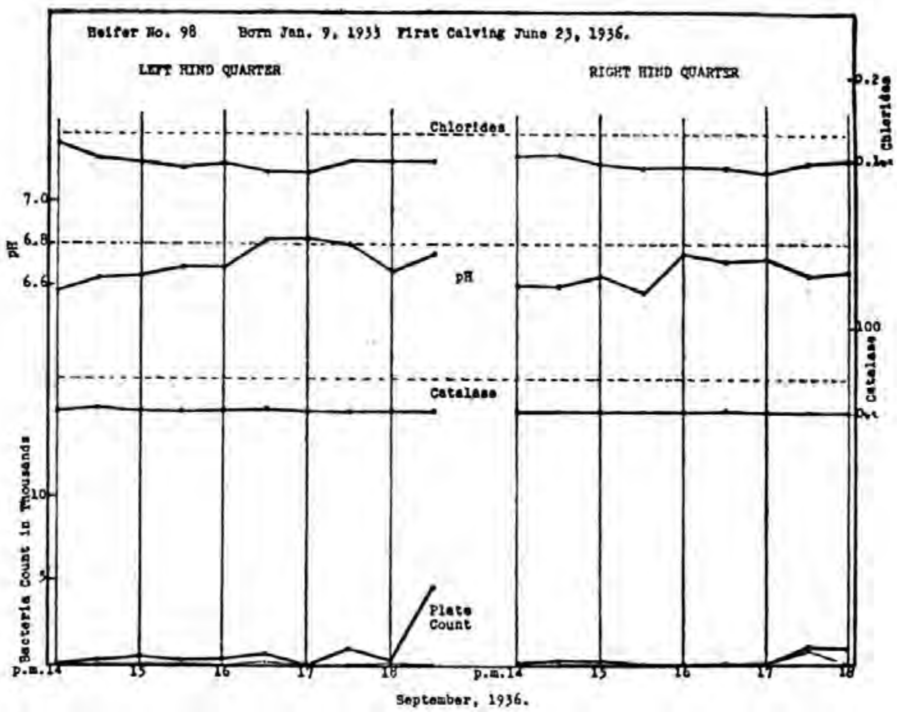


No. 8

by Dr. Walker on October 1, revealed a "pulpy" texture in this quarter but no induration. While there is a tendency for the counts from all four quarters to fluctuate in unison, this does not hold true for the biochemical values, although for the right hind quarter peak counts coincide with peak values. In spite of the higher level of counts on this quarter, the biochemical values (other than catalase) are comparable to those from the other quarters.

Heifer No. 98

This heifer freshened June 23, 1936, and had not been checked before the series of ten successive samplings commencing September 14. Data are presented in Charts 8 and 9. It will be observed that, with one or two exceptions, there are only minor fluctuations in the values for chlorides and pH, the values for all four quarters being



No. 9

fairly close together. The level of values for pH appears to be somewhat high in comparison with those for chlorides and catalase. Counts were uniformly low on all quarters, corynebacteria being the predominant flora. In contrast with those previously described, the udder of this heifer may be regarded as a fairly normal specimen.

It should be pointed out that the entire herd has been free from tuberculosis and contagious abortion for some years, so that the causative organisms concerned in these two diseases do not enter into the picture.

Summary and Conclusions

Heifers giving foremilk of abnormal composition from apparently normal udders have been studied by the examination of several series of samples taken at successive milkings.

Examination of over 400 samples from one heifer has failed to disclose any streptococci, the microflora comprising mainly udder cocci and corynebacteria.

A marked increase in bacterial numbers in the secretion from a previously normal quarter, followed some weeks later by abnormal biochemical values, suggests the possibility of a cause and effect relationship, as does the correlation between rhythmic fluctuations in counts and biochemical values noted on another quarter. However, the possibility of a physiological factor being responsible can not be ruled out on the basis of the data on hand.

High values for catalase, chlorides and pH in the foremilk do not always indicate infection with mastitis streptococci or other specific pathogens, and a positive diagnosis should be based primarily on the demonstration of the causative organism.

References

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Discussion

Dr. Harding: Reference was made in the presentation by Professor Johns to the fact that counts were made of the body cells in the milk of these heifers, at least in some instances. I remember twenty years ago when studies of body cells in milk were really vigorously pushed. Dr. Breed, in demonstrating his method which later led to the Breed test for bacteria, found that various udders had a very periodic fluctuation in the number of cells present in milk.

If my memory serves me right, that fluctuation was characteristically different in different udders. I have wondered if they found any correlation between the fluctuations of the cells in the udders and the other values which were presented to us here?

Mr. Johns: We have found that there is a definite correlation. We have been using the catalase test rather than the cell count, using Professor Hastings' multiplication because we find it much simpler and quicker than making cell counts. The two seem to correlate excellently.

In the case of this first heifer, as you observed, the three values in general went up as though they were all worked by the same mechanism. Apparently that is not always the case, because there was one heifer with a streptococcus infection in which the catalase values were distinctly higher in relation to the level of chloride and pH than was the case for the other three.

Dr. Harding: Then the problem with regard to some of those cows resolves itself into what makes the cells come over in that peculiar, irregular way.

Mr. Johns: That would throw a great deal of light on the subject, if it were possible to discover the reason for it.

Of course, another factor is that certain healthy cows throw off epithelial cells in the milk at a much greater rate than do others, which would give a higher value for your catalase, without apparently affecting the chlorides or pH.

Secretary Brooks: Some time before I had the privilege of reading this paper, as I did, I started in to try to find the answer, for my own information, to the question as to what a normal udder was or is or, more specifically, as to whether leukocytes and bacteria were present in the udder in the absence of disease.

I thought that was going to be a very simple question to answer,—that I would only have to turn to any book on milk to find the answer. Well, I turned to several of them and what I found in practically all of them was that they treated the usual conditions as normal conditions. Then I turned to books on human physiology, histology, pathology and obstetrics. I went through two or three of each and by piecing together a little that I found here and there, I got enough information to warrant what seemed to me to be some reasonable tentative conclusions. I thought possibly some of you would be interested in these conclusions.

First, with reference to the leukocytes, the question was whether they are present in the tissues of the gland before bacterial invasion of the gland has occurred. These were the tentative conclusions that I finally reached as a result of the examination of about eight or ten different books:

Leukocytes evidently are present in the mammary gland tissue at all times. As pregnancy occurs and lactation approaches and the blood supply of the gland greatly increases, as it does at that time, the leukocytes increase and enter the alveoli of the gland and get into the milk. They are present in relatively large numbers at the beginning of lactation and also usually in somewhat smaller numbers, at the end of lactation, with a few present in between those periods, in the alveoli of the gland and in the milk. In the presence of infection and inflammation, they ordinarily apparently greatly increase. I say "ordinarily" because it appears at least in relation to the human, that occasionally there is an infection of such overwhelming virulence that the leukocytes do not respond. Looking back to my hospital days thirty-odd years ago, I recall that when we found a case of pneumonia which the leukocyte count was low instead of high, as was ordinarily expected, we looked upon that as a case in which a bad prognosis should be made; the infection was overwhelming.

When the leukocytes are present associated with inflammation, then we think of them as pus cells and I have not been able to find any clear distinction between a pus cell and an ordinary leukocyte, but my assumption is that the pus cell is simply a leukocyte more or less broken down and associated with the other products of inflammation.

As an example of the little that we know about normal udders—and when I speak of normal udders I am thinking of udders before lactation has occurred. I could not find evidence that any work had been done on udders or human breasts before the occurrence of lactation.

But as an example of the little that is known: referring to colostrum cells, I found one book on histology and one on milk which said they were leukocytes which had absorbed fat particles, and one on physiology and one on obstetrics that said they were epithelial cells. That is a 50-50 division of opinion, apparently.

With reference to the bacteria, the question there was whether they were present in the gland before it had actually been exposed to infection. I found statements in some of the books that human milk is "practically sterile" and that the normal mammary gland is "probably" sterile,—all very vague, nothing definite.

My conclusions were that bacteria are not present in the udder until infection has occurred. Of course after lactation begins, the bovine udder is constantly exposed to infection by way of the teat. If streptococci or other organisms are repeatedly found, it probably means the existence of foci of infection which of course may be in the teat canal rather than in the udder. They may of course be so small as to be of little, if any, practical importance. If infection is the usual and ordinary thing in bovine udders, practically unavoidable, then perhaps we should consider the slightly infected udder as normal as long as there are no evidences of inflammatory change. This discussion does not relate too closely to Mr. Johns' paper, and yet I thought you might be interested in the problem that I encountered in trying to get that little information

Dr. Harding: Mr. President, I believe that a good deal of the confusion and difficulties which face the milk inspector in connection with this matter of mastitis arises from the fact that we do not have a good background of what is the normal situation in the udder of a cow.

My curiosity regarding the udder flora was quite continuous for about ten years, during which time we examined bacteriologically and to some extent physically the udders of a good many cows. I perhaps am speaking out of turn here, because when I was taking my course in dairy bacteriology under Dr. Russell, I was informed that the secretion in the udder of a cow was probably sterile. This makes your statement regarding the textbooks sound very familiar.

I remember with what astonishment Dr. Archibald R. Ward displayed to me about 1899 at Cornell University plates carrying bits of tissue from various portions of the udder which had been removed aseptically and placed in the agar and we saw the beautiful growths which were coming out from those bits of tissue collected aseptically from various portions of a normal udder.

Secretary Brooks: Was that after lactation began or before there had been any lactation?

Dr. Harding: During lactation.

That matter led me later to follow up this question of what does go on in the udder of a cow and not only out of our work but the work of others developed, I think, that there is a niche in nature into which bacteria have crowded and adapted themselves, and there is just as normal a flora in udders as there is normal flora on the skin or in sewage or in water.

It happens that the flora of the udder is predominantly a coccus flora. The udder is, I think, structurally an enfolding of the skin and it is probably to be expected that the normal flora of the udder should be quite similar to the normal flora of the skin on the exterior of the body.

The presence of those germs in there seems to be just a normal arrangement of nature. This is not restricted to the time the cow is in flow of milk. My observations, I think, have never included heifers that had not become pregnant, but I have examined the secretions from the cows in the intervals between lactation and there is quite a flora which remains in the udder. In fact, the wellknown cathartic effect attributed to the first milk from the udder it seems to me might quite possibly arise, at least in part, from the fact that bacteria had been living there for weeks and months and growing and their by-products accumulating in the udder, unless they had diffused into the circulation and gone elsewhere, so that that cathartic effect of the first milk from the udder might quite possibly be connected with the germ life which has been growing normally in the udder in the period between lactations.

Secretary Brooks: Dr. Harding, this is perhaps an academic question, but do you not believe that if the bovine udder were protected from infection to the same degree that the human female breast is, it might continue to be sterile?

Dr. Harding: It is protected, I think, in much the same way with regard to a good many organisms, but it is not a protection against organisms in general. It is apparently a specific protection against certain organisms. As I mentioned last night, we found that a cow's milk was very detrimental to the growth of certain organisms,—organisms presumably which have lived in the udder of that cow.

There is a balance obtained there, and the germ just keeps a toe hold and grows along, not abundantly but just sort of casually. It keeps growing like the cactus keeps growing on the desert in the western country.

But that same organism, put into the milk of another cow, which presumably had never experienced that organism, may make quite a little growth for a time. Antibodies of some sort or some other protection is developed there so that the puzzling thing is that you will have sometimes for weeks and months an udder flora of a given kind running along fifty or seventy-five per cubic centimeter. About one udder in fifty, I think on the average, will give you counts up around a hundred thousand or so per cubic centimeter. I am speaking now of the counts on our more ordinary agar.

You know, there is some disadvantage in having been born too soon, and we did not know about the remarkable results of blood agar plates in those days or we would probably have had a different picture in several particulars. There was a flora in the udder that we were not getting in our study.

MILK CONTROL IN PENNSYLVANIA

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PENNSYLVANIA, like some of the states in milk control work for many years, ran along on more or less a haphazard program. It was only in 1929 that any coordination on regulations, inspection and sanitation was developed. At that time the Legislature passed what they called a milk control law.

In 1933 that milk control law was amended. The Act of 1929 was not too intelligently written and the Act of 1933 was not too intelligently amended, so that we had a situation in the State that sometimes those who were attempting to enforce health regulations were not able to understand, due to the ambiguous amendments.

Then, in addition to that, we had absolutely no coordination between the local municipalities and the State. As a matter of fact, there was considerable antagonism existing between the State Department of Health and the health officers in the large cities. That was particularly true of Philadelphia and Pittsburgh.

To complicate the situation a little further, we have a system of approved inspectors who are given an examination and a certificate by the State Department of Health to do the actual farm inspection work. These men work directly for the dealer or are employed by the dealer and paid by the dealer. There were 350 or 400 of those men, and there were as many interpretations of what Act 428 meant as there were approved inspectors.

We had another difficulty. The Dairy Councils in the various large cities, attempting to do quality control work, assuming authority at times that did not belong to them, further complicated the situation.

In Pennsylvania, like so many states, even at the present time, they are attempting to do a job for fluid milk and neglecting entirely the job that has to be done on ice cream or evaporated milk.

To complicate things further, politicians usually got in a few licks for good measure when the health officer who was trying to do a decent job tried to enforce something which was not very popular in the section where he was trying to do enforcement.

About two years ago we started to correct that situation. We invited the cooperation of the local health officers, the milk dealers, the ice cream manufacturers, the medical associations and any other organization which was interested in health measures. I think that was the first time that the State Department of Health at Harrisburg had ever asked outside cooperation.

As a result of putting our feet under the conference table, we evolved the present Act which is known as Act 210. That was signed by the Governor July 2, 1935.

I might point out specifically some of the defects that we found in the old Act. As I said, first, there was a very definite lack of uniformity not only in the Act itself but in the regulation between the municipalities and the local health officers and the State. The dealers sometimes acted on their own ideas as to what constituted a safe bottle of milk. There were as many different barn inspection score sheets as you had individual dealers. There was no protection for the consumer on ice cream or any dairy product other than fluid milk.

In attempting to correct those defects, the present Act was first repealed and then rewritten. We tried to put it in logical sequence, stressing the important things from the health standpoint, and to keep the practical aspects of the situation before us.

We provided for uniformity. Some of you may have seen the inspection form that we use in Pennsylvania.

We tried to take the best ideas out of the blanks used in New York, New Jersey and any other state, and incorporate them in our Pennsylvania regulations, making our regulations what we considered the best practices in other states.

Heretofore there had been minimum regulations, and those minimum regulations were so loosely drawn that half the time we did not know what they meant.

Today we have uniformity. We have not taken away from the municipality the right to exceed the regulations of the state of Pennsylvania, as was written in the old Act, but in suggesting uniformity and in attempting to get uniformity we received from the State Association of Municipal Inspectors a promise that they would go back into their municipalities and incorporate into their local ordinances the provisions of Act 210 and the regulations of the advisory health board.

That has actually happened. Recently the city of Philadelphia finished rewriting its ordinance which, for all practical purposes, is the same as Act 210, the state regulations, providing a very close degree of cooperation and a very close degree of uniformity.

That has been true in Pittsburgh, where they are using identically the same regulations and identically the same farm inspection sheet.

We raised the standards for these approved inspections; physically it is impossible for the State Department of Health with twenty-one men (recently we added seven more to the staff) to supervise adequately eighty thousand farms, seven thousand dealers, five thousand raw milk producers and about three thousand to thirty-five hundred ice cream manufacturers, so we must depend, as far as the farm inspection work goes, on the system of approved inspectors.

Any person who could pass an examination the questions and answers of which were known beforehand, whether he be a soda water fountain clerk or a dry goods ribbon seller or a blacksmith or foundryman, could get a certificate as an approved inspector.

He would be turned loose on a bunch of unsuspecting farmers to tell them what constituted quality production.

That is not true in the state of Pennsylvania today. We raised our requirements for inspectors. We demand some technical training, some practical training, a lot of common sense and good moral character, besides passing an examination which is not given out in advance.

In the last year we have revoked the certificates of about seventy-five inspectors because we found them going from farm to farm with eyes closed and putting hieroglyphics on farm inspection reports which meant nothing. Now we are getting better jobs done out on the farm.

Probably some of you will agree with the speaker preceding me who said "fools rush in where angels fear to tread." We made another important change in our set-up in the state of Pennsylvania. We rushed into the ice cream situation and we rushed into the butter that is used in ice cream, and we rushed into the evaporated milk situation.

We have a theory in Pennsylvania that the consumer of ice cream, the consumer of evaporated milk, is just as much entitled to health protection as the consumer of a bottle of fluid milk and we can not very well see the sense of asking the milk dealer, the farmer, to produce his fluid milk to meet all the rigid requirements of his state or local municipality and then let the door be wide open for the use of—well, say Russian butter, as we found in Pennsylvania last season—uninspected centralizer butter and ice cream from sources where the manufacturer advertised to his producer, "Bring in your cream when you come to town on Monday to Thursday. We will wash your can, whether you have a quart or pint or gallon; see it weighed in; you get your cash," and then in big type, "No farm inspection required."

I think we have made progress due to the cooperation of the reputable ice cream manufacturers and the fluid milk and ice cream industry and the Association health officers. We are gradually putting ice cream in Pennsylvania on exactly the same sanitary level as grade A milk or any bottle of fluid milk. That is as it should be!

From actual records of inspections, there have been about a million pounds less of uninspected butter used in the manufacture of ice cream from June up to the present time.

We have the problem in the state, as you have in your states, that there is a certain element in the industry that has no regard for quality, that thinks of milk only in terms of a commodity as coal or pig iron or garbage. Health regulations are something to get around, if possible. But I think we are gradually eliminating that type of dealer, that type of farmer, from the picture.

We could not do it without the support of the reputable dealer and manufacturer in the industry and fortunately we have had that support.

We still have the situation in the state where some dealers keep rushing to their local politicians to see if there is not some way by which they can circumvent a health regulation. In my opinion it is only a stupid politician who interferes in health regulations. We are attempting in Harrisburg to keep that type of interference out of health measures.

I should like to have been here when you had a discussion on interstate shipments of cream because we have changed our set-up and have put butter and all the dairy products that go into ice cream under inspection. We have also put evaporated milk under these regulations and their products will not be approved until they do meet the regulations. At the present time we have two manufacturers of evaporated milk, one in the state and one out of the state, making a very definite effort to meet health requirements.

That is one of the biggest problems that we have, and I think it is probably one of the biggest problems that the surrounding and neighboring states have.

We operate on the policy that we are not asking a farmer or dealer outside of Pennsylvania to do anything more than we require within the borders of our own state. Before we will look at a supply within the state or out of the state, there are certain things that must be done first.

That supply must have been gone over with a fine tooth comb by the dealer's own approved inspector, of course under our supervision, and the supply brought up to the standards of the state.

I know and you know that there are not any 100 per cent set-ups, but we have enough headaches within the state of Pennsylvania without taking on more. We have a big enough job to do, to correct the condition that has existed for years for Pennsylvania was known the length and breadth of the United States as the state where cream that was not good enough to sell in any other community could be dumped on the market.

We want to see that condition changed. We want to see the condition in Pennsylvania mean that no product can be sold within the state, whether it is ice cream, evaporated milk or fluid product, that is not as good as any other product coming under any inspection in the United States.

That leads up to the question I have been discussing with some of the men since I have been here. We say that products can not be sold in the state of Pennsylvania, whether ice cream or fluid milk, until they meet our requirements.

We have a score sheet, and on the back of the score sheet we have interpreted the requirements because we want to avoid the confusion for three hundred and fifty approved inspectors in trying to interpret what the score sheet means.

We lay a lot of stress on the barn inspection report, not because it is a barn inspection report,—we realize the limitations of it,—but because it is our own practical method of checking the supply of the dealer. We require that he have that inspection report hanging in his milk plant before he—the dealer—accepts milk from a farm; that that farm meet the requirements before the milk is accepted.

When we come around on regular or irregular check inspections, that farm inspection report is first checked against his receipts on his weigh sheet, together with the physical examination of herds which is part of our set-up.

If we find a farm inspection report that is 100 per cent, we go out and check that supply because we do not believe that there are 100 per cent supplies. If we find a group of inspection reports hanging up where the inspector has done an honest job but the dealer feels that he has done his part when he has a piece of paper hanging up in his shop, again we go out and check the supply and if the inspector finds conditions warrant official action we call the dealer to Harrisburg to show cause why his permit to do business in the state should not be revoked.

We lay a lot of stress on that farm inspection report, because it is our only practical way to cover every farm and every shipper.

In addition we had to change our standard for plants. We have many obsolete plants in Pennsylvania. We have brought those standards up. We have rewritten our advisory health board regulations.

We are attempting to put into practice in the plants the very best known practices in construction and equipment that we know, which means that quite a large number of plants are being remodeled from top to bottom; several dealers are building entirely new plants of permanent construction with no wood in the plant at all. We have a big job to do there.

Before milk can be sold in the state of Pennsylvania,—or any dairy product, ice cream or any of the products that go into ice cream—the dealer, at his own expense, must put in shape his own supply to meet the requirements of the state. After that is done, he makes an application. We then send men to check on the work of the approved inspector and in the case of a new applicant to do business in the state, it means a 100 per cent check of every farm that is shipping to that plant.

Personally, we can not see why the health department should do the missionary work for the milk dealer. We think it is the dealer's business to have his supply in shape. So we do not do any preliminary missionary work. We do not believe in emergency permits. We believe that if a health regulation is sound for ten months of the year, it is sound for twelve months of the year; that there is no emergency that can arise that will justify us letting down our bars so far as health regulations are concerned.

If that happens to mean that the dealer has been so shortsighted that he has not been able to anticipate his requirements,—in plain English, that is his hard luck, not the hard luck of the Health Department. We think that we have a duty to protect the health of the consumer three hundred and sixty-five days in the year and we do not believe that issuing an emergency or temporary permit because of a shortage here or a shortage there can be justified from any standpoint as a health measure.

This may be contrary to some standard beliefs but we think that milk as it goes into a plant should be fit to drink as it comes from the cow, and that the practice of the industry or a portion of it will have to be changed in the belief that it can take any product, regardless of where it is produced or how it is produced, and through mechanical means, be made into a quality product. We do not think so. We think that it is the dealer's responsibility, the health department's responsibility, to see that the raw products that go into a dealer's plant, whether it be an ice cream plant or fluid milk plant, be safe to drink before they go through the mechanical processes so that there will not be any serious outbreak of milkborne disease.

We have a problem in the state along that line. There are about five thousand producers of raw milk. We keep our fingers crossed most of the time, but fortunately we have not had any serious outbreaks of milkborne diseases.

We have just very recently required that all raw milk sold in the state of Pennsylvania be from Bang-tested herds. One of the inconsistencies of the old Act was that Grade A raw milk in Pennsylvania must be from Bang-tested herds but raw milk could be from untested herds, which meant that the farmer, the average individual shipper, applied for a raw milk permit and out of our five thousand raw milk permits we probably had less than one-half of one per cent Grade A raw milk permits.

The number of raw milk producers in Pennsylvania is increasing rather than decreasing. We do not leave the job of supervising the raw milk supplies to any other organization. That is the job of the Department of Health. We do not let an approved inspector do that; we do that work with our own men.

Strange as it may seem, we are getting splendid cooperation from the producer in meeting the requirements of Bang-tested herds, and we are not finding a very large percentage of reactors in the herds of our raw milk producers.

We are only starting the program in the state but we are making considerable progress. We hope that by the time the next season rolls around, particularly the ice cream season, our determination that all ice cream sold in Pennsylvania will be made from the same type of material that goes into a bottle of Grade A milk, will be recognized.

As a matter of fact, there is very little difference in the set-up today in Pennsylvania between Grade A milk and straight milk for pasteurization. If we want to have a differentiation between Grade A milk and milk for pasteurization, we will have to rewrite entirely our Grade A milk requirements because, as they stand today on the statute books of the state, our milk for pasteurization requirements are as high or higher than our Grade A requirements with just two exceptions—the use of a strip cup and a bacteria count.

We have a regular supply of milk for pasteurization coming into many cities today which consistently is below, in bacteria count, some of the Grade A pasteurized milk that is being sold. I think that is moving forward in the right direction. We are about to rewrite our Grade A requirements so that there will be enough difference between the straight milk for pasteurization and Grade A milk to justify the three cents difference in the price to the consumer.

Discussion

Mr. Jennings: Have you had or do you anticipate any difficulty from the Federal Trade Commission or the Interstate Commerce Commission because you say to companies in Minnesota or Seattle, Washington, "Your evaporated or condensed milk can not come into the state of Pennsylvania unless inspected"—or when you say to the manufacturer of butter in Iowa or Minnesota, "Your butter can not come into the state of Pennsylvania unless produced under inspected conditions?"

Mr. Moffett: We have not had any difficulty up to the present time and if we properly interpret the rulings of the United States Supreme Court and other courts, I do not think we will have any difficulty. Every interpretation that I can get hold of and that we have had referred to our Attorney General's department, tells us that a state or municipality has the right to protect the health of its consumers.

If we were asking the manufacturer of butter in Iowa or Minnesota to do something different than we are doing within the state of Pennsylvania, then I think the Federal Trade Commission or Interstate Commerce Commission would have a right to step on our necks. But when we are enforcing in the state the same regulations that we are requiring from anyone else who wants to do business in the state, whether they live in or out of it, I think we are on safe legal ground.

I see no reason why we should ask the farmers of Pennsylvania and the milk dealers and ice cream manufacturers of Pennsylvania to invest enormous sums in plants, equipment, farms, etc. to meet our regulations and then jeopardize that investment (looking at it purely from a monetary point of view) for the dealer or for the farmer in letting the Russians ship butter to Pennsylvania to go into ice cream and be eaten by the consumers of the state of Pennsylvania.

I think the last ruling of the Supreme Court in New York very definitely said that it probably can not regulate prices but when it comes to a health measure, it can protect the health of their consumer, and that is all we are trying to do. We are not trying to establish artificial trade barriers; we are not trying to set up any embargoes or walls around each state. But we are trying to give the consumers of the state of Pennsylvania honest protection in every phase of the industry.

We do not include table butter. In other words, we have nothing to do with the butter that the consumer eats on his table. The only time we ever have anything to do with butter is in its use in the manufacture of ice cream.

The same with evaporated milk. If it goes into chocolate factories we have nothing to do with it, but we do have something to do with milk in tin cans. Of course we have not done anything about it up to the present time.

Mr. Frank: Why do you draw that distinction between butter for ice cream and for table use, for example?

Mr. Moffett: Simply because we realized the absolute impracticability of attempting to regulate and supervise the butter industry from the standpoint of one state. That is a job for the federal government. We believe in taking one thing at a time. We took the ice cream industry because Pennsylvania, I think, stands first in the manufacture and consumption of ice cream and we could not see any logical reason why the youngster who eats an ice cream cone or the patient in a hospital should be subjected to danger from *B. coli* and other organisms. We give them protection when they drink a bottle of milk and should give them the same protection when they eat ice cream.

We did not take on cheese, butter, soups, chocolates, because we are just one little state and chocolate is made in California, butter is made in Russia and in New Zealand, and we could not possibly hope to go to New Zealand and Russia to inspect the farms and factories that make butter. That is the only reason for a distinction.

Secretary Brooks: I would like to ask Mr. Moffett two questions—one with reference to your certificates of approval of milk inspectors. After you have once issued them, do they stand until they are revoked or are they issued periodically?

Mr. Moffett: They have to be renewed every year. Then there is a three dollar renewal fee. They can be revoked for cause without a hearing. In other words, if an inspector is doing a sloppy job or an inefficient job or a dishonest job, we can simply revoke the certificate and he can no longer work for any milk dealer or any permit holder in the state of Pennsylvania; he's through! And when we once revoke those certificates, we very seldom reissue them even though the inspector has a change of heart later on.

Secretary Brooks: When you issue them it is for a year?

Mr. Moffett: For one year.

Secretary Brooks: The other question is where are bacteria counts made on your local milk supplies. Do you have a system of local laboratories?

Mr. Moffett: That is the weakest part of our whole set-up. We have not yet established, even a bacterial standard for milk. We did not have it in our Act up until this past law, which gives the Secretary the right to establish bacteriological standards.

We have some sixty laboratories over the state with directors who are approved by the Department of Health. Those laboratories do the check-testing on A milk. They must furnish us reports once a week on their entire A milk supply, but on the regular B supply we exercise no supervision from a bacteriological point of view.

What we are working toward and what I hope we can accomplish is to lay not quite so much stress on farm inspection but stress more, milk as it comes onto the platform with the known tests that are used in the industry to determine the quality of the milk as it arrives at the station, and then before any farm inspection is made to have the tests as determined at the station and follow them back to correct the conditions, because we know (as all of you know) that you may have ideal environmental conditions and be producing hog swill. That is often true.

Secretary Brooks: What proportion of milk is Grade A?

Mr. Moffett: Philadelphia sells more Grade A milk than any other section of the state, and I think the proportion to bottle milk is about 40 per cent.

Grade A milk sometimes is a mysterious thing. I think I can say safely that there is more Grade A milk sold in Pennsylvania than is produced in Pennsylvania. That is a situation that we are going to correct. We have just engaged a bacteriologist and I expect to use him entirely in seeing that when Grade A milk is sold to the consumer, that it is Grade A milk before it comes into a milk plant,—that it meets with our Grade A requirements for the raw milk before it comes into the plant. That is not true entirely in the state at the present time.

It is too easy to make Grade A milk out of good, high-grade milk for pasteurization, with a little cream added to it, and then three cents differential is paid for that added cream.

Dr. Harding: I can not quite clearly visualize just what part pasteurization is playing in the plans of the Department for safeguarding the dairy products. Can he clarify that a little?

Mr. Moffett: Yes. We have stepped up our entire program so that pasteurization today means pasteurization; it does not mean moving a chart with your finger and inking it in for a temperature—so that when milk is pasteurized it is pasteurized properly under close supervision.

We believe in pasteurization. We believe in closer supervision over pasteurized products. We believe, in addition, that mere pasteurization of milk does not mean that the consumer is getting a quality product. We want to start at the farms first and get the supply right on the farm, at the platform, and then add the factor of safety through pasteurization.

We do not believe in depending entirely on pasteurization to give the consumer what he thinks is a quality product. That is the basis on which our inspection used to operate. We cared very little, previously, except for one thing,—that we could go into a plant and could look at a chart and could see on that chart various and sundry ups and downs with temperatures. We did not go very far back of that chart.

Today we are insisting on better equipment, more efficient equipment; we are insisting on a set-up for plants which is going to put our plants in Pennsylvania in relatively the same position into which we are hoping to bring our farms. In other words, we are trying to work out a well-rounded program starting with the farm, with the source of the raw supplies, getting a quality product there, bringing it up to a plant which is a quality plant operated by a quality operator who is not just selling a commodity but who is selling a food that should be produced in a plant under scrupulously clean conditions, the same as you would expect to find in a hospital or any other place where they are handling food.

That is the ideal we are shooting at, and if you will come to Pennsylvania you will see some plants that have been remodeled in the last year which, before we started to work on them, compared very unfavorably with the farmer's barn. Today they compare very favorably, from the standpoint of construction, fly protection, sanitation, efficient equipment, efficient methods, to any plant—so that when the product is pasteurized we know it has been pasteurized and it is being produced and handled under exactly the same conditions we want it handled on the farm.

We are not stressing one part of the program; we are trying to stress a well-rounded program starting first with quality on the farm, quality all the way through, quality in the plants, so that when the consumer gets either a bottle of raw milk or pasteurized milk, the cap on the top of the bottle means just exactly what it says.

We have a recent development in Pennsylvania in regard to the label. Dealers sometimes are depending on extravagant advertising. For instance, we have a designation for Grade A pasteurized milk. You will find one dealer says it is his "Premier Grade A Raw Milk." Another calls it "DeLuxe Grade A Milk." Another dealer has something else, "Grade A Milk." Those names do not mean a thing from the standpoint of the public. Grade A pasteurized milk is either Grade A milk or it is not Grade A milk. There is not any such thing as DeLuxe or Premier or anything else. They are simply advertising imaginations of a clever copy-writer.

When the Health Department approves the cap on a bottle of milk, the dealer does not have to spend millions of dollars thinking up advertising slogans to try to convince the public that that milk is a quality product.

Mr. Jennings: Do you have in Philadelphia the A, AA, AAA and AAA grades?

Mr. Moffett: Yes, and it does not mean anything.

Mr. Jennings: Is it still on the labels?

Mr. Moffett: It is still used on the labels, and until we get our advisory board health regulations promulgated, there is not much we can do about it. I think we do have, in the Act, enough authority to wipe out all the slogans and extravagant trademarks being used today, but we are waiting until we get our advisory health board regulations and then we are not going to permit anything on the milk bottle cap except the name and address of the dealer, the designation of the milk —whether raw, pasteurized, certified or Grade A,—and then if he wants to blow his own horn he can do it in the newspapers, because the milk bottle cap stands for what the Health Department stands for. We do not know the difference between Premier, DeLuxe or straight Grade A milk.

Mr. Beckett: Mr. Holmquist of New York met me in the lobby last night and said, "I did not know any milk work was being done in Delaware."

After hearing Mr. Moffett, I think I will tell you a little of the milk work that is being done in Delaware. We have only three counties in our little state but all milk control work on both raw and pasteurized milk is completely centralized in the State Board of Health under the Division of Sanitation. We do all the inspectional work, including dairies and pasteurizing plants and collect samples from all the different communities in the State. This applies only to the territory outside of the city of Wilmington which is controlled by the city board of health.

I believe we are the only state in the Union where the work is entirely done by the state board of health and no local work is done at all.

Our regulations are modeled very much after the United States Public Health Service regulations except we have eliminated Grades C and D. In other words, we have Grades A and B pasteurized and Grades A and B raw. The bacterial count for Grade A raw is 50,000 and Grade B raw 200,000.

I thought you might be interested in what this little state of Delaware has been doing the last eight or ten years.

Mr. Bremer: I wonder if I could ask Mr. Moffett to explain briefly the system of indemnity payments to farmers, since you require that for raw producers.

Mr. Moffett: The farmers are signed up under the federal plan which gives them fifty dollars for purebreds and twenty-five dollars for grades. The State has its plan which requires quarantining the animals. It is a question from the standpoint of raw milk; we can not permit that. The animal must, if it reacts, be taken from the farm and slaughtered.

So the work is being done under the cooperation of the federal and state plans.

President Grim: This is a very interesting discussion. I think another answer to Mr. Frank's question as to why we cover butter for ice cream and do not cover it for table use as largely is because we can cover butter for use in ice cream and still have ice cream. If we attempted to cover butter for table use—applying the same standard as for ice cream we would not have any butter for our tables. There is hardly any butter that would meet the sanitary requirements applied to fluid cream or butter for ice cream manufacture.

Butter is unnecessary for ice cream manufacture, since we may use frozen cream so readily. As long as we can store the inspected cream when it is flush and use it during the short periods we can get along without butter. I think if we are going to try to supervise ice cream, we must supervise everything that goes into it.

Maybe some day we can do the same thing with butter for table use.

REPORT OF COMMITTEE ON MILK PLANT PRACTICE

United States Milky Way [1]

EACH morning 30,000,000 quarts of milk are left at United States doorways—milk that must be absolutely pure for though it is the most healthful of all human foods it is potentially the most dangerous. Difficult to realize is the fact that today with milk a part of many a United States schoolroom routine only a generation ago in a single United States city more than 4,000 children were dying every year from but one of the hundreds of diseases which were then being transmitted by milk. Crucial year in the United States milk industry was 1892, milestone in the advancement of public health. In that year, in Springfield, Mass., a typhoid epidemic was first traced directly to infected milk. By 1905 every large United States city had declared open warfare on impure milk. Backed by an army of public health officials, dairies soon had their own inspectors probing every nook and corner where milk was produced, handled or sold. First attack was centered on the sources of supply. Later came the milk bottle. Later still, educational campaigns convinced the public that pasteurization was not harmful. In small centers, where dairies could not afford high cost pasteurizing machines, strict supervision filled the gap. Today few are the cities which boast no model dairies, where cows are pampered and groomed to a degree of contentment undreamed of a decade ago. Yet despite all efforts, the United States does not top the list due to the vast rural districts of the south and midwest, where milk is still sold in bulk. Here stands the last frontier unconquered by milk hygienists, a frontier where aggressive work is under way, bringing nearer the day when all

United States citizens will be safe from the threat of milkborne disease.

Milk Control Boards

Milk control boards are now operating in many states. They fix the price of milk to producers and consumers, also specifying the qualifications for the various grades of milk usually stating the minimum per cent of butter fat for each grade. Other states have milk regulation boards which specify the pre-pasteurized count of each grade of milk as well as the post-pasteurized count. Possibly because of the above mentioned facts some dealers may have slipped some in the matter of quality control, but in the main dealer organizations and milk control officials are carrying out their programs of quality control. In the field methylene blue reductase tests and Breed direct counts seem to be the most prevalent methods in use.

The latter method serves as a guide for the inspector so far as the type organisms in the smear denote the type of contamination.

The Breed direct count seems to be the most helpful to milk control officials at country creameries and city milk plants.

Cold Clarification

For many years milk was clarified at temperatures varying from 85° to 95° Fahrenheit, previous to heating and holding. This procedure was later followed by filtration at 110° to 120° Fahrenheit. The initial cost of a clarifier was high, also the upkeep of same; on the other hand the initial cost of a filter was low and the upkeep not so expensive as a clarifier. Dealers now seem to look with favor on cold clarification.

Mr. Ralph Irwin of Harrisburg, Pennsylvania, states:

"The clarifier certainly removes considerable slime and dirt that would remain in the milk if a filter is used instead of a clarifier. The clarifier costs more money than a filter and usually higher maintenance.

Clarifiers may be used successfully in cold milk. We have been doing so in a number of plants for several years. We must realize that the clarifier usually increases the counts but not the number of bacteria, colonies being broken in pieces through the clarifier."

Professor H. A. Harding makes the following comments:

"The material which accumulates in the clarifier bowl is about the most unattractive looking mass to be found anywhere in connection with dairy products. However, if one attempts to classify this material I think it will be found that it usually carries just about enough dirt to give it a gray color, and the bulk of the material is what is ordinarily classed under milk solids not fat, being a fairly normal element in milk. Many dealers are now returning to clarification."

Mr. Paul F. Kreuger, Chicago, Illinois, states:

"A cold milk filter has recently been put into use in several Chicago dairies. The filter consists of a small sized tank, having a large number of screens made of filter cloth, the milk passing from one screen to another by means of baffles. This outfit is made by a Chicago concern and seems to work satisfactorily."

Milk Plant Design

Many years have passed since this subject was discussed and no doubt the problems are just about as difficult now as they were years ago. The same questions arise today. One story and multiple story plants are topics of discussion. Gravity flow, elimination of pumps, less sanitary lines are still taken into consideration when planning a plant. One story plants with a balcony are still popular; pumping milk to processing equipment on balcony floor and then running processed milk over cooler into filler. Designing plants for a small milk business should be considered by that committee. Usually these plants are located in districts where the sales issue is to patronize the local dealer. These talks accomplish results and over a period of years the business may double or triple; it is an easy matter to increase the processing equipment, add another section to a cooler and install a larger bottle filler. When all these changes are completed we find the milk storage chest too small and no way to increase it, other than to add another story to plant and revamp the entire setup. Large dealers when building a new plant plan facilities for doubling their business and in but few instances will you find much overcrowding in this type of plants.

Milk Equipment

Our Association, through the Committee on Milk Plant Equipment, has been extremely active and progressive. They have offered many valuable suggestions. The matter of valves, thermometers (indicating and recording) have been fairly well settled, also the heating of milk foam. The Committee on Milk Plant Practice is extremely interested in any new developments and depends on the Committee on Milk Plant Equipment for information and advice.

Cleaning Equipment

The cleaning of apparatus used for processing milk is an essential factor in quality control. Many large plants employ cleaning squads who start cleaning at the end of the day's run and have the equipment in good shape for the next day's processing, and naturally there is a laboratory check on their work.

Caseination, or burned-on deposits, are difficulties encountered in many plants. This is usually due to the temperature differential of the heating medium and milk, also failure to cool hot equipment and rinse it quickly and thoroughly after emptying.

This condition is sometimes found in smaller plants where bottling is completed by noontime and the same employees who process, clean the equipment in the afternoon. Small plants can help their quality by running 180° Fahrenheit water throughout the entire equipment before processing the following day.

"When Writing Mention This Report"

Cooling and Transportation

Much stress has been laid on this point, which has resulted in the use of insulated cooling tanks as well as mechanical refrigeration. Following up this practice and completing the job of transporting the milk to the creamery properly cooled was the next problem. Insulated trucks have answered this problem; milk can be transported many miles with a very slight rise in temperature. The advent of refrigerated trucks has reduced the number of country creameries. The government's program of improving roads has been indirectly responsible for this situation.

Refrigerated trucks have been responsible for tank cars. The improved roads have made it possible to collect enough milk to fill a tank car, eliminating the use of forty-quart cans at the creamery. These cans must be washed at city plants and again at country creameries. Now they are washed at country plants, and if properly handled cans can be returned to producers in a clean condition.

Tank cars are easily cleaned, and if properly cared for at country creamery before filling no trouble will be encountered.

Mr. Ralph Irwin states that the cooling of the milk at the farm is of major importance so far as quality goes. It also has a health significance in that high temperature at the farm promotes a growth of organisms producing toxins. This is not affected by pasteurization. In fact there is no way to overcome the damage done by bacterial growth. We can do more to increase the consumption of milk by properly cooling the night's milk at the farm.

Bottle Washing

Manufacturers realizing the necessity of scaling down the size of bottle washers to meet the needs of smaller dealers have placed on the market soaker washers to handle the product of a six-route milk dealer, and needless to say small dealers have taken advantage of this situation. Some of the first types of soaker washers were not built for temperatures exceeding 130° Fahrenheit. The latter type of soaker washers surmounted all of these difficulties.

Smaller plants using plate washers must insist that the prerinse remove all loose milk from bottles and a thorough check must be made on jets at frequent intervals through the run. Mr. Matthews of Miami, Florida, explains their method:

"Our larger plants use soaker washers and our small plants are all required to have steam chambers for sterilization of bottles and all movable equipment. We ask for 180° Fahrenheit for twenty to thirty minutes in steam chest or chamber."

Mr. D. K. Douglas, of Saskatchewan, states:

"We have no regulations regarding temperature, but we have insisted that where machine washed, the temperature should not be less than 160° Fahrenheit. Small dealers are compelled to wash in water at 130° F., rinse at 160° to 180° F., then steam not less than twenty-five pounds pressure for thirty seconds.

Mr. Irwin presents the Pennsylvania regulations:

"We require the Soaker Type Washer to heat the bottles to not less than 165° F. for a period of not less than three minutes. On the older type machines we can not heat them this length of time, we require hot water jets at 180° F. Some inspectors are willing to accept cans and bottles washed by the cold process. Our experience with chlorine on the farm and in a plant has indicated that we are not ready to do away with heat. We allow the use of chlorine at any point in the washing process, and in any strength desired, provided the chemical is removed in the final washing process.

Mr. Paul Kreuger suggests the following:

(1) The proportion of caustic alkali in relation to soda ash shall be at least two to one.

(2) The amount of caustic alkali permitted is a minimum of 1.6 per cent reckoned as N•OH.

(3) The minimum temperature of the soaker washer solution shall be 120 degrees Fahrenheit.

(4) Bottles shall be submerged in the caustic solution for at least five minutes.

(5) Final sterilization of the bottle shall be by means of live steam, hot water or an approved solution containing not less than 50 parts per million of available chlorine.

A suitable device for testing the amount of caustic alkali present in the solution shall be provided and used daily.

The alkali solution shall be renewed at least every two weeks, or oftener when deemed necessary by the Board of Health.

Milk Plants for Milk and Milk Products

Recent developments have forced milk dealers into the sale of orange drinks, coffee, eggs, mayonnaise, none of which have any direct connection with milk.

Sellers of orange drinks in some instances call to the attention of consumers the Vitamin C content of this product.

Recently much research work has been carried on by Mack, Fellers, Maclinn & Bean at Amherst [2] on this subject. They state: "Some states specifying standards for orange drinks such as orangeade to be called such must be made from orange juice, sugar and water in such proportion that the finished drink shall not contain less than fifteen per cent of orange juice."

A number of states and cities require that orange drinks be processed in equipment (or rooms) not used for the handling of fluid milk.

While some dairy orange beverages are fairly antiscorbutics, they contain on the average only ten per cent as much Vitamin C as fresh orange juice.

Fresh orange juice contains 228 to 258 units of Vitamin C. Many dairy orange beverages can not be considered satisfactory substitutes for fresh or canned orange juice as carriers of Vitamin C.

Reconstructed dairy orange beverages rapidly lose their Vitamin C content on standing at room temperature. The loss at cold storage temperature is much less but is still considerable.

I have been informed by Mr. Douglas that the Province of Ontario in Canada by recent legislation has taken

the same action as the state of New Hampshire and he further adds: "I hope our association takes a definite stand on this matter."

With but one exception the members of this Committee who replied believe that the bottling of orange juice in milk plants should be forbidden.

It seems peculiar that a committee of this type should not make some comments on pasteurization. Many of the members thought that enough had been written on this subject. Other members referred to short time pasteurization.

A. R. Tolland, *Chairman*

H. A. Harding	C. B. Matthews
C. A. Abele	D. K. Douglas
Paul F. Krueger	W. B. Palmer
H. R. Estes	Ralph E. Irwin

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THE SCOPE OF THE MILK SANITATION STUDIES OF THE PUBLIC HEALTH SERVICE

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DURING the past ten years the milk sanitation studies of the Public Health Service have included projects designed to answer the following questions:

(1) How frequently do milkborne outbreaks of disease occur?

(2) To what extent do American communities attempt to control milk supplies and to what extent are their citizens protected by such major measures as pasteurization, tuberculin testing, abortion testing, etc.?

(3) How can processes of pasteurization be tested to determine whether they are effective, and how can the efficiency of various types of pasteurization be compared with each other?

(4) How can processes of germicidal treatment of dairy and milk plant equipment be tested to determine whether they are effective, and how can the efficiency of various treatment methods be compared quantitatively?

(5) How should pasteurizer inlet and outlet valves be designed?

(6) Are air and foam heaters necessary and how should they be designed and operated?

(7) What is the cost of strict enforcement of the type of milk ordinance recommended by the Public Health Service?

(8) Does pasteurizing or otherwise heating milk significantly affect its food value?

(9) What is the public health significance of keeping milk cold in the home?

(10) Can the Public Health Service milk ordinance be successfully applied to a very large city?

Following is a brief discussion of each of these projects:

(1) How frequently do milkborne outbreaks of disease occur?

This question forms the subject of an annual study by the Public Health Service. When the present milk investigations program was begun the only available information on milkborne outbreaks was that contained in compilations of outbreaks which had found their way into the literature. It was suspected that many outbreaks were not described in the literature. Hence in 1923 we instituted an annual questionnaire survey addressed to all state health officers and to all local health officers of municipalities of 10,000 population and over. Whereas prior to the inauguration of these annual studies the number of outbreaks reported annually in the literature averaged approximately six, the annual surveys of the past ten years indicate that the average is at least 43.5 milkborne outbreaks per year.

(2) To what extent do American communities attempt to control milk supplies and to what extent are their citizens protected by such major measures as pasteurization, tuberculin testing, abortion testing, etc.?

These studies are intended to be repeated every four or five years. The first study was made in 1927 and was limited to statistical compilations of the extent of pasteurization and tuberculin testing in municipalities of 10,000 population and over. The study was repeated in 1931 and developed the interesting fact that for this population group the mean percentage of milk pasteurized had increased from 81.8% in 1927 to 87.5% in 1931, and the mean percentage of milk from tuberculin tested cows had increased from 68.1% in 1927 to 88.7% in 1931.

During the past year a much expanded study of the same type has been in progress. The expanded study seeks answers to a great many additional questions. It also includes communities of less than 10,000 population. That part of the study is being conducted in collaboration with the "Committee on Improving Milk Supplies in Small Communities" of this Association. The report of this Committee will be presented during this session.

It is believed that these studies should be repeated every four or five years in order that we may become apprised from time to time of the weak points in the battle line. The weakest point in the present battle line is the almost unbelievably large number of communities of under 10,000 population which have practically no protection against milkborne disease.

(3) How can processes of pasteurization be tested to determine whether they are effective, and how can the efficiency of various types of pasteurization be compared with each other?

Our first attack on this problem was to test various types of pasteurization apparatus by means of thermometers or thermocouple equipment and determine the deviations in temperature during the holding period between the hottest and coldest particles of milk. From these results was derived a maximum allowable temperature tolerance. It was concluded that no apparatus should be approved which showed a temperature deviation greater than 1°F. It was further concluded that all major types of thirty-minute equipment could relatively easily be constructed and operated to comply with such a requirement.

The definition of thirty-minute pasteurization contained in the present Public Health Service milk ordinance was based on these conclusions. The temperature required to be shown by the indicating and recording thermometers was set at 142°F. plus a 1° tolerance to cover deviations in milk temperature, and plus a ½°F. tolerance to cover permissible deviations in thermometer accuracy. If now we accepted 142° for thirty minutes as lethal if applied to every particle of milk we might rest assured that apparatus designed and operated in accordance with the above definition would prevent milkborne outbreaks.

However, when the problem of high-temperature short-time pasteurization arose, we found ourselves in relatively uncharted waters. While some laboratory work had been done at the higher temperatures, the results were neither sufficiently consistent nor convincing to justify the assumption that at 160°F. any given holding time was sufficiently effective.

Accordingly, when we tested 160° pasteurization in collaboration with several state boards of health we resorted to the use of a criterion pathogen. Milk was heavily inoculated with cultures of bovine tuberculosis and passed through the full scale apparatus. From this work it was concluded that a fifteen-second holding time would be more than ample to devitalize tuberculosis, and from this work was derived the second part of the definition of pasteurization now contained in the Public Health Service milk ordinance.

However, valuable as were these two projects on thirty-minute and fifteen-second pasteurization, and while they did give assurance that either method would prevent milkborne outbreaks of disease they did not answer the important question "Which of the two methods has the greater factor of safety?" We really do not know today the exact temperature which in fifteen seconds will have the same lethal effect as 142° F. in thirty minutes. For all we know 160° F. for fifteen seconds may really be safer than 142° F. for thirty minutes, or vice versa.

Again, it is highly probable that in the future other combinations of time and temperature than 142° F. for thirty minutes and 160° F. for fifteen seconds will be suggested. It may be proposed, for example, that milk be held for five minutes at 150° F. instead of for thirty minutes at 142. This would greatly increase the capacity of a given plant without increasing the holder volume. There would seem to be no defensible reason for condemning such a proposal if it can be demonstrated that five minutes at 150° F. is really the equivalent of thirty minutes at 142° F.

For the above reason the Public Health Service has been engaged on the isolation of a nonpathogenic organism which is somewhat more heat resistant than the most heat resistant milkborne pathogen, and which is consistent in its behavior. We are studying nonpathogens because the use of nonpathogens will permit research under safe conditions in milk plants. We hope to find one which is consistent in its behavior in order that the results of two given series of observations may be fairly comparable with each other.

If we closely determine the characteristics of such an organism and then fix on a standard percentage killing which may be used as an adequate criterion of heat treatment we can then test each of the various methods of pasteurization and each of the individual designs and determine for each one its relative factor of safety. All that we need do is to determine for each method or each design the lowest temperature which at any given holding period will yield the above mentioned standard percentage killing. Then if we wish to express the temperature factor of safety afforded by the 142°-thirty-minute combination we need merely give the difference in degrees between 142° F. and the temperature for which thirty minutes yields the standard percentage devitalization. Similarly we can determine the temperature factor of safety afforded by 160° F. at fifteen seconds and thus compare the two.

Suppose now that we find the temperature margin of safety at 142° F. to be six degrees, and suppose it is decided that the same margin should be required for all time and temperature combinations. If then the industry wishes to use a five-minute holding period we can easily determine the required pasteurization temperature for this holding time by determining the temperature which in five minutes will yield the standard percentage killing of our test organism, and by adding 6° F. to that.

It is too early to say whether our efforts in the above direction will be finally successful, but the attainment of such a goal is certainly worth much effort.

(4) How can processes of germicidal treatment of dairy and milk plant equipment be tested to determine whether they are effective, and how can the efficiency of various processes be compared?

This is a somewhat similar problem to the immediately preceding one. It may prove to be the more difficult of the two. It will involve an intensive study not only of heat methods, but also of chemical methods. We have used our test organism to make preliminary studies of the relative efficiency of various chlorine compounds. Our plan of procedure is to determine for each chlorine compound the number of parts per million required to produce a standard percentage killing of a standard concentration in a standard time, at a standard temperature, at a standard pH, and with a standard concentration of organic matter. For the three latter the standard will be the least favorable magnitude observed in actual practice. This study is important because the chlorine compounds at present on the market appear to vary considerably in their relative efficiency.

(5) How should pasteurizer inlet and outlet valves be designed?

We have been engaged upon this problem for a number of years and some of the results of our work are now contained in the Public Health Service Milk Code. It has become evident that the principles which should underlie the location of leak grooves, air vents, and stops, are not sufficiently generally understood. We are contemplating the release of a publication which will discuss our studies on this problem in more detail than is possible in the Code.

(6) Are air and foam heaters necessary and how should they be designed?

Our studies on this project have shown that milk foam is nearly always insufficiently pasteurized and we have worked out designs of air heaters which appear to function satisfactorily. We are contemplating a publication which will discuss these studies and designs in more detail than is possible in the Code.

(7) What is the cost of strictly enforcing the Public Health Service milk ordinance?

This project was undertaken last year and the results are included in reprint No. 1723 from the Public Health Reports.* The study showed that the Public Health Service milk ordinance is not prohibitively costly to enforce. The mean cost reported by the seventy-four cities which were strictly enforcing the ordinance, as shown by ratings of 90 per cent or higher, was 8.3 cents per capita per year or one-half cent per gallon. This means that such milk control increases the taxes of a family of four only thirty or forty cents per year. Certainly this can not be considered too much to pay for protection against milkborne disease.

(8) Does pasteurization significantly affect the food value of milk?

This research project was undertaken several years ago and the results for children of ten months to six years of age were published in reprint No. 1549 from the Public Health Reports.† They showed that the growth promoting capacity of milk is not significantly affected by pasteurization or other heating if account is taken of the supplementary diet received by children in that age group. It is hoped that some time in the future it may be possible to extend this study to infants of ten months and younger.

(9) What is the public health significance of keeping milk cold in the house?

* Reprint No. 1723 "Study and Analysis of the Cost of Local Milk Control."
† Reprint No. 1549 "Do Children Who Drink Raw Milk Thrive Better Than Children Who Drink Pasteurized or Other Heated Milk?"

The work done on this project has included attempts to answer such questions as the following: How much does the housewife increase the bacterial count of milk during the period it remains in the ice box if she allows it to become warm on the door step and places it in the ice box in its warm condition? If typhoid fever or diphtheria organisms happen to be present in the milk, how much will this practice increase them in number? This work has been completed and the manuscript is ready for distribution.

(10) Can the Public Health Service milk ordinance be successfully applied to a very large city?

Because of the fact that the Public Health Service milk ordinance was first adopted by relatively small southern communities it was seriously questioned whether such an ordinance could be sufficiently flexible to meet the conditions existing in large cities. During the past ten years the ordinance has been adopted by progressively larger and larger cities. Last year it was adopted by the city of Chicago. Through the courtesy of Dr. Herman N. Bundesen, president of the Chicago Board of Health, the Public Health Service has been closely studying the progress of the enforcement of the ordinance in that city. If the results are successful, as our studies to date seem to indicate they will be, this should finally settle the question as to whether the Public Health Service milk ordinance is sufficiently flexible to be adapted to population groups varying in size from less than 10,000 to more than 3,000,000.

EXPERIENCES IN MEETING MILK FLAVOR PROBLEMS

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MY FIRST experience as a teacher dealing with milk flavor problems was on an occasion when I was invited by a buyer of market milk to visit with him the market milk dairies in an alfalfa growing section in California. The buyer asked me what feed might be given to cows along with alfalfa to modify the alfalfa flavor in milk. My reply was that I did not know but I would try to find out. The following semester two senior students were given this problem on which to work. They fed different quantities of alfalfa and silage to dairy cows so that the feeds were consumed at intervals of one, two, three, four, and five hours before milking. They also fed oat hay to cows, which gave very little flavor to milk, and a mixture of alfalfa and oat hay. The conclusions of this study were that ten pounds of alfalfa hay or twenty-five pounds of green cut alfalfa would give a distinct feed flavor to milk but it was most prominent when the feed was placed before the cows two hours before milking. They also fed a mixture of oat and alfalfa hay and we concluded that alfalfa contained a definite quantity of flavor-producing materials and if the same amount of alfalfa was fed, other feeds containing less flavor-producing materials would not modify the flavor of the alfalfa unless the quantity of alfalfa fed was reduced.

Normal Constituents of Milk Influencing Taste

When samples of milk were taken of each cow in the station herd to decide which cows would be used for the feeding experiments referred to above, it was observed that the milk from certain cows had a more pleasant taste than that produced by others. We were concerned in finding out the cause of this and particularly in the study carried out by the writer in association with G. A. Koestler of the Swiss Dairy and Bacteriological Experiment Station. We determined that lactose or milk sugar gave the normal mildly sweet taste to milk and that the relation between the lactose and chlorides of milk determined the pleasantness of taste. In general, cows producing the higher lactose percentage in their milk produced better tasting milk provided the chloride percentage was relatively low. This chloride-lactose relation is believed to be most concerned with the natural pleasant taste of milk, but if flavor-producing feeds are consumed by cows during the last four or five hours before milking the feed flavor will obscure the more delicate taste of the lactose and chlorides and the flavor of the milk will be less pleasing.

When ordering milk in a restaurant in a town on the Pacific Coast, I was served a bottle of milk with the feed flavor so strong that it was almost unpalatable. This experience was a decade or so ago when little thought was given to the subject of feed flavors in milk. Sufficient publicity has been given to this subject in recent years to encourage producers of market milk to regulate the time of feeding their cows so that feed flavors are not now nearly so prevalent in market milk. When flavor-producing feeds are withheld from cows during the five-hour period before milking, objectionable feed flavor will not usually be observed in the milk.

Rancidity of Milk

My first experience with rancidity of milk was at the Dairy Experiment Station at Liebefeld, Bern, Switzerland, where I was studying the subject of milk flavors. When sampling milk from each cow of the station herd, one animal was found to produce milk which became rancid six hours after the milk was drawn. The flavor was described as bitter-rancid and has been reported by Palmer as resulting from the presence of the lipase ferment in the milk at the time it is drawn from the udder. This milk, when mixed with normal milk from other cows, will cause the mixture to become rancid after it has stood for twelve or more hours, and when it was mixed with normal milk, as little as 5 per cent of the rancid milk when mixed with milk from other cows will cause an off-flavor in the milk.

Several other cases of rancid milk being produced by individual cows have been studied. In one instance, two of seventeen cows produced milk which became rancid within a few hours after it was drawn from the cows and when the milk from these two cows was mixed with the other fifteen, an off-flavor was developed and caused most of the customers to discontinue taking milk from the dairy concerned. When samples from each of these cows were collected and the rancid samples identified and the milk from these cows kept separate, there was no further trouble with rancid milk.

In another dairy supplying market cream to milk distributors, I was told that the milk had a bad odor and flavor and could not be accepted unless the condition was overcome. Nineteen cows were concerned. Samples were taken from each cow and brought to our dairy laboratory. Two of these samples showed rancid odor and flavor. These cows were separated from the herd and no further complaints received from the milk produced by the other seventeen animals.

In another instance milk from an individual cow was brought to the laboratory for examination. It developed a rancid odor and flavor characteristic of milk which contains the lipase ferment. The animal was examined by a veterinarian and pronounced normal, but the cow had been milking for about a year and a half. The owner was advised either to dry the cow or to pasteurize the milk.

The milk was heated to a temperature of 145°F. for thirty minutes and then allowed to cool. This prevented the development of rancid milk. A survey of 536 cows supplying the college creamery showed 3.17 per cent of the cows producing milk which became rancid twelve hours after the milk was drawn. These samples were taken during the winter months when there is a larger percentage of animals advanced in lactation. This condition was observed more commonly in cows advanced in lactation which had been milked a year or more without freshening. Some of the cows milked less than a year but which were soon to freshen also produced milk that became rancid. Three cows in the station herd were found to be producing rancid milk. Two of them had been milking for over a year.

Rancidity in milk and cream caused by lipase is an important problem. If the dairyman is distributing raw milk, the milk from one cow mixed with several will cause the mixture to become rancid after twelve or more hours. If the milk distributor is buying milk in a rural section, separating it and shipping the cream to the city raw, the entire cream supply may become rancid after fifteen to twenty hours. The remedy for the producer is to check the flavor of milk from each cow six to twelve hours after it is produced. Rancidity is easily recognized by odor and flavor. If the cream supply is reaching the city rancid, the best immediate remedy would be for the milk to be delivered to the country receiving plant soon after each milking, separated and the cream pasteurized. This will destroy the lipase ferment and prevent the development of rancidity.

Oxidized Flavor of Milk

About five years ago I visited a city of 100,000 population. I took my lunch in a local cafeteria and the milk served was extremely oxidized. I had an opportunity of

visiting the pasteurizing plant from which this milk was sold and there was exposed copper in many places in the plant. The milk cooler had several pipes with the tin partially removed and the yellow copper exposed to the milk as it passed over the cooler. The pipe lines were all made of tin copper and most of the tin had been removed from the effect of brushing and the use of washing solutions. Bronze milk pumps were used and nearly all the tin had been worn from the surface. There was scarcely a piece of equipment in the plant that did not offer opportunities for chemical action by the milk in dissolving iron and copper and adding to the metal contamination of the milk. I had an opportunity of speaking to a group of dairy people in that town while I was there and I discussed the subject of flavors in milk and pointed out some of these conditions which up to that time had been given little consideration by the dairy industry. The plant to which I refer has since given this subject consideration and has installed chrome nickel iron equipment whenever its use could be applied to advantage. This, of course, is one of the first steps to take in overcoming oxidized flavor in milk unless frequent tinning of plated metals can be carried out.

During the years 1930 and 1934 inclusive, a record was kept of the flavor criticisms of more than 100 samples of pasteurized milk entered in the California State Fair dairy products contests. From 17 to 29 per cent of the samples scored for flavor were reported to be oxidized. Oxidized flavor is more common in pasteurized milk than in raw milk because the metals causing oxidization are more soluble in hot milk than in cold milk. Apparently also the warmer temperatures stimulate chemical changes which cause oxidization in pasteurized milk to take place more rapidly.

Some manufacturers of dairy equipment have sold milk pipes and fittings made of so-called "white metal." Although this metal does not show the copper color, it contains a high percentage of copper in combination with nickel and other metals. It has been found to affect the flavor of the milk similarly to that produced by Monel metal and pure copper. A market milk pasteurizing plant in San Francisco was having complaints about the flavor of the milk which they sold. They referred the complaints to the dairy supply company from whom the equipment was purchased. Samples of milk were taken from each of the dairymen producing the milk and from the milk as it passed through different pieces of equipment in the plant. The samples were submitted to the College for flavoring and oxidized flavor was found in those samples where warm or hot milk had passed through the white metal pipe lines, while none of the raw milk coming from the dairies showed oxidization. It is worthy of note that the first milk coming through the pipe lines and that passing through the pipes during the succeeding one or two hours showed more oxidized flavor than the milk passed through the pipe lines after four hours' operation. This difference in the amount of oxidized flavor in different portions of milk is explained by the presence of salts which form on the moist inner surface of the pipe lines after sterilization (these are observed as a green stain in the case of copper), and after the milk has passed through a pipe line for several hours, the surface becomes more or less coated with milk solids and the milk passing through the pipe lines is less exposed to the action of the metal.

The California Experiment Station Staff working with Professor E. S. Guthrie * of Cornell University has carried out an extensive study of the influence of the common metals on the flavor of milk. In the beginning it con-

* Corrosion of Metals by Milk and its Relation to the Oxidized Flavors of Milk. E. S. Guthrie, C. L. Roadhouse and G. A. Richardson. Hilgardia, Vol. 5, No. 14, March, 1931.

firmed the earlier work of Hunziker.* Guthrie, Roadhouse and Richardson drew the following conclusions concerning the action of various metals on the flavor of milk.

Copper, and copper alloys, such as ambrac, brass, bronze, monel metal, nickel silver (German silver), and Waukesha metal showed weight losses when exposed to sweet milk and produced oxidized flavors in such milk.

Tin plated copper or copper alloys were unsatisfactory on account of mechanical wearing away of the plating. Chromium-plated copper was less satisfactory in this regard than tin plated copper.

Pure nickel showed high weight losses and became badly clouded when exposed to sweet milk. This metal often induced oxidized flavors in milk.

The chromium alloys, Ascoloy and Enduro A, showed little or no weight losses and remained clear in appearance, but in certain milks induced slight oxidized flavors.

The chromium-nickel alloys—Enduro Nirosta KA 2 and Allegheny metal—when well polished, pure aluminum, glass enamel, and carefully tin plated metals showed little or no weight losses, remained clear in appearance, and produced no oxidized flavors when exposed to sweet milk.

Aeration of the milk during the pasteurization procedure (144°F. for thirty minutes with an additional sixty minutes for raising and lowering the temperature) increased the tendency for the development of oxidized flavors.

Influence of Sunlight on Milk

As early as 1920, Hammer and Cordes reported that brown glass milk bottles protected milk from the action of sunlight which was reported to influence the flavor of milk. Later studies by several workers has indicated that

* Metals and Their Various Influences on Milk. O. F. Hunziker. Proceedings World Dairy Congress 1928, pages 136-150.

sunlight is an important factor in causing off-flavors in milk. Although the change in the milk caused by sunlight is believed to be due to the oxidation of fat, direct sunlight will change the flavor of milk during the period of exposure whereas oxidized flavor from the contact of milk with metals develops slowly, not being noticeable until after one to three days in storage. The oxidized flavor has been noted in milk exposed to direct sunlight for as short a time as ten minutes while indirect light will cause the flavor within forty-five minutes during summer months. Sunshine flavor in milk is largely controlled if the distributing truck is covered to protect the bottles from sunshine during delivery and if the householder takes the milk inside as soon as it is delivered.

Conclusions

Sufficient knowledge is available to make it possible to produce milk free from all objectionable tastes, flavors and odors.

Milk producers and distributors supplying some cities with milk are interested in this subject and are applying this knowledge with benefit to the consumers and to their respective businesses.

If the consumption of fluid milk is to be maintained or increased, the product must be kept uniformly palatable from day to day. If it has an unpleasant flavor, many persons will not use it or they will take only limited quantities when a larger amount would be beneficial.

Since milk distributors in large cities do not usually produce the milk which they sell, they should check for taste and flavor all that they purchase and should withhold from distribution any that is not pleasing to them.

THE INFLUENCE OF METHOD OF STERILIZING EQUIPMENT ON DEVELOPMENT OF OXIDIZED FLAVORS IN MILK *

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IT IS very probable that an effect of certain metals upon the flavor of milk was observed from the very beginning of the extensive use of metals for equipment at the close of the last century. Both tin and oak were recommended for dairy equipment from 1850 to 1875. Commencing about 1920 the effect of metals on flavor of milk has been subjected to numerous studies probably due to the development of new alloys and to marked improvement in the quality of milk products. It is now generally conceded that this flavor (metallic, cappy, cardboard, stale, or oxidized) might develop in milk not subjected to exposure to either iron or copper. The development of the oxidized flavor is accelerated by increased copper content of the milk, by pasteurization at 63°C. for thirty minutes, by very low bacterial counts, and by elimination of green feeds in the rations of the cows. It is also known that the contamination of milk with copper and iron is greatest in the first milk through the equipment and that such milk becomes oxidized in flavor.

In 1932 it was noticed in our dairy operations that chlorine sterilization of equipment greatly accelerated the development of oxidized flavor when compared with hot water sterilization. It was believed that this effect was due to high copper contamination and experiments were planned to establish this relationship.

* This investigation recently appeared in detail in the *Journal of Dairy Science*.

Experimental Methods

Milk Production Methods

In these studies it was planned to have all conditions favorable to the development of the oxidized flavor except metal contamination. The experiments were conducted in January, February, and March when the cows were on winter feeds. Bacterial counts were held low by careful cleaning and sterilization of equipment used in the barn. Pails, cans, etc., were sterilized in a cabinet heated to 200°F. for ten minutes and this cabinet also served as a drier. The milking machine rubber parts were sterilized with hot water at 165-170°F. for two minutes immediately after and just before use. No chlorine was employed for sterilizing any of the barn utensils.

Contact of the milk with all metals except aluminum was avoided until the milk reached the pasteurizing room. The milk passed through rubber tubes into aluminum pails. It was poured directly into aluminum cans which were placed in ice water for cooling the milk. The only contact with any other metals was a well tinned stopcock in the milk line at the head of the milking machine pail.

In the pasteurizing room the milk was stirred in the aluminum cans, and sampled for bacteriological analyses, for copper and iron determinations, and for flavor and keeping quality. It was then emptied into a twenty-gallon well tinned copper tank, pumped through a bronze rotary pump, through a filter into a 125-gallon spray vat pasteurizer lined with 18-8 alloy steel. The sanitary piping was nine feet in length and was an alloy of iron, nickel, and copper. After pasteurization at 143°F. for thirty minutes the milk passed through four feet of piping to a surface tubular cooler on which it was cooled below 40°F. before entering aluminum cans. The first twenty-five pounds of milk off the cooler were caught in a sterilized can, the next twenty-five pounds in another sterile can, then the next fifty pounds, then the next 100 pounds, then the next 100 pounds, and finally another 100 pounds. Samples were secured of each consecutive batch of pasteurized milk for analysis and flavor tests.

Sterilization Procedures

The principal objective of the investigation was to establish the relationship of the method of sterilization to the development of oxidized flavor. When hot water sterilization was employed, water at 165-170°F. was pumped through the pipe line into the pasteurizer and over the cooler for a period of five minutes just prior to use. Two methods were followed with chlorine sterilization. In the one instance fifteen gallons of a chlorine solution with a sodium carbonate base, containing 100 parts per million of available chlorine were pumped through the equipment at 100°F. Immediately thereafter the milk was pumped into the pasteurizer. A period of nearly one hour elapsed before the hot milk began to flow over the cooler. In another series of tests the contact of the chlorine solution with the metal lasted for five minutes after which period water at 165-170°F. was pumped through the equipment with the thought that the action of chlorine on the metal would be stopped by the rinse. In all instances sterilization was accomplished just prior to use of the equipment.

Keeping Quality Tests

The cooled milk was promptly placed in sterilized pint glass bottles and stored at 34-40°F. At the end of one hour, and one, two, and three days a bottle of each sample was warmed to 80°F., scored independently by three judges, and discarded.

Bacteriological Methods

The bacterial content of the raw and pasteurized milks was estimated by the plate method and the methylene blue reduction test following Standard Methods. It was recognized that more accurate procedures might have been employed to estimate bacterial numbers but the methods employed were ample to establish the point under consideration, namely that the milk was of low bacterial content. Bacterial counts and methylene blue tests were made in duplicate on each sample of milk each time that it was scored for flavor.

The bacteriological data obtained are not presented in detail as they are negative and it is important in this study only to know that the count was very low. All samples of raw milk when fresh and after storage at 34-40°F. for one, two, and three days gave a standard plate count which varied from 1,200 to 8,000 with the majority of counts ranging from 2,000 to 5,000. The methylene blue reduction time of the fresh and aged raw milks varied from eleven to twenty-five hours with the majority of periods ranging from eighteen to twenty-two hours. The bacterial counts of the fresh and aged pasteurized milks were nearly all below 100 and no count exceeded 250. The methylene blue reduction periods for the pasteurized milks varied from fifteen to thirty hours with a majority of tests from twenty to twenty-five hours. These data clearly exclude bacteria as a cause or a preventive of the oxidized flavor.

Analysis of Milk for Copper and Iron

The analytical procedures which we have used were the diethyldithiocarbanate method for copper and the thiocyanate method for iron.

Results

The results secured from two series of experiments using hot water at 165-170°F. for sterilization of the pasteurization equipment are given in Table 1. The footnotes to Table 1 which summarize the bacterial counts and methylene blue reduction periods indicate a very low bacterial content which others have shown to be inducive to oxidized flavor. In the table each score on flavor is the average of three judges scoring independently.

Table 1

KEEPING QUALITY AND THE COPPER AND IRON CONTENT OF MILK PASTEURIZED AND COOLED IN EQUIPMENT STERILIZED WITH HOT WATER

MILK SAMPLE		FLAVOR SCORES				MG. PER 1000 GM. MILK		
No.	Treatment	1 hour	1 day	2 days	3 days	Copper	Iron	Total
W 10	Raw	22.8	22.3	21.2	22.1	0.172	0.302	0.474
W 11	Past. 0–25 lbs.	23.0	22.5*	17.0*	17.5*	0.863	0.457	1.320
W 12	Past. 25–50 lbs.	23.0	23.0	21.0*	17.8*	0.244	0.453	0.697
W 13	Past. 50–100 lbs.	23.0	22.8	22.8	21.8	0.230	0.289	0.519
W 14	Past. 100–200 lbs.	23.0	23.0	22.8	22.3	0.224	0.293	0.517
W 15	Past. 200–300 lbs.	22.7	23.0	22.8	22.3	--------	--------	--------
W 16	Past. 300–400 lbs.	23.0	22.8	23.0	22.5	--------	--------	--------
W 20	Raw	22.4	22.2	22.8	22.2	0.104	0.324	0.428
W 21	Past. 0–25 lbs.	22.5	21.3*	19.8*	19.3*	0.223	0.345	0.568
W 22	Past. 25–50 lbs.	22.8	23.0	22.7	21.9*	0.157	0.325	0.482
W 23	Past. 50–100 lbs.	23.0	22.8	22.7	22.2*	0.146	0.319	0.465
W 24	Past. 100–200 lbs.	23.0	23.0	22.8	22.8	0.153	0.324	0.477
W 25	Past. 200–300 lbs.	23.0	23.0	22.8	22.7	--------	--------	--------
W 26	Past. 300–400 lbs.	23.0	23.0	22.8	22.8	--------	--------	--------

* Oxidized according to at least two of the three judges.

W 10—Plate count 2,300 to 7,200; methylene blue reduction time 11 to 16 hours; 5.1 per cent fat.

W 11–W 16—All plate counts were less than 100; methylene blue reduction time 17 to 22 hours.

W 20—Plate count 4,900 to 7,600; methylene blue reduction time 17 to 19 hours; 5.2 per cent fat.

W 21–W 26—All plate counts were less than 100; methylene blue reduction time 17 to 26 hours.

It will be noted that the raw milk and the hot milk which passed through the equipment after the first fifty pounds had been through, kept well for three days without the development of oxidized flavor. All samples of milk were of excellent flavor when one hour old. However, the first twenty-five pounds of milk through the equipment developed a trace of oxidized flavor in one day and was bad in two days. The second twenty-five pounds of milk through the equipment developed an oxidized

flavor in two or in three days. It should be borne in mind that the tendency of this milk to develop the oxidized flavor was accentuated by the passage through only four feet of piping and over a tubular cooler.

The iron and copper content of the milk markedly increased by exposure to the metal but the increase was very small after the first fifty pounds of milk had passed over the cooler.

Table 2
KEEPING QUALITY AND THE COPPER AND IRON CONTENT OF MILK PASTEURIZED AND COOLED IN EQUIPMENT STERILIZED WITH A CHLORINE SOLUTION

MILK SAMPLE		FLAVOR SCORES				MG. PER 1000 GM. MILK		
No.	Treatment	1 hour	1 day	2 days	3 days	Copper	Iron	Total
C 10	Raw	22.0	21.8	22.2	20.8	0.155	0.456	0.611
C 11	Past. 0–25 lbs.	19.5†	17.3*	15.3*	15.3*	0.335	0.675	1.010
C 12	Past. 25–50 lbs.	21.8	22.1	17.3*	16.6*	0.313	0.550	0.863
C 13	Past. 50–100 lbs.	23.3	22.5	21.2	16.6*	0.245	0.537	0.882
C 14	Past. 100–200 lbs.	23.3	22.8	22.5	19.0*	0.203	0.537	0.740
C 15	Past. 200–300 lbs.	23.3	22.5	22.0	18.7*	....	....	....
C 16	Past. 300–400 lbs.	23.5	22.8	22.2	20.8*	....	....	....
C 20	Raw	22.8	21.8	21.5	21.2	0.096	0.363	0.459
C 21	Past. 0–25 lbs.	21.0†	16.8*	17.6*	14.3*	0.177	0.451	0.628
C 22	Past. 25–50 lbs.	22.7	22.2*	20.7*	20.2*	0.155	0.369	0.524
C 23	Past. 50–100 lbs.	23.5	22.3	21.0	21.1*	0.137	0.370	0.507
C 24	Past. 100–200 lbs.	23.5	22.8	22.0	21.5	0.121	0.366	0.487
C 25	Past. 200-300 lbs.	23.0	22.8	22.0	21.3	....	....	....
C 26	Past. 300–400 lbs.	23.3	22.5	22.0	21.8	....	....	....

* Oxidized according to at least two of the three judges.
† Medicinal or antiseptic (coal tar flavor).
C 10—Plate count 2,000 to 2,800; methylene blue reduction time 18 to 23 hours; 4.85 per cent fat.
C 11-C 16—All plate counts were less than 100; methylene blue reduction time 21 to 30 hours.
C 20—Plate count 2,500 to 3,500; methylene blue reduction time 18 to 23 hours; 5.65 per cent fat.
C 21-C 26—All plate counts were less than 100; methylene blue reduction time 20 to 26 hours.

It is evident that removal of the first twenty-five pounds of milk from the milk supply would have materially reduced the copper and iron content of the remainder of the milk and the tendency to become oxidized. The first twenty-five pounds of milk through the equipment had a copper and iron content of 1.32 parts per million. After 100 pounds of milk had been cooled the copper and iron content of the milk was practically identical with that of the raw milk that had never come in contact with these metals. Apparently the cold milk did not remove appreciable amounts of these metals from the tinned copper, bronze, alloy, and 18-8 stainless steel with which it came in contact for fifteen to thirty minutes.

Table 3

KEEPING QUALITY AND THE COPPER AND IRON CONTENT OF MILK PASTEURIZED AND COOLED IN EQUIPMENT STERILIZED WITH A CHLORINE SOLUTION AND RINSED WITH HOT WATER

MILK SAMPLE		FLAVOR SCORES				MG. PER 1000 GM. MILK		
No.	Treatment	1 hour	1 day	2 days	3 days	Copper	Iron	Total
R 10	Raw	22.8	22.5	21.5	22.1	0.104	0.517	0.621
R 11	Past. 0–25 lbs.	22.8	21.0*	18.0*	17.0*	0.296	0.810	1.106
R 12	Past. 25–50 lbs.	23.0	23.0	22.0	20.2*	0.197	0.585	0.782
R 13	Past. 50–100 lbs.	23.0	23.0	22.3	21.5*	0.194	0.580	0.774
R 14	Past. 100–200 lbs.	22.8	23.0	22.2	22.8	0.194	0.580	0.774
R 15	Past. 200–300 lbs.	23.0	23.0	22.7	22.8	-------	-------	-------
R 16	Past. 300–400 lbs.	22.7	23.0	22.3	22.8	-------	-------	-------
R 20	Raw	22.8	22.5	22.8	22.0	0.153	0.313	0.466
R 21	Past. 0–25 lbs.	22.8	20.3*	18.8*	20.0*	0.402	0.387	0.789
R 22	Past. 25–50 lbs.	23.0	23.0	22.8	22.2*	0.302	0.355	0.657
R 23	Past. 50–100 lbs.	22.8	23.0	23.0	22.7	0.256	0.315	0.571
R 24	Past. 100–200 lbs.	22.7	23.0	23.0	22.4	0.222	0.310	0.532
R 25	Past. 200–300 lbs.	23.0	22.8	23.0	23.0	-------	-------	-------
R 26	Past. 300–400 lbs.	23.0	23.0	23.0	22.8	-------	-------	-------

* Oxidized according to at least two of the three judges.

R 10—Plate count 2,900 to 5,200; methylene blue reduction time 15 to 22 hours; 5.3 per cent fat.

R 11-R 16—All plate counts were less than 100; methylene blue reduction time 15 to 24 hours.

R 20—Plate count 2,200 to 4,400; methylene blue reduction time 15 to 20 hours; 5.1 per cent fat.

R 21-R 26—All plate counts were less than 270; methylene blue reduction time 15 to 25 hours.

CHLORINE STERILIZATION

The results secured from two series of experiments using a chlorine solution for the sterilization of the pasteurization equipment are given in Table 2. The bacterial contents of the raw and pasteurized milks were very low as indicated by agar plate counts and methylene blue reduction periods.

As in the previous experiments the raw milk kept well and did not become oxidized. The first twenty-five pounds of hot milk which passed through the equipment was almost unfit to drink within one hour due to an objectionable coal tar flavor. This milk was so strongly oxidized in one day that it was no longer suitable for consumption. The next twenty-five pounds of hot milk to pass through the equipment was strongly oxidized in two days and milk subsequently secured remained good in flavor for two days. There was a tendency, however, for all of this milk to be poorer in flavor than other milk after a storage of three days.

Contrary to expectations the iron and copper contents of the milks were practically identical to those of milks produced by hot water sterilization and there was no probability of explaining the differences in flavor on the basis of increased metal content of the milk.

In the experiments reported in Table 3, the chlorine solution acted on the metal of the equipment for five minutes and was then rinsed out with hot water. The bacterial content of the milk was again very low. A survey of the flavor scores indicates that the milk was of a flavor comparable to that secured by hot water sterilization. Only the first twenty-five pounds of hot milk through the equipment became oxidized in one day and the second twenty-five pounds of milk became oxidized in three days. At the end of three days all of the milk cooled subsequent to the first fifty pounds was of good flavor like the milk which passed through equipment sterilized by hot water only.

Copper and Iron Content of Milk

There are many references in the literature to the iron and copper content of milk as secreted by the cow and in market milk. The data secured in this study are of special interests as the newer methods of analyses were employed and the milk was not exposed to these two metals until it was ready for processing. The raw milk represents the actual composition as secreted by the cow. In the pasteurized samples if the first 100 pounds through the equipment were discarded, the analyses of pasteurized milk represents the lowest metal content that could be secured with the metal equipment used in these experiments.

The results of the six experiments are given in Table 4. The raw milk contained an average of 0.131 parts per million of copper and 0.379 p.p.m. of iron. These results are much lower than those in the literature but they compare very favorably with the copper content of milk found by Conn, Johnson, Trebler, and Karpenko for milk obtained directly in glass containers. As a result of processing the milk the copper content was increased 0.055 p.p.m. and the iron content 0.02 p.p.m. These small increases indicate that large contaminations as frequently reported can be avoided.

Table 4

THE COPPER AND IRON CONTENT OF RAW AND LABORATORY PASTEURIZED MILK EXPRESSED AS MILLIGRAMS PER 1,000 GRAMS OF MILK

SAMPLE	RAW		PASTEURIZED*		INCREASE DUE TO PASTEURIZATION	
	Copper	Iron	Copper	Iron	Copper	Iron
1	0.172	0.302	0.224	0.293	0.052	—0.009
2	0.104	0.324	0.153	0.324	0.049	0.000
3	0.155	0.456	0.203	0.537	0.048	0.081
4	0.096	0.363	0.121	0.366	0.025	0.003
5	0.104	0.517	0.194	0.580	0.090	0.063
6	0.153	0.313	0.222	0.310	0.069	—0.003
Average	0.131	0.379	0.186	0.401	0.055	0.022

* The results given represent minimum values secured after 300 pounds of milk had passed through part of the equipment.

Discussion

The development of the oxidized flavor in milk in these experiments was accelerated by contact of hot milk within a copper-iron-nickel alloy sanitary pipe and to the outer surface of a tinned copper cooler. The copper and iron content of the first hot milk through the equipment was approximately doubled by such exposure irrespective of the method of sterilization of the equipment but the oxidized flavor was intensified to the greatest degree by chlorine sterilization not promptly followed by rinsing with hot water.

Exposure of the cold milk to the same type of metals produced no detectable increase in copper and iron in the milk and no tendency toward oxidized flavor.

It is evident that the metal itself was of major importance in these studies as exposure of hot milk to stainless steel in the pasteurizing vat did not increase the iron content of the milk or the tendency to become oxidized, irrespective of the method of sterilization.

Although it is true that increased copper and iron contents were associated with oxidized flavor, nevertheless other factors are involved as the rapidity with which this off-flavor developed and the intensity of the flavor could not be correlated with the increase in the metal content. Apparently the amount of copper and iron required to accelerate the oxidation is very small and somewhat larger amounts are of minor significance or, as is probably the case, the contact of the milk with the metal is of greatest importance. It is known that undissolved metal may catalyze reactions and it would be expected that chlorination of a copper-iron-nickel alloy would clean the metal surface to give most intimate contact with the milk. After some milk had passed through the equipment there would be a protective milk coating which would reduce contact of metal and milk.

It has been clearly established with milk and ice cream by other investigators that copper added in substantial amounts does produce the oxidized flavor but the flavor may develop without exposure of milk to metals. That the tendency for milk to become oxidized in flavor is characteristic for milk of individual cows even when not exposed to metals has been clearly demonstrated by others.

Samples of the first milk from the pasteurizer over the cooler were taken at two commercial milk plants. In the one plant the equipment was chlorine sterilized followed immediately by a hot water rinse. The sanitary piping and cooler were made of tinned copper in good condition inside. The first milk through this equipment developed the oxidized flavor somewhat sooner than the remainder of the milk but the difference was slight, probably due to tin being a poor catalyst for oxidations. In the other plant the sanitary piping was aluminum and the cooler was tinned copper without exposed copper. This equipment was sterilized with hot saline solution followed by the hot milk, part of which served to flush the equipment. In this plant the first milk into the bottle kept as well as milk cooled later, a result to be expected. It is interesting to note, however, that milk from both plants became mildly oxidized in flavor in two days whereas the milk used in the other experiments reported in this paper was usually not oxidized in three days.

Conclusions

Exposure of milk at the pasteurization temperature to certain metals increased the iron and copper content of the milk and greatly accelerated the development of oxidized or cappy flavor. The solution of metals was not affected, in these experiments, by the method of sterilization of the equipment but the development of oxidized flavor was most pronounced when chlorine sterilization was employed. Hence, the amount of dissolved copper and iron was not the only factor involved in the development of oxidized flavor. If the first milk through the equipment was discarded the pasteurized milk showed a decreased tendency to become oxidized especially if the equipment was sterilized with hot water or if chlorine sterilization was followed promptly by a hot water rinse. The intensity of oxidized flavor secured in experiments of this character was shown to be greatly affected by the type of metal, and the type of chlorine solution should also affect the results.

Milk as secreted by the cow contained 0.131 parts per million of copper and 0.379 parts per million of iron. After pasteurization of the milk and after the first milk through the equipment was discarded the copper content of pasteurized milk was 0.186 p.p.m. and the iron content was 0.401 p.p.m. These data are relatively low when compared with other data in the literature.

THE INFLUENCE OF THE RATION ON MILK FLAVOR

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IT IS very significant that when cows are turned into pasture in the spring off-flavor troubles tend to disappear and the milk acquires a rich flavor and good color. But after weeks of poor pasturage or inferior winter feed many cows produce milk lacking in rich flavor and good color. At such seasons complaints of cappy, cardboard, tallowy, oxidized, or rancid flavor are most common. This common experience suggests that these off-flavors may be due to the feeding of rations in which certain accessory food factors have been greatly diminished by curing or storage. Furthermore, observations over a period of months on two large farms producing high grade milk suggested the same thought. In one herd few cows produced milk which acquired an off-flavor after two to four day's storage while in the other herd many cows produced such milk. Careful veterinary supervision assured consideration of only healthy animals. The cows in both herds were fed in much the same way on corn silage, alfalfa hay, and grain mixture. One important difference was noted in the ration. The herd having the small number of cows producing milk of off-flavor was fed nine-ten pounds of the best machine dried alfalfa hay whereas that having the high incidence of off-flavor was fed smaller amounts of field cured alfalfa hay. Shortly before this observation was made, Russell, Taylor and Chichester [1] had demonstrated that machine dried alfalfa of the kind used in these experiments contained approximately as much carotene as did the fresh cut plant but that carotene was rapidly destroyed under the best conditions of field curing. Three days of field curing under normal conditions caused a loss of nine-tenths of the carotene. These investigators have also demonstrated that once the plant is dried the carotene content diminishes slowly and at about the same rate for machine dried and field cured material.

In October 1935 the writer in collaboration with Doctors J. G. Hardenbergh and L. T. Wilson of the Walker-Gordon Laboratory Company started a series of feeding experiments at the Walker-Gordon farm which has been continued since that date. These experiments have yielded the results which will be presented for your consideration. The first experiment was undertaken to determine whether a difference in flavor could be produced in milk by substituting field cured alfalfa of good quality for machine cured alfalfa.

We happened to have under observation a Holstein cow whose milk acquired a very slight rancidity only part of the time. Rancidity was first noted in milk produced eleven and one-half weeks after lactation, that being the first sample examined. From that date to the time our experiment commenced, six and one-half months after parturition, sixty-two samples were examined of which sixty-three per cent were definitely good, developing no trace of rancidity. The remainder produced a very slight rancidity after holding two or more days at approximately 40° F., warming and tasting. It was thought that if malnutrition played a part in the production of this rancidity a larger percentage of the daily samples would become rancid and the rancidity would become more intense if number one field cured alfalfa were substituted for the machine cured alfalfa which the cow had been receiving. The ration consisted of approximately twenty-five pounds of corn silage, nine-ten pounds of alfalfa hay and nine-ten pounds of grain concentrate per day. It should be remembered that the milk was of the highest quality bacteriologically, and that we were concerned only with flavors inherent in the raw milk.

The change from machine dried to field cured alfalfa was made on October 9. The results are presented in Table 1.

Table 1

Field Cured Alfalfa Substituted for Machine Cured Alfalfa in Ration Oct. 9-Nov. 14, Incl.

Date	Flavor	Date	Flavor	Date	Flavor	Date	Flavor
Sept. 24	Good	Oct. 10	R	Oct. 26	Good	Nov. 11	
25	"	11		27	SR	12	Salty, R
26	"	12		28	R	13	R
27	"	13		29	R	14	SR
28	"	14		30	SR	15	Salty
29	"	15		31	SR	16	Good
30	"	16	SR	Nov. 1	R	17	Good
Oct. 1	"	17	R	2	R	18	VSR
2	SR	18	R	3	Salty, R	19	VSR
3		19	Good	4	OR	20	Good
4	VSR	20		5	OR	21	Good
5		21	R	6	R	22	Good
6		22	R	7	R	23	Salty
7	Good	23		8	R	24	R
8	"	24	Good	9	R	25	VSR
9	SR	25	"	10	Salty, R	26	VSR

Blank space indicates no sample was received.
R=Rancid; V=Very; S=Slightly, O=Oxidized; OR=Oxidized flavor which was later masked by a rancid flavor.

Of 13 daily samples in the preliminary seventeen-day period, September 24-October 10 inclusive, only four, or 23.5 per cent, acquired a rancid flavor, whereas of the twenty-seven daily samples taken in the thirty-day period, October 16 to November 14 inclusive, twenty-three, or 85 per cent acquired a rancid flavor. Furthermore, the intensity of the rancidity increased during the feeding of the field cured alfalfa. Flavor improvement was noted subsequent to the feeding of machine cured alfalfa on November 14. On November 28 field cured alfalfa was again introduced into the feed to return the cow to a condition of rancid milk in preparation for Experiment 2. Attention is called to the samples taken on

November 4 and 5 which are marked OR. These samples had a pronounced oxidized flavor when fresh which became masked by the rancidity which developed on standing. We will return to this and similar observations later.

Having apparently demonstrated a difference between machine and field cured alfalfa hay, another experiment was undertaken with the thought of determining the effect of a factor present in these hays in different amounts. The factor first considered was the yellow pigment carotene, the material responsible for the yellow color of butterfat, which in the animal body can be converted to vitamin A. Good reasons existed for selecting this factor. As previously mentioned investigators at the New Jersey Agricultural Experiment Station had demonstrated that it was not affected by the artificial drying process employed. Other investigators, particularly Baumann and Steenbock [2] at the Wisconsin Agricultural Experiment Station had demonstrated that both the carotene and vitamin A content of milk decreased markedly as pastures dried up and animals were on winter rations and increased when fresh green fodder was fed in spring and summer. Furthermore one of the outstanding characteristics of carotene is that it may play an important rôle in retarding oxidation. There is good reason for believing that the rancid and oxidized flavors in milk may have their origin in this type of change affecting the fats and associated components of the milk. Consequently in Experiment 2 we sought to determine the effect of the addition of carrots to the ration. Ordinary garden carrots are approximately three times richer in carotene than fresh alfalfa. The same animal used in the previous work now in advanced lactation and producing milk which became quite rancid after being held one day, was fed approximately ten pounds of field cured alfalfa hay, twenty pounds of corn silage, five pounds of carrots, and ten pounds of grain mixture. As shown in

Table 2 the feeding of carrots was commenced on December 12.

Results of this feeding appear very definitely in the milk of the nineteenth and continued through the twenty-fourth. The milk of the twenty-fifth and twenty-sixth had an oxidized flavor; that of subsequent days became rancid. Unknown to the person testing the milks, the supply of carrots had become exhausted on the twenty-first. Feeding of carrots was again commenced on January 2 this time in a somewhat greater quantity than before, seven-eight pounds per day, because of the advanced lactation period. Again after a six-day period on the improved ration the milk ceased to acquire any off-flavor after holding it even four to six days, warming and tasting. The feeding of carrots was discontinued on January 29, but milk of good flavor was produced for about two and one-half weeks after which it gradually acquired a very rancid flavor. This change is recorded in Table 3.

Table 2

Field Cured Alfalfa Nov. 28-Dec. 12, incl.
Carrots, Five Pounds per day, Dec. 13-21, incl.
Carrots, seven-eight pounds per day, Jan. 2-29, incl.

Date	Flavor	Date	Flavor	Date	Flavor	Date	Flavor
Nov. 27	Good	Dec. 13	O_2, R	Dec. 29	VSR	Jan. 14	Good
28		14	R	30	VSR	15	"
29	Good	15		31	VSR	16	"
30		16	O, R	Jan. 1		17	"
Dec. 1	SR	17	SR	2	VSR	18	"
2	O, SR	18	VSR	3	VSR	19	"
3	O, SR	19	Good	4	O, VSR	20	"
4	O_3	20	"	5	VSR	21	"
5	O_2	21	"	6	VSR	22	"
6	O, R	22	"	7	VSR	23	"
7	Good	23		8	Good	24	"
8		24	Good	9	"	25	"
9	R	25	O	10	"	26	SR
10	R	26	O	11	"	27	Good
11	R	27	VSR	12	"	28	SR
12		28	VSR	13	"	29	SR

R=Rancid; S=Slightly; V=Very; O=Oxidized. Intensity of off-flavor indicated by numeral after letter. Blank space indicates no sample was received.

Due to the carrots the best milk produced by this cow was produced ten and one-half to eleven and one-half months after calving.

Up to the present all data deal with taste alone. During the experiment just described determinations of lipase activity were determined by the method of Pal-

Table 3

CARROTS REMOVED FROM RATION JAN. 29

Date		Flavor	Date		Flavor	Date		Flavor	Date		Flavor
Jan.	30	Good	Feb.	16	Good	Mar.	4	R	Mar.	21	SR
	31	"		17	Good		5	VSR		22	
Feb.	1	"		18	VSR		6	Good		23	R_3
	2	"		19	R		7			24	R_3
	3	"		20	R		8	R_2		25	R_4
	4	”		21	R		9	R		26	R_4
	5	"		22	SR		10	R		27	
	6	"		23	R		11	R		28	
	7	"		24	R		12	R_2		29	R_4
	8	"		25	R_2		13	R_2		30	R_4
	9			26	R		14			31	R_4
	10	Good		27	R		15	R	Apr.	1	R_4
	11	"		28	SR		16	R		2	R_4
	12	"		29	Good		17			3	R_4
	13	"	Mar.	1	R		18	R_3			
	14	"		2	O, R_2		19	O, R			
	15	VSR		3	O		20	R			

mer [3] modified by Anderson.[4] These values are presented in Table 4. In this connection we have noted repeatedly that the most delicate chemical methods of detecting lipase activity are not as reliable as the sense of taste.

A subsequent experiment was conducted to determine the effect of feeding a carotene high ration to a cow producing milk with an oxidizd flavor. The ration was the same as in the previous experiment, except that the animal had received machine dried alfalfa at all times. Carrots were added at the rate of approximately four-five pounds per day. The results are shown in Table 5. Milk of good flavor was produced three days after the feeding of carrots commenced. This continued for a week after the carrots were removed from the ration.

To determine whether the flavor improvement obtained in the preceding experiments was due to the conversion of carotene to Vitamin A in the animal, a Vitamin A concentrate of high potency,* 10,000 units per gram of corn oil in which it was dissolved, was added to the ration of a cow producing a rancid flavor. Most of the time 500,000 U.S.P. units of Vitamin A were added to the daily ration, but as high as 1,000,000 units were added for several days, after the lower level brought no response.

Table 4

FLAVOR AND LIPASE VALUES
Carrots, Approx. 8 lbs. per day 1/2-1/29
Ordinary Production Ration after 1/29

		Lipase		
Date	Flavor	Test	Control	Difference
Jan. 29	Good	17.30	13.55	3.75
31	"	16.5	12.8	3.7
Feb. 2	"	16.1	12.5	4.1
5	"	15.2	12.0	3.2
8	"	16.5	13.7	2.8
14	"	16.15	12.85	3.3
22	SR	16.2	12.5	3.7
28	SR	16.1	12.7	3.4
Mar. 16	R	19.8	12.6	7.2
17	R	22.8	13.1	9.7
19	O, R	19.2	13.9	5.3
20	R	21.0	14.5	6.5
21	SR	19.1	12.5	6.6
25	R_4	23.9	15.4	8.5
29	R_4	27.5	15.6	11.9
Apr. 2	R_4	26.9	16.7	10.2
4	R_4	27.7	17.3	10.4

We feel sure considerable improvement resulted from the Vitamin A feeding which continued for nearly four weeks, but the rancid flavor was not eliminated from all samples. The effectiveness of the Vitamin A was not at all comparable to the weight of carrots calculated to be an equivalent source of the vitamin. Weeks later the rancidity was eliminated from the milk of this same cow by

* Supplied through cooperation of the National Oil Products Company, Inc., Harrison, N. J.

feeding her approximately fifteen pounds instead of the usual ten pounds of alfalfa hay, and reducing the silage proportionately. The alfalfa in this case was the first cutting, machine dried, and fed within two weeks after cutting. It was undoubtedly much richer in the active factor than the alfalfa fed during the winter months, due to slow deterioration during storage.

Table 5
ELIMINATION OF OXIDIZED FLAVOR
Carrots, 5 lbs. per day, Jan. 29-Feb. 7

Date	Flavor	Date	Flavor	Date	Flavor	Date	Flavor
Jan. 21	O_2	Feb. 3	Good	Feb. 15	O	Feb. 27	O
23	O_2	4	"	16	0	28	O
24	O	5	"	17	O	29	
25	O	6	"	18	O_2	Mar. 1	O
26	O_2	7	"	19	O_2	2	O
27	O	8	"	20	O_3	3	O_3
28	O_2	9	"	21	O	4	O
29	O_2	10	"	22	O_3	5	SO
30	O_2	11	"	23		6	O
31	O	12	"	24	O	7	O
Feb. 1	Good	13	"	25	O	8	O
2	"	14	"	26	VSO	9	O_2, R

In more recent experiments with a group of sixteen cows, eight on test ration and eight on control ration, feeding alfalfa hay, corn silage, and concentrate in the quantities previously mentioned, we have been able to bring about a change from good to oxidized flavor and from good to rancid flavor by replacing good machine dried alfalfa hay with poor field cured alfalfa hay. Seven of the eight test animals were of Guernsey breed, the other, cow number 30, being Brown Swiss. All were comparatively young animals at about the same stage of lactation. The changes in milk flavor induced by the feeding of poor field cured alfalfa are shown in Table 6.

Daily samples were tasted after holding forty-eight hours at approximately 40° F.; three-day intervals being recorded in the table to conserve space.

It will be noted that great differences exist between animals of the same breed with reference to the time required for off-flavor development when a change in ration is made. We feel that this may be related in part to the quantity of milk produced. Under the conditions of our experiment we were unable to cause cow 26 to produce off-flavored milk. Her daily production was appreciably below that of the other animals in the group. Cow 31 was the only member of the group which produced milk of rancid flavor. Other observations also tend to indicate that the rancid flavor is less common than oxidized flavors in raw milk.

Table 6
OFF FLAVOR INDUCTION
Cows on Machine Cured Alfalfa (10 pounds) silage, and concentrate

Date.		Cow Number							
		26	27	28	29	30	31	32	33
		Flavor Record							
July	8	flat	g	g	g	g	old	g	g
	9	flat	g	g	g	g	g	g	g
	10	SO	g	g	g	g	g	g	g
	11	g	g	S. salt	g	g	g	g	g
	12	g	g	g	g	SO	g	g	g
	13	g	g	g	S. flat	g	g	g	g
		Old Field Cured Alfalfa Hay instead of Good Machine Cured Alfalfa							
July	26	g	g	S. flat	O	SO	g	g	g
	29	S. flat	g	g	O_3	VSR	SO	g	O_3
Aug	1	O_3	g	g	g	O_2	O_2R	O	g
	4	g	g	g	R_2	O	g	g	O

In order to determine whether a ration high in vitamin C would have any effect on milk flavor cows 29 and 30 were fed five pounds of fresh cabbage daily for a period of over three weeks, the silage being reduced by a proportionate amount and the field cured alfalfa and concentrate being unchanged. It will be noted from Table 7 that the cabbage had no beneficial effect. Symbols denoting milk flavor during the period in which cabbage was fed are enclosed in box.

TABLE 7

OFF FLAVOR INDUCTION
Old Field Cured Alfalfa Fed Instead of Good Machine Cured Alfalfa (July 13)
Cows 29 and 30 Fed Cabbage, Five Pounds Daily, 8/13-9/6

Date		Cow Number							
		26	27	28	29	30	31	32	33
				Flavor Record					
Aug.	7	g	g	g	O_3	O_3	R_1	g	g
	10	g	g	g	O_1	O_4	R_1	g	g
	13	g	g	g	O_2	SO	R_3	O_3	g
	16	g	O	O	O_2	O_1	R_3	O_2	g
	19	g	SO	SO	O_3	O_4	R_4	O_2	g
	22	g	O_2	O_3	O_1	O_2	R_4	O_2	O_1
	25	g	O_2	O	SO	O_2	R_4	SO	O_1
	28	SO	O	SO	O	O_4	R_4	O_2	SO
	31	g	g	SO	O_1	O_3	R_3	SO	VSO
Sept.	3	O_1	O_2	VSO	O_3	O_3	R_2	O_2	SR
	6	O_1	VSO	O_2	O_4	O_1	R	g	VSO
	9	g	g	SO	O	O_1	R_2	g	VSO

g=good; O=oxidized; R=rancid; V=very; S=slightly

In Table 8 we have tabulated the vitamin C values for milk, from all eight cows, when fresh and after twenty-four and forty-eight hours, along with flavor after forty-eight hours. These samples were taken on September 1, toward the close of the period during which the vitamin C high ration was fed cows 29 and 30. That milk from these cows was not higher in vitamin C is in harmony with the findings of others. That vitamin C loss is not proportional to off-flavor development in these raw milks is also of interest. It should be mentioned that these vitamin C determinations were repeated on another set of samples with almost identical results.

On September 10 we modified our experiment in such a manner as to bring most of these animals back to such a condition as to produce milk of good flavor presuming our previous results in this connection were correct. The modification consisted of giving all cows, with the exceptions of 26, 29, and 30, good hay instead of poor hay. Cows 29 and 30 were continued on the poor hay but carrots were added to the feed; four pounds daily for cow 29 and two pounds daily for cow 30. Cows 29 and 30 were selected for this feeding because they were the first to develop off-flavors and produced the strongest

TABLE 8

OFF-FLAVOR INDUCTION VITAMIN C
Cows 29 and 30 receiving ration high in Vitamin C

Cow	Vitamin C per liter Fresh	24 hrs.	48 hrs.	Flavor
	mgm	mgm	mgm	
26	19.7	12.3	5.3	Good
27	19.4	12.0	3.7	O_1
28	18.2	7.4	3.9	O_3
29	18.6	10.1	4.4	O_3
30	20.0	4.4	4.1	O_3
31	16.7	3.4	4.1	R_3
32	18.9	3.6	4.1	SO
33	18.9	4.4	4.1	SO

O=oxidized; R=rancid; S=slightly

off-flavors. Cow 26 was continued on poor hay to see if she would continue to produce good milk as her lactation period progressed. The results of these modifications in feeding are summarized in Table 9.

You will note that cow 26 continued to produce good milk on the poor hay. It must be remembered that this animal produced an appreciably smaller volume of milk. After ten days on the machine dried alfalfa hay cows 32 and 33 produced milk which did not acquire an off-flavor. Only six days were required for cow 28 to produce such milk. About twenty days were required for cow 27 to produce good milk consistently. Cow 31, which produced milk acquiring a very rancid flavor when fed the poor alfalfa hay, did not produce milk which remained good until after nearly a month on the good alfalfa. You will note that a similar time was required for cows 29

TABLE 9

OFF-FLAVOR INDUCTION

Commenced feeding good alfalfa hay again Sept. 10

Cow 26 kept on poor alfalfa hay

Cow 29 kept on poor alfalfa hay + four pounds carrots daily

Cow 30 kept on poor alfalfa hay + two pounds carrots daily

Date	Cow Number								Remarks
	26	27	28	29	30	31	32	33	
Sept. 10	g	VSO	O	O_3	O	VSR	SO	g	
13	g	O	g	O_1	VSO	R	g	O_1	
16	g	g	g	O_3	O_1	R	VSR	VSR	Began three day holding for flavor.
19	g	SO	SR	g	VSR	R_3	SR	SR	
22	O_2	O_3	g	O_3	O_2	R_2	g	g	cool weather
23	g	SO	g	g?	g?	SR	g	g	
24	g	g	g	VSO	g	SR	g	g	
26	g	g	g	O	SO	VSR	g	g	carrots ran out
28	VSR	g	salty	g	g	g	g	g	
29	g	VSO		O_3	g	g	g	g	
30	g	g		O_2	O_1	R	g	g	carrots again
Oct. 1	g	g		O_2	O_2	R	g	g	
3	g	g		VSO	g	SR	g	SR	No. 31 increase hay five pounds.
6	g	g		O_1	VSO	VSR	g	g	
7	g	g		g	VSO	VSR	g	g	
8	g	g		g	g	g	g	g	

and 30 which were fed carrots, four pounds and two pounds respectively. In the case of the latter it should be pointed out, however, that we ran out of carrots at a time when their milks appeared to be nearly normal. The table indicates the manner in which intensity of off-flavor increased due to the absence of carrots from the ration.

It is clear that we have been able to cause a change from the production of good milk to milk which acquired either oxidized or rancid flavors simply by changing the hay fed to the producing animals. We have been able to cause these same animals to produce milk of good color and flavor by feeding a good quality of hay or a poor hay plus a small quantity of carrots.

As to the specific factor, or factors, responsible for the production of milk of good flavor, and lack of which appears to result in milk of disagreeable flavor, we would like to make the following remarks:

This factor, or factors, is present in alfalfa dried in such a manner as to conserve color and certain accessory food factors, one of which is carotene or pro-vitamin A. In poor field cured alfalfa these factors are deficient. The factor, or factors, appeared to be present in good red carrots to a considerably greater extent than in alfalfa. We thus eliminated certain constituents of the green plant, such as chlorophyll. Since the amounts of carrots necessary appears to be rather small, apparently other constituents can be eliminated, such as inorganic salts. Since carrots which are high in carotene, pro-vitamin A, and very low in vitamin C, caused the change from milk of poor quality to milk of good quality, and cabbage which is very high in vitamin C, and in which carotene appears to be absent, was incapable of bringing about such a change we feel vitamin C, ascorbic acid, is not the factor responsible for the good milk. The somewhat beneficial effect of feeding the vitamin A concentrate also leads us to feel we are working in the right direction.

The time elapsing between change in ration and subsequent change in milk color and flavor also suggests that we are dealing with a physiological change not unlike those controlled by vitamins.

Furthermore, the physical and chemical properties of carotene are properties of the factor we are seeking, as far as we know them.

In order to determine whether the food factor we are seeking is actually carotene, or something associated with it in plant materials, we are now preparing to feed one of the most expensive compounds ever fed to a cow, pure carotene.

The practical applications of this work stand out clearly. Every effort should be made to preserve the unstable constituents of the green plant which are easily lost in the changes involved in field curing. The richness of a plant material in substances necessary for the production of milk of good flavor appears, in large measure at least, to be associated with green color. Thus an alfalfa hay of green color would be expected to be far superior to a field-cured alfalfa hay possessing a brown or yellow color. The preservation of grasses and legumes by the addition of acids, known as the A.I.V. method, and by the addition of molasses should be very helpful in this connection. The machine-drying of hay insures a very good product, but is not yet available for the ordinary farmer.

As our knowledge of the necessary material and its distribution in plants increases it is altogether likely that we may fortify otherwise poor rations with plants not commonly used now for animal feeding, as in certain of our experiments where carrots were used for this purpose.

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Discussion

Mr. Frank: I should like to ask Dr. Dahlberg whether I understand correctly that it is possible to produce oxidation flavor when the chemical changes which produce the flavor are so small that they cannot be measured?

Dr. Dahlberg: I think the answer probably should be put almost evasive of the question. Chemical changes which do occur in flavors have not been detected chemically even though the flavor seems to be an obvious one that we should be able to detect, so that while the proof may not be absolutely perfect the inference is correct.

Mr. Frank: Well, assuming that is so, and assuming that copper acts as a catalyzer, might it not be possible to produce the oxidation flavor without being able to detect the amount of copper which produced it?

Or again, would it be possible for the amount of chlorine left upon the apparatus during sterilization to produce the oxidation flavor even though no copper whatever had gone into solution?

Dr. Dahlberg: I would assume that is not possible because in such experiments as we conducted in a limited way and those which others have reported in the literature, the very small amounts of chlorine added to milk do not affect, materially speaking, quality. Then too, in the case of the sterilization only with hot water the effect of the metal was present but to a lesser extent, so I would be inclined to think that the amount of chlorine which is actually dissolved could scarcely be a factor.

Mr. Frank: I was going to ask you then if you had used chlorine on other metals than copper, such as stainless steel and found you did not get the oxidized flavor, would that answer the question absolutely?

Dr. Dahlberg: That has been done by other investigators checking in various ways and there is no doubt the effect varies with the metal. There is no question about that. Also the effect varies with the chlorine sterilizer to a certain extent.

We were interested in checking this quite largely with a metal which was known to give some effect in order that we could establish this relationship between the rate of solution and the development of the off flavor which we expected to cure. We would not have replaced the particular metal which was known to have produced the off flavor for this experiment. We wanted it there so we would have missed that particular point.

Mr. Yates: This is rather confusing. What is the factor or what are the factors involved in so-called oxidized flavor? We have all been through the mill of chlorine sterilization and hot water sterilization. We all have the oxidized flavor dominating in places where chlorine has not

M+
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been used and vice versa. We find it where there are large amounts of copper exposed. I was in a plant the other day where I think there was not a square inch of the equipment which was not exposed and they have never had a case of oxidized flavor from this plant. In other places where there is not much of any copper exposure it is very pronounced. I would like to know what the causative agent is and then possibly we could discuss it intelligently.

Dr. Anderson: I think the question is a very good one. I think some of those who have been working in the field can see some light. As to the responsible factor, we do not know what causes oxidized flavors. It certainly is one of the minor constituents of milk. I think that is the best anyone can say at the present time.

Dr. Greenbank spoke on the subject yesterday. He did not know what factor was responsible for the off-flavor but pointed out that the material, whatever it is, when present, is readily oxidizable. I think the factor is present in some milks in greater amount than in others. Whether the oxidation goes on in one or two steps, he thought the latter, the factor is oxidized to a substance which produces the peculiar taste. The unoxidized factor can not be tasted. I think we can look at it in that way.

Well then, if that is the case, you can see how these other aspects of the problem fit together. I pointed out that milk from a certain cow might be oxidized in twenty-four hours. Milk from the same cow a little later, as her condition improved, required forty-eight hours for oxidation. Later it required a longer time. In this case, as the condition of the cow changed the amount of the factor causing the off-flavor appeared to decrease and an increased holding time was necessary to detect the off-flavor in the milk. Time was an important consideration in ~~this case~~, (the milk being raw and untouched by metal).

To come to the work of Professor Dahlberg, he was not concerned with raw milk. He speeded up the oxidation by means of catalysis with the metal with which the milk came in contact. In pasteurization we have not only the metal but the effect of metal plus heat. In that case perhaps but a very small amount of the oxidizable factor is necessary to produce the off-flavor, an amount which would not cause the flavor change in raw milk but which shows up when that milk is subjected to the combined action of metal and heat in the pasteurizing plant.

Then you brought up another good point with reference to a plant which had a lot of exposed copper and in which they did not have trouble. It is altogether possible that there was some other force operating to neutralize the effect of the exposed copper. We know that the presence of certain organic compounds can do that. The presence of reducing bacteria can do it. So I think these aspects do fit together somewhat, and in a year or two we will know much more about these off-flavors and the conditions under which they develop than we do at the present time.

Dr. Roadhouse: I believe more comment might be made in answer to Mr. Yates' statement about the plant equipment showing considerable copper and not producing oxidized flavor in the milk.

It is recognized that compounds of copper accumulate on the surface of the metal when it is left moist. These compounds are more active than the metal itself, and their accumulation may be dissolved by the milk or they may be removed by thorough washing or polishing, so the result will depend on whether the metal was recently cleaned and bright or whether it was darkened by oxidation or otherwise corroded.

Dr. Dahlberg: Might I add one word which will add a little further to the confusion? People have, of course, tried to find the agent which is involved, and that is exceedingly difficult.

In some of the experiments which we conducted we thought that we might, toward the end of the investigation, definitely establish the very small parts of copper which might be needed to bring about this reaction and we added copper direct to the milk in quantities up to one part per million and never secured any oxidized flavor.

In endeavoring to find the reason for that we finally recognized that the obvious reason was that in rapidly agitating the milk in order to incorporate the copper we were incorporating air and apparently this oxidation was partially prevented by oxygen itself, so that is why I mentioned or casually remarked in my talk that we call it oxidized flavor and maybe it is not.

Mr. Scales: I would like to ask Dr. Dahlberg if he had any evidence in that first twenty-five pounds of milk that became so oxidized that would support Dr. Greenbank's theory of going from the aldehyde form to the acid form in the oxidation. That is, if further agitation of that twenty-five pounds with heating would have had any effect in eliminating the oxidized flavor.

Dr. Dahlberg: I really do not know. I suppose it is ridiculous to guess.

Dr. Anderson: I was reflecting on that very point last night, and I am quite sure that I can find somewhere in my notes a record of a flavor developing and later disappearing. It was when we were feeding Vitamin A. The cow was almost at a point where the milk was consistently good. In certain samples we were mighty sure that we had an appreciable off-flavor. I am not quite positive whether it was oxidized or rancid, but we had an off-flavor. When I ran into it the second time I had others in the laboratory check me up. The off-flavor was present within twenty-four hours. When we tasted that same bottle of milk the next day it was good. The flavor was not strong in any case. I think it tends to support Greenbank's theory.

Dr. Harding: There is one question which, if we might have the right answer, at least would cheer us.

In the paper presented by Dr. Roadhouse, pointing out the wide range of food materials which added undesirable flavors to milk, he found I think only one or two food substances which were helpful. The practical problem which faces the milk producer is, what can he keep a cow alive on and get milk out of the cow and still not have bad flavors? If Dr. Roadhouse has a little comfort along that line I think it might soothe some of our ruffled feelings.

Dr. Roadhouse: Although it was not pointed out in this discussion today, I believe that Dr. Harding is familiar with the literature that makes it clear that if any of the feeds commonly used in dairy rations are withheld from the cows during the five hours preceding milking, that the feed flavor will have been eliminated sufficiently so it would not be objectionable in the milk.

I am informed by those who are recognized authorities on animal feeding and dairy herd management that it is entirely possible for an animal, the cow, to consume all the feed she needs to produce the maximum milk flow within the period between the last milking and five hours before the next milking, if she is being milked twice a day, and produce milk in sufficient quantities and not have the flavor transmitted from the feed to the milk. Is that sufficient answer to your question.

Dr. Harding: It looks to me, Roadhouse, as though your recommendation was to put the cow on a reducing diet.

Dr. Roadhouse: I do not believe I used that term. It is a matter of when the animal is fed. We have figures to support our work. I have not presented them here. I know Dr. Harding is familiar with Bulletin 595 of the California Agricultural Experiment Station, which is available at Berkeley, California, in which these subjects are discussed from a feeding standpoint. I have not dealt with the feed aspects of this subject today.

ADDRESS *

J. LYNN MAHAFFEY, M.D.
Director of Health, Trenton, N. J.

WHEN Mr. Scofield, Chief of the Food and Drugs Bureau of the State Department of Health of New Jersey requested me to appear before your meeting he promised to furnish me with information that would be of interest to this group. Mr. Scofield is well to do and is protected in his work by civil service. With such a background he rules without favor. Our Department is proud of his work.

I have before me the promised information and am told by Mr. Scofield not to use it, as much of the material was discussed at your afternoon meeting. We are pleased to have so many ladies present. As my speech was prepared for gentlemen only, much of it must be deleted.

I have been much interested in the tremendous increase in life expectancy in our country during the past one hundred and fifty years, a period filled with great changes. We have in New Jersey the oldest organized medical society in this country, organized more than one hundred and sixty years ago. The New Jersey State Department of Health is also one of the oldest in the United States. At the time of the organization of the New Jersey Medical Society the average span of life was thirty-five years. Today it is sixty-four years. What has brought about this great change?

The activities of all persons engaged in the improvement of health have contributed to this change. The physician, nurse and sanitarian cooperating with local and state departments of health have brought better housing, better refrigeration of food, good water, better sewage disposal and a protection in the isolation of those

* Delivered at dinner session.

who have communicable or contagious disease. Epidemics are studied early, the source of the trouble found and corrective measures adopted.

Teeth, tonsils and the diseased appendixes have received attention. The modern plan of health work surpasses that of any past era. The discovery that germ life is the cause of almost all communicable diseases was soon followed by the use of antiseptics.

The prevention and cure of diphtheria is probably the outstanding example of good health work during the past sixty years. The milk program with its plan to furnish pure clean milk to the consumer has brought marvelous improvement in lessening gastrointestinal disturbances, and diseases which heretofore were traced to milk are markedly lessened because of pasteurization.

Cleanliness and a health consciousness which now affect the entire population have done much to help this program. Much credit is due to the International Association of Milk Sanitarians in this plan for better milk and better milk has brought better health to all ages.

The life expectancy period is still thirty-five years in India because of impure water, bad housing, overcrowding. New Zealand, because of its equable climate and close attention to sanitary conditions has the longest life span of any part of the world, sixty-six years.

I spent three summers in a western Pennsylvania town of about two thousand population before my graduation in medicine in 1902. Little attention was given to the sanitary conditions in this coal mining town. Many stray dogs and cats roamed about, and it was considered the duty of the student medico to rid the town of these pests annually by the use of strychnia placed in small pieces of meat—a rather crude but very effective means of eradication.

It was also the medical student's duty to care for the annual epidemic of typhoid cases which occurred in this town. I knew nothing about the care of typhoid fever except what I learned from the text books, as I had had little instruction in the care or treatment of typhoid patients until my third year in college. My superior was called when some troublesome complication arose. This condition began about July 15 and we had from one hundred to one hundred fifty cases each summer and everyone knew the source of trouble was in two wells in the lower part of the town. There was no thought about boiling the water. The Pittsburgh newspapers carried annually front page news about the annual outbreak of typhoid in this and neighboring towns. The Pennsylvania State Department of Health did nothing to eradicate this trouble and in fact the national government had a few years previously sent to the hospitals of Philadelphia over six hundred veterans of the Spanish-American War for treatment of typhoid contracted in the military camp at Chickamauga. The coal mining town was forty miles from a hospital, the patients were nursed by their own people and the death rate was extremely high. I recite this story because it happened in my experience and one marvels that such a condition could exist as recently as thirty-four years ago.

Now epidemiologists are sent immediately on the discovery of typhoid in any part of New Jersey and every attempt made to locate the source of trouble. So effective has been our sanitary control in New Jersey during the past year that we have had but twenty-two deaths from typhoid fever. Nine of these were traced to out of the state sources. We have a population of 4,500,000 people and no deaths from diptheria were reported to the State Department of Health during the four months previous to October 1, 1936.

We had in New Jersey a very nasty condition in the oyster district about three years ago. A complaint arose that many oyster shuckers were affected with syphilis.

A careful survey showed that there were many cases in this group. In dealing with this situation two representatives from the State Department of Health spent much time giving lectures in the small church and schoolhouse, at which time still pictures and moving pictures were shown. From these the populace, consisting of poor whites and colored people, learned much about the horrors of syphilis. After these lectures for some period of time an opportunity was given to the workers to have the Wassermann blood test made. Many responded and after a few days the entire population, numbering six hundred and twenty-eight were Wassermann tested. One hundred and twenty-eight were found to have some form of syphilis. A local physician treated all but two of these cases during the following winter. A fee for treatment was agreed upon and paid by the workers. The arsphenamine used in the treatment was furnished free by the State Department of Health. We think we carried on a marvelous program in that particular section of the State.

We have had a cream puff situation that was not very satisfactory. Many of you know how cream puffs are made—after being used, the cream puff filling machine is often not properly cleansed. For that reason a batch of cream puffs filled from an unclean machine is dangerous food. Very often the cream puffs are taken from the bakery, placed in a small store window, exposed to heat and sunlight, and as this cream puff filling makes a perfect culture media for the development of germs, we have had several serious outbreaks of gastrointestinal disturbances traced directly to cream puffs. Cream puff manufacturers have cooperated in the move to break up this dangerous practice.

We also have a problem in the typhoid carrier which I think will be interesting to you. In New Jersey there are about eighty recognized typhoid carriers. As you know a typhoid carrier is one who may or may not have had a recognized case of typhoid fever, but who harbors in his intestinal tract billions of typhoid germs. If he be employed in the milk business or some business where the handling of food is necessary, he may very easily infect a great many people, through the food they take.

When we find these people in the food handling business we have to prohibit work of this kind and try to get them into other occupations. Sometimes they drift back and even though we make every attempt to check up on their whereabouts, we occasionally find them back in the milk or restaurant business.

It seems to me that some effective means must be taken by the various states to keep these men and women out of the food handling business, and if necessary in selected cases, I believe they should be pensioned and kept out of all business. The gall bladder is often the seat of infection and Connecticut and New York have provided funds for the removal of the gall bladder in selected cases. It has been found that the germs of typhoid are facultative and adapt themselves to the mucosa of the gall bladder, multiplying rapidly and trickle down through the intestinal tract; and this process may continue as long as the carrier lives. I have reference, of course, to the intestinal typhoid carrier. If the source of the trouble is determined to be in the urinary tract, in most cases little can be done to alleviate or correct the condition.

We have records of three or four cases in New Jersey where the removal of the gall bladder has been followed by very brilliant results and after a period of six or eight months they were no longer considered typhoid carriers.

The State Department of Health in the 1936 session of the Legislature presented a bill which provided for supervision and whole or partial maintenance of certain typhoid carriers. This bill received much attention, was favorably discussed in Trenton, but finally died in committee.

It seems to me that our State Department of Health, in its inspections particularly, is called upon to do work that we ought not be compelled to do. I have reference to the careless men in the dairy industry. I believe that a man milking a cow day after day with an ulcerated udder certainly should have some instructions given him or some very definite plan should be followed to enlighten him on what this means.

We have had in this State several outbreaks of septic sore throat and gastrointestinal disturbances, and after checking the herds found several cows with large ulcers on the udders. These cows had been milked by hand daily for weeks previous to this time. It seems to me that there is no excuse for this practice.

We appreciate to the fullest the fine cooperation we are receiving from this association and other associations interested in better milk. The New Jersey State Department of Health will continue its efforts for pure clean milk and we pray for a continuance of your support.

THE PRESENT STATUS OF BANG'S DISEASE IN MAN *

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FOR CENTURIES there was known on the shores of the Mediterranean a disease which, because of the wave-like character of its fever, was called "undulant fever" and because of its particular prevalence on the island of Malta got the name "Malta fever." It was there in 1887 that Bruce discovered its cause and called it *micrococcus melitensis,*—a spherical-shaped organism, and it was there that the British Naval Commission in the years 1905 to 1907 discovered that this organism was harbored in the goats of the Island and that it was transmitted by the goats' milk to the human inhabitants.

There has been known for years a disease of cattle, contagious abortion, a condition that is of prime importance in the dairy industry, as all of you know far better than I. The cause of this disease, *bacillus abortus,* a rod-shaped organism, was discovered in 1896 by Bang.

More than twenty years later Miss Alice Evans, working in our Bureau of Animal Industry in Washington on a problem set her by Dr. Eichorn, found that these two organisms, the *micrococcus melitensis* that caused Malta fever, apparently,—a spherical germ,—and the *bacillus abortus* that caused contagious abortion in cattle, a rod-shaped germ, were indistinguishable. It was hard to tell in cultures whether they were very short rods or slightly lengthened spheres, and by all cultural characteristics it was impossible to separate one from the other. It took special agglutination tests to distinguish between the two. In fact, these two organisms, until then considered as far apart as the poles,—*micrococcus melitensis* and *bacillus*

* Delivered at dinner session.

abortus,—were found to be more closely related than are the separate strains of the pneumococcus.

On the basis of that finding and with her knowledge of the great pathogenicity for man of the Malta fever germ from the goat, she predicted that in all likelihood this germ from the cow would likewise be found to be a disease producer in man. But it took six years before the first human case was described in Baltimore by Kieffer.

Then one by one, an isolated case here and there began to be reported. In 1927 when I had seen the second case in Pennsylvania, I was able to find in the literature of this country only thirty-four other cases of undoubted human infection from bovine origin.

It was the thought of the few who were interested along these lines that this was probably a bit of a medical curiosity and would not amount to much. However, I was struck by three things:

In the first place, those thirty-six cases were spotted all over the United States. They came from every possible section of the country.

In the second place, the clinical picture which those patients manifested was so widely varied, so extremely different from case to case, that it corresponded in that particular to Malta fever, the goat disease, which is likewise extremely varied in its clinical manifestations,—so varied that even in the countries where it is known to physicians, patients are usually treated for something else for a time before the true state of affairs is recognized.

Finally, those thirty-six cases were reported by a comparatively limited group of individuals who were interested from the laboratory standpoint in this work or in a few instances by those who had seen Malta fever in the tropics.

For these reasons I ventured to predict at that time that many more cases would be discovered in the future and that it would in all likelihood be a matter of no little public health importance. To what extent this prediction was justified you may judge for yourselves. Only two years later Simpson was able to collect in the United States records of two thousand, three hundred, sixty-five cases and in a few more years that number had risen to nine thousand, nine hundred sixty-five.

Now, in the intervening years, much has been learned about this type of infection, its mode of transmission, and so on. Unfortunately, however, there are still great gaps in our knowledge,—gaps which are responsible for not a little difference of opinion as to a number of things: In the first place, as to the relative importance of this disease in human medicine; in the second place, as to the relative importance of various factors concerned in its transmission, the strains of organism involved, and so on.

What of the importance of undulant fever in human medicine? This has not been settled by any means but it is looming larger and larger each year. Only three years ago the Section on Hygiene of the League of Nations decided that this disease represented one of the major health problems of the world. In 1933, Allesandroni and Pacelli, writing under the auspices of the Italian Health Ministry, published a large monograph under the title, "Brucellosis—a Social Peril." On the other hand, in this city only two years ago Dr. Hardy of Iowa, speaking before the Association of American Physicians, suggested that as far as general health was concerned, undulant fever is probably not of major importance. You can take your choice between those extremes. Personally, I am inclined to side against Dr. Hardy in this matter, and for the following reasons:

I feel that beyond a doubt many cases of this disease are still being overlooked. A prime reason for it I have already referred to, namely: the enormous number of clinical guises in which this disease can show up. It was

described years ago as "an infection of uncertain course and indefinite duration". There is nothing typical that you can tie to in that kind of a description.

I told you a while ago that up to 1935 there had been reported in this country 9,965 cases. When you look over that literature, however, you will find that three men managed to see or have referred to them over three hundred of these cases,—three men had seen one-thirtieth of the reported cases in the country. What about the other 129,997 practicing physicians?

One of these three men, Dr. Harris, reported fifty-one cases from a small town in New York state that he had seen in his own general practice. He was alert to the possibility of the disease. I still feel that the overwhelming majority of our doctors are not fully aware of the possibilities.

Geographical figures are also interesting in this regard. About four years ago the state of Iowa reported 758 cases. The neighboring state of Nebraska reported just twenty-seven. The state of Missouri reported 564 cases; the adjoining state of Arkansas reported sixteen. Do you believe for one minute that state boundaries are a barrier to this disease?

Perhaps from the standpoint of mortality the disease is not going to loom very large in human medicine because, fortunately, the mortality is rather low. There have been, however, outbreaks of the goat type of disease in which the mortality rose to 14 per cent and the mortality in the earlier human cases ranged between 3 per cent and 5 per cent; that percentage is tending to fall somewhat as more and more of the milder cases are being recognized and reported.

However, from the standpoint of morbidity, from the standpoint of the invaliding of individuals, it is an extremely important disease when you consider that its average duration is three months and that it can last anywhere from two days up to many years.

We have learned much about the types of organism involved. There are three major strains, as you know,—the goat strain that is responsible for the disease in the tropics primarily; the hog strain, which is much less virulent but nevertheless is a pretty bad actor on occasions; and then the bovine, the cattle strain, which is decidedly the least virulent of the three.

It is true that all these strains are disease-producing not only for that particular animal but for the other animals interchangeably, as well as many other species of animals that I have not mentioned, including man. One therefore can not generalize and be too flat-footed about saying that all undulant fever is due chiefly to hog strains or to turn the thing around and say they are all due to cattle strains. That is largely a matter of geographical location.

Hardy, in Iowa, found that of sixty-nine strains isolated from human cases, forty-five were undoubted hog strains, and therefore concluded that the hog was the major factor in the human disease problem. He pointed out, too, that 20 per cent of hogs as they came to slaughter in Iowa were found to be infected.

On the other hand, in the state of New York, a state from which over 11 per cent of all the cases occurring in this country have been reported, the hog population is comparatively small and the goat population still smaller. It is not surprising, therefore, that Gilbert and Coleman, two years ago, in reporting on strains isolated from 117 different milks, found 113 of them to be bovine and only four hog strains. And as far as the hog population of New York state is concerned, there is some information on that, too, in that Boak and Carpenter found in a little over a thousand hog carcasses only two to be affected,—an incidence of less than .2 of one per cent.

In Virginia the story is rather similar. Starr and Maxcy found that the cattle involvement averaged over 10 per cent and in some counties was well over 15 per cent, whereas in 813 hogs that they examined, less than 3 per cent were found infected and nearly all of the infected animals came from a single batch slaughtered in Richmond. They stated further that in Virginia no case had as yet been traced directly to hog or goat infection. It is obvious that the problem differs with the community.

As regards prevalence of this type of infection among various animals, figures have accumulated so far which are rather interesting. For instance, as a result of the government work in the last couple of years in a survey of this infection in cattle, I have been able to get this figure:

Of 3,317,760 cows examined in the country, 381,657 were reactors;—an incidence of 11.2 per cent. Nearly half of all herds examined were infected. That is a pretty widespread and important disease.

The figures for foreign countries are similar. In England the report is that over half the herds are infected and Hobbe says that in Germany 60 per cent of the herds are infected. As regards hogs, you have heard the figures varying from 20 per cent in Iowa down to .2 per cent in New York. There are no figures that I have been able to find on the prevalence among sheep in this country but in France the degree of infection is surprisingly high. In one year at least, three-fourths of the cases of Malta fever, undulant fever, were traced to sheep as the source of infection.

Horses can be involved, and only within a year or so White and Swett have reported an epidemic in which the infection was transferred from horses to a dairy herd and in turn from this herd to the human consumers of the milk.

The dog likewise is vulnerable to this infection and there have been some interesting facts on wild animal involvement. For example, the buffalo and the elk that are roaming the national ranges, wherever they have come in contact with infected cattle herds over the same grazing areas, now show a decided prevalence of this infection.

Still more interesting is a report that has come from France within the past year where Karkadurovsky examined thirty-four rats which were captured in connection with a dairy place, the herd of the dairy being infected. Eleven of the thirty-four rats were found to give positive cultures from liver, spleen and other organs. It is therefore proved that the infection can pass from cattle to rats. The next step will be to see how it gets back from the rat, perhaps by way of the hog, to man.

And in man himself the organism has been found in the absence of disease. There is an interesting report within the year by Goldstein, Fox and Carpenter who examined the stools of 219 healthy individuals and found that two of these individuals were eliminating live cultures of this organism. Neither individual had any disease manifestation, so here is another type of carrier that maybe the Health Departments will have to worry about some day.

As regards the modes of infection, the contact type of infection, which I mention first is, as you know, an extremely important one, particularly in certain areas and in certain industries. Particularly among meat packers has this been found to be a peculiarly prevalent condition. So, for instance, Meyer and Geiger found 16.6 per cent positive reactors among sixteen hundred workers in a meat packing establishment. Hall and Learmonth found that eight of nineteen meat inspectors in Colorado were positive reactors. Jordan, in Iowa, found that .2 of 1 per cent of blood sera from the population at large gave positive reactions, whereas among two hundred-odd meat packers the percentage was 13.6 per cent. Moreover, in Iowa the meat packers have contributed 10 per cent of the cases of undulant fever in man, while they comprise less than .1 of 1 per cent of the population.

It is not surprising, under these circumstances, that an occupational hazard will bring with it the question of medico-legal aspects and there have arisen problems along this line in several countries. It is being written into the laws of Argentina and it has been raised within the year in France.

That may be another headache for our legislators!

There has been some difference of opinion again here as to which type of carcass is most likely to hurt the meat packer. Thus it has been found that in certain areas those that handle the hogs were much more often involved than those that handled beef carcasses. But this was not the case in every place and there is plenty of evidence to show that the slaughtering of either type of infected animal carries with it a distinct danger of infecting the handler.

It is not surprising, too, that this disease should be particularly common among veterinarians. The figures go something like this: About 30 per cent of veterinarians in this country and in Germany give positive reactions. Not all of these have had the clinical disease. Only a few will give a clear-cut story of what must have been undulant fever. In a majority of them, perhaps, the disease was just a sub-clinical and mild type of an affair or a very short affair that was overlooked. But the fact remains that there is a decided occupational hazard there.

Here is an interesting group of figures that Thompson in Denmark gathered along these lines: He examined eighteen veterinary students and found that they all were negative. Six months after they had gotten into practice, fifteen of the eighteen gave a positive agglutination reaction.

While we are on the subject of contacts, it may be interesting to point out that it is not merely a matter of contaminating the hands and in that way contaminating food and getting the infection in by way of the digestive tract, though these are decided possibilities. In line with the work done some years ago by Carpenter and Boak when they showed that guinea pigs could be infected through the unbroken skin, it is quite likely that some of these infections in man occur through the skin, probably tiny abrasions. There are examples reported,—one recently in a fourteen-year-old girl who got the infection by way of the finger while she was milking a cow.

My last case of this type I saw as late as three o'clock this afternoon—a young veterinarian who developed his infection last July after attending to a cow that had aborted and his symptoms began first with axillary adenopathy, enlargement of the lymph gland in the axilla of the arm he had used in his manipulation, and those glands persisted in an enlarged state, were tender, painful, then slowly subsided and at the same time the clinical manifestations came on. I feel reasonably confident that this was probably such a contact type of infection.

Infection can occur by way of the conjunctiva. I remind you only of the work of Cotton and his associates who found that whereas feeding experiments failed repeatedly to infect heifers, yet the installation of 1 cc. of a broth culture of this organism resulted almost in 100 per cent of takes.

Then there is even the possibility of infection man to man; in one instance I know of, infection of woman to man, where a woman who had aborted because of this disease managed to infect the gynecologist who attended her.

I forgot to mention that, from the occupational standpoint, of course the next in importance are all those who come in contact with the live infected animals,—farmers and dairymen. That accounts for the great disproportion in this contact group of the infection in one sex over the other. In the contact cases we find the male involved at least six times as often as women.

Turning now to milk as a means of conveying this disease, the outstanding thing that has developed is that the disease is conveyed by raw milk. To my knowledge no case of undulant fever in man has been traced to effectively pasteurized milk. One must put the accent on "effectively," because there is evidence to show that if anything slips up there can be ineffective pasteurization and the organism, particularly the hog strain, may live through it.

But even with that possibility, the chance is disappearingly small of getting the disease from pasteurized milk. I know of no case in Philadelphia that has ever been traced to pasteurized milk. A year or so ago Dr. Brooks made a comment on this very point when he showed that of 255 cases reported in the state of New York in a certain period of time, there were eight in the city of New York and 257 upstate.

You see that whether one deals with contacts or with milkborne type of infection, the disease is primarily one of small towns and rural communities where milk is consumed raw or where there can be contact with the infected animals.

Milkborne infection varies with the community. I have told you that Starr and Maxcy in Virginia claimed that over 60 per cent of cases of undulant fever there reported have been traced to milk and only 40 per cent to contact cases. Gilbert and Coleman, speaking for New York, emphasize the importance of milk over contacts in that community.

Yet there are those who, in spite of these figures, try to insist on contact and would exonerate milk absolutely as a cause. Only a year ago, writing in the Illinois Medical Journal, Dr. Welch, a veterinarian, insisted that it was purely a matter of contact and he tried to show that the probable reason for these folks, particularly the women, for getting the infection, was that they handled infected hog meat in the course of their domestic duties.

Well now, in New York state a woman would have to handle pork chops from five hundred different hogs before she would finally get an infected pork chop. That is a little bit too far to ask anybody's credulity to stretch!

In regard to the milk mode of dissemination, there are certain factors of importance that have been uncovered. In the first place, there is the factor of dilution, where the chances of getting the disease are great if you drink the milk from a single cow that is putting out the organisms in large numbers; the chances are progressively less as you drink the pooled milk of a herd, and the fewer animals that are affected in that herd, the less the chance of contracting the disease.

So for example, Cameron and Wells in Maryland, in tracing a series of cases of human infection, found that every one of them was traceable to a herd in which more than 20 per cent of the animals were involved. They found no cases from herds with less than 20 per cent. Starr and Maxcy in Virginia had a similar experience in that their possible cases came from the herds with fifteen or more per cent infected animals and not from the lesser infected herds.

In regard to this matter of degree of involvement of herds, Bogan made an interesting observation. He took three tuberculosis sanatoria in which all the patients drank raw milk from the herds. In one of the three institutions the herd was heavily infected. In the other two there was only a small number of infected cows. In the institution with the heavily infected herds, of 854 people consuming milk, sixty-six were found to give positive agglutination tests and forty-one of those had fever, whereas in the other two institutions not one patient gave a positive agglutination reaction,—again the factor of dilution.

Then there is the matter of variation in the pathogenicity of the germ, its virulence,—a factor about which, unfortunately, we as yet know little or nothing.

Then there is the question of the strain of organism. I have said that these different strains are interchangeable and what is happening not infrequently is that hog strains get into herds and the virulence of the hog strain is undoubtedly greater. Some of the rather acute outbreaks have been traced to such an infection of a herd by the hog type of organism.

But whether the strain be a hog strain, as it usually is in Iowa, or whether it be a bovine strain as it usually is in New York State, the fact remains that from the practical standpoint, if the infection is milkborne it is a milk problem, a cattle problem.

As regards other dairy products and the chance of their causing trouble, there is not much to say. It is possible that ice cream might be a factor because it has been shown that hog strains of the organism kept at a temperature of from minus 15° to minus 20° will be alive and kicking after four hundred days.

As regards cheese, those cheeses which are made from soured milk are never likely to cause any trouble because in the process of souring this organism is killed off in about four days. In all the other cheeses, bacterial action is somewhat slower, but eventually does kill off the brucella organisms, certainly in not over three months and usually decidedly less. Cheese, therefore, is not an important factor and probably the same may be said of butter.

There are, however, many unexplained points in connection with this disease. One of these is, "Why don't we see more of this illness in that part of the population that consumes the most raw milk,—namely, young children"? When I first surveyed this situation in those first thirty-six cases, the youngest was thirteen. Since that time, however, not a few cases have been reported in children as young as six months. The fact still remains, though, that the number of cases among these youngsters is comparatively smaller than one would expect.

One possible reason might be this: Is it true perhaps that the sexually immature individual is, for some reason or other, less vulnerable to this infection than the mature? I remind you of the same situation in the bovine field where calves are not infected; in fact, it is not until maturity is reached that the disease becomes at all prevalent among them. Perhaps the human young has a similar unexplained immunity.

There is the further chance that these children may have an infection, but that it is of a very mild and unrecognized type. An observation along that line was made by MacBride and some of his associates when they investigated children in an institution,—some two hundred-odd children, all of whom were getting raw milk,—and they found among those tested that one-seventh of these youngsters gave positive agglutination reactions. One-seventh!

Now you might ask, Is not that perhaps due simply to the ingestion of organisms which were killed in the digestive tract but which nevertheless may have set up immune processes after being absorbed?

We know in man one can produce immune substance in the blood to the typhoid bacillus, if one feeds enough dead typhoid bacilli. However, there is no evidence to show that feeding of dead brucella organisms will produce the slightest immune response. That has been tried in guinea pigs, for example. Huge amounts of killed cultures have been fed to guinea pigs and in no instance did agglutination production develop. Apparently it must take an actual infection before agglutinins will be developed. This infection may be exceedingly mild but the fact remains it is still an infection.

Is undulant fever on the increase?

That question is debatable. There are a good many that suggest that perhaps it is on the increase. They point to the large numbers of cases that are being reported from place to place. However, it is also possible that we may have been overlooking them.

Just to get a little sidelight on this particular point, I went through the records of the University Hospital for twenty years,—the cases of typhoid fever, so-called. Each year I was able to pick out a certain block of cases that had been pigeon-holed as typhoid fever. Why? Because they had a long-continued fever, a leukopenia, an enlarged spleen and the disease looked like typhoid fever, even though the Widal test was negative and blood cultures were negative. Several of those cases had relapses or recrudescences of their "typhoid." They were nothing but undulations of undulant fever, I am quite sure.

Five of them, I recall, happened to be in sailors who had just arrived in the port of Philadelphia from the West Indies where they had been consuming goats' milk and yet the diagnosis was missed!

Even now such mistakes are being made. There is at present in the University Hospital a young man who comes from a small town in New Jersey. He was diagnosed by two doctors as having tuberculosis. X-ray pictures were taken and they managed to see something a little bit fluffy up in one apex that made them a bit suspicious and,—good clinical practice!—they told this young fellow to take this situation in hand early and undergo a tuberculosis cure. He was admitted to a sanitarium at White Haven, and there it was found out that he did not have tuberculosis but undulant fever,—raw milk supply just outside of Trenton.

Roth, in Germany, has raised the point, as have some others, as to whether or not the alleged increase of this disease might be due to the practice of attempting to immunize cattle with vaccines of live cultures of low virulence. The matter is not settled but there is enough evidence on his side to make you just wonder a little as to whether that has not been a factor in this affair. I am not prepared to answer the question.

From the standpoint of the clinical picture of the disease in man, I am not going to give you a dissertation on that. I just want to read you a few of the names that have been reported in connection with the complications, —just the complications—that have occurred in the literature of the last year or so:

bronchopneumonia
osteoarthritis
purapura
nephritis
hepatitis
cholecystitis, (a case that was proved and cured at operation; the gall bladder contained the organism in pure culture.)
splenic disease with enlargement
phlebitis
gastrointestinal hemorrhage
meningitis.

Next let me call your attention to a group of six interesting cases. When Hardy spoke before the Association of American Physicians two years ago and made the point that he did not think this disease was of much importance as a public health problem, he reported nevertheless among his own observations these complications:

A patient with meningitis
A patient with osteomyelitis. The osteomyelitis had involved the man's humerus and had lasted for eight years. A case of

mycotic aneurism; the organism was recovered in pure culture from the mycotic aneurism. The mycotic aneurism happened to rupture into the meningeal space and killed the patient.

Two cases were osteomyelitis of the vertebrae that simulated Potts' disease.

Then he said, "Just how frequent are such infections as I have here illustrated, we don't know." You bet we don't know! And they are much more frequent than most of us may suspect.

Another clinical point that I want to mention again is the duration of this disease. It can last anywhere from two days to many years. Next let me emphasize how vague the clinical picture of the disease can be. You can read an article on this particular subject written by Alice Evans herself a few years ago in which, commenting the vagueness of their stories, she pointed out how such patients were shunted from pillar to post, from one doctor to another, trying to get a diagnosis and all they could get was a diagnosis of neurasthenia. It happened to be her own case that she was referring to in one of these. She herself went around for three years, in spite of the fact that she had been working with this organism and the infection should have been suspected, (she as well as five of the six others assigned to investigate this disease in the Public Health Service laboratories came down with it) with a diagnosis of neurasthenia until the true state of affairs was finally discovered. She had a negative agglutination reaction.

That is just another one of the tricky things in this disease. You find negative reactors among human cases, too.

The diagnosis is obviously difficult. It takes the use of everything at our command in the way of diagnostic procedure,—agglutination reaction, skin tests, blood cultures, phagocytic index determination—but above all it takes a knowledge on the part of the doctor that this disease exists and must be considered in every case of protracted fever or other ailment of an infectious nature that he can't quite get to the bottom of.

As for the treatment, it would take me about ten minutes just to read the names of the things that have been used, and you can put it down that the value of a therapeutic measure for a given disease is in inverse proportion to the number of therapeutic agents that have been recommended for that disease. So of all these various things, not any one amounts to much, irrespective of the claims of the manufacturing houses about this serum and that brucellin preparation and the other vaccine.

Boak and Carpenter have recently reviewed our knowledge of treatment of this disease (February 1936 number of "Medicine"). They conclude that the one thing that seems to have done any real good in any form of treatment, whether a chemical injection or a vaccine injection, is the so-called non-specific protein reaction,—a shock reaction with fever, that the treatment produced. Ervin has reported very good results in a series of ten cases in which the intravenous injection of typhoid vaccine was the means used to produce the shock reaction.

From the standpoint of prophylaxis, attempts to prevent the disease by vaccination, the injection of killed organisms, as we do for typhoid, has proved a lamentable failure in man and beast. The use of low-virulence living vaccines in cattle has been worked with for a long time and there is perhaps some encouragement in the results thus far obtained. However, the thing is far from a settled state and we can not as yet promise ourselves much from this procedure.

Pasteurization of milk will take care of those cases that got their infection in that way. However, that will not affect the minority in some regions and the majority in others who get their infection by contact. After all, whether milk or contact, the underlying problem concerns the eradication of this disease in animals. And that, you can well appreciate, is an enormous problem.

We already have some inkling that it will work. So for example, in Washington County in Maryland, they were having cases regularly and frequently for several years, the longest interval between cases being three months and for the most part coming closer together than that. When the milkshed for that county was finally cleared of this infection, no cases had occurred after seven months at the time of reporting. Multiply that experiment a thousand-fold and we will be getting somewhere!

Over twenty years ago, and before he had the slightest inkling about the cattle infection which was going to help his argument along, Nicolle, the great French investigator of this disease, uttered the prophetic words: "Malta fever,—the disease of the future."

One may say today, as far as the dairy industry is concerned, "Undulant fever,—the disease of the present."

VITAMIN-C CONTENT OF DAIRY ORANGE BEVERAGES *

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Introduction

A RECENT development in the dairy business is the successful sale of bottled orange drinks as an adjunct to the distribution of fluid milk. This innovation has received sudden and widespread acceptance among milk distributors. A survey [1] of the milk business published in the October, 1935 issue of the *Milk Plant Monthly* revealed that to the question, "Do you find it profitable and desirable to sell an orange drink?", the ratio of positive to negative answers was roughly three to one.

Fletcher (1935) states that the cost for processing orangeade from concentrates was found to be 0.15 cents a gallon, against .035 cents a gallon for milk.

A number of states have passed regulations regarding the composition and processing of dairy drinks. Several states specify that an orangeade, to be called such, must be made from orange juice, sugar, and water in such proportions that the finished orange drinks contains not less than 15 per cent of orange juice. A number of states and cities also require that orange beverages be processed in equipment (or rooms) not used for the handling of fluid milk.

Goss (1925) and Nelson and Mottern (1933) reported respectively on the high vitamin-C potency of vacuum concentrated and frozen orange juices. Koch and Koch (1932) found Orange-Crush beverage, if dispensed within

* Presented by Prof. J. H. Frandsen of Massachusetts State College, Amherst, Mass.

ten days after dilution of the concentrate, contained only six to seven units of vitamin C per ounce.

We have seen no recent vitamin-C studies on reconstituted dairy orange beverages although vitamin-C content is undoubtedly of more significance than any other property and is the principal dietary essential in orange drinks. Furthermore, the vitamin-C content is a point often stressed in the selling of orange drinks. This study was carried out in order to furnish some much needed information as to the vitamin-C content of dairy orange beverages.

Preparation of Orange Beverage Base

According to Mottern (1935) the orange juice is usually extracted on hand reamers, since machine pressing extracts too much oil from the rind. The extracted juice is screened, and color, sugar, and citric acid or lemon juice are added. This base is then deaerated as it flows over the baffles in a thin film under a partial vacuum. After deaeration the product is flash pasteurized, then cooled to 76.7° C. (170° F.), and filled into special enamel-lined sanitary tin cans. The cans are immediately placed under a shower of cold water in order to cool the juice to cold-storage temperatures.

Some juices are vacuum concentrated after pasteurization to give a higher juice content or to permit greater dilution. The concentration is carried on in glass-lined vacuum tanks at a low temperature of about 36.7° C. (98° F.). The concentrated juice requires careful storage in a cool, darkened place to prevent darkening.

The dairy orange beverages now being distributed contain from 10 to 16 per cent of orange juice. The amount of lemon juice or citric acid added to the base is sufficient to give a final acidity of .3 to .4 per cent in the finished beverage. The use of lemon juice for standardizing the acidity increases the vitamin-C content of the beverage.

The addition of color to the base becomes illegal after July 1, 1936, by federal regulation.

Biological Assay of Dairy Orange Beverages

The orange beverages were made up from the fresh concentrate or base according to direction furnished by the manufacturer. Fresh batches were made up every other day and stored at 2.2 to 4.4° C. (36 to 40° F.) in half-pint milk bottles sealed with cardboard caps.

The standard assay technique of Sherman, LaMer, and Campbell (1922) was used, with the exception that the experiment was terminated on the seventy-fourth day. Young guinea pigs weighing from 280 to 350 grams were used in the experiment. All were gaining weight when

Table 1

Biological Assay of Orange Beverages for Vitamin C

Orange product	No. of animals	Amt. fed daily	Av. change in wt.	Av. survival period	Av. scurvy score	Estimated protective level	Units of vitamin C [1]
		grams	*grams*	*days*		*grams*	*per oz.*
Green spot	3	6	5	72	7	—	—
Green spot	3	10	191	74	0	8	35.0
Mission	3	10	−123	66	11	—	—
Mission	6	20	35	68	7	—	—
Mission	3	30	143	74	1	32	9.0
Lash's	3	10	−116	46	13	—	—
Lash's	6	20	− 39	67	8	—	—
Lash's	3 [2]	30	95	74	3	37	7.8
Dromedary, canned orange juice [3]	3	1.5	216	90	0	1.3	215.0
Fresh Florida orange juice [3]	3	1.5	217	90	0	1.2	235.4
Negative control	2	0	−165	29	14	—	—

placed on the dietary regimen with orange beverage as the sole source of vitamin C. In general the guinea pigs voluntarily consumed the beverages, though when as

[1] International units based on an estimated protective level of .5 mg. of pure ascorbic acid per guinea pig. One International unit of vitamin C is the antiscorbutic activity of .05 mg. of pure l-ascorbic acid.

[2] One guinea pig died after 31 days with no evidence of scurvy.

[3] These results were obtained in another experiment which ran for 90 days; all other assays were terminated after 74 days.

much as 30 cc. daily was fed, occasionally some was left. By feeding twice a day this difficulty was overcome. All animals were autopsied and scored for scurvy lesions as suggested by Sherman, *et al.* (1922).

Assays of canned and fresh orange juices are included for comparison (Table 1). The two negative controls died of scurvy after twenty-eight and thirty days respectively. The Green Spot orange beverage samples were considerably higher in vitamin C than either the Mission or Lash but were less than one-sixth as valuable as fresh orange juice. The samples of Dromedary canned orange juice examined were an excellent source of vitamin C.

Chemical Titration Values for Ascorbic Acid in Dairy Orange Beverages

All the samples of orange beverages were evaluated for ascorbic acid (vitamin C) by the new chemical procedure of Bessey and King (1933). Fresh 2,6-dichlorophenol-indophenol indicator was made up and standardized against pure ascorbic acid (redoxon). Several determinations were made on each sample so that the values as given in Table 2 should be reasonably trustworthy. Two distinct samples each of Green Spot and Mission were used. Pure Florida orange juice and Dromedary canned orange juice (Florida) were also used for comparison with the orange-type beverages.

The iodine titration method for vitamin C recommended by Reynolds and Stevens (1934) of the Research Laboratory, California Fruit Growers' Exchange, for citrus products was also used for the sake of comparison. The iodine solution was standardized against pure ascorbic acid.

Comparison of Methods

The direct comparative results obtained by the use of the two chemical methods and the biological assay agree very well. For example, fresh orange juice by the biological assay, dye, and iodine methods contained 235.4, 228, and 258 units respectively of vitamin C. For Green Spot Dairy Orange the three methods gave corresponding values of 35.0, 39.6, and 36.8 units of vitamin C. Within limits it appears that all three methods give reasonably accurate results. A further comparison of the two chemical methods is found in Table 3.

Results

The best carriers of vitamin C are Dari-O, Green Spot, and Nesbitt. These contain only 16 to 23 per cent as much vitamin C as fresh orange juice (Table 2). Several of the dairy orange beverages contain so little vitamin C

Table 2

CHEMICAL TITRATION VALUES FOR ASCORBIC ACID (VITAMIN C) IN DAIRY ORANGE BEVERAGES

Orange product	Dye method				Iodine method			
	No. determinations	Ascorbic acid per gram juice	Calc'd protective level	Units of vitamin C	No. determinations	Ascorbic acid per gram juice	Calc'd protective level	Units of vitamin C
		mg.av.	grams	per oz.		mg.av.	grams	per oz.
Dario-O	4	.093	5.4	53.0	3	.077	6.5	43.6
Green Spot A	4	.070	7.1	39.6	3	.065	7.7	36.8
Nesbitt	4	.065	7.7	36.8	3	.061	8.2	34.6
Green Spot B	3	.066	7.6	37.4	3	.065	7.7	36.8
Cal-Ade	3	.048	10.4	27.2	3	.040	12.5	22.6
Bireley's	5	.048	10.5	27.2	3	.049	10.2	27.8
Mission A	5	.024	20.9	13.6	5	.031	16.9	17.6
Mission B	4	.021	23.8	11.8	6	.024	20.9	13.6
Lash's	3	.019	26.3	10.8	6	.02	25.0	11.4
Valen'ju	4	.018	27.8	10.2	3	.016	31.3	9.0
Dair-E	3	.013	38.5	7.4	6	.020	25.0	11.4
Virginia Dare (synthetic)	6	.003	166.7	0.2	8	.006	83.3	0.4
Fresh Florida orange juice	3	.403	1.24	228.0	3	.456	1.10	258.0
Dromedary canned orange juice	2	.377	1.33	213.2		not determined		
Ascorbic acid solution containing .1 mg. per c.c.	4	.10	5.0	56.6				

that they must be considered very poor sources of this vitamin. The synthetic Virginia Dare could hardly be classed with the other drinks because it is clearly a synthetic flavor and there is no claim that it contains either orange juice or vitamin C. The Dromedary canned

Table 3

Loss of Vitamin C in Dairy Orange Beverages on Standing

Orange product and storage conditions	Dye titration method			Iodine titration method		
	Ascorbic acid	Units of vitamin C	Percentage loss	Ascorbic acid	Units of vitamin C	Percentage loss
	mg. per gm.	*per oz.*	*per cent*	*mg. per gm.*	*per oz.*	*per cent*
Green Spot, fresh	0.066	37.4	0	0.065	36.8	0
Green Spot, 20 hrs. at 4.4° C. (40° F.)	0.055	31.2	16.6	0.055	31.2	15.4
Green Spot, 44 hrs. at 4.4° C. (40° F.)	0.046	26.0	30.3	0.049	27.4	24.6
Green Spot, 20 hrs. at 23.9° C. (75° F.)	0.025	14.2	62.1	0.022	12.4	66.1
Green Spot, 44 hrs. at 23.9° C. (75° F.)	0.0068	3.8	89.7	0.015	8.4	76.9
Dair-E, fresh	0.011	6.2	0	0.011	6.2	0
Dair-E, 20 hrs. at 4.4° C. (40° F.)	0.0066	3.6	44.0	0.0074	4.2	32.7
Dair-E, 44 hrs. at 4.4° C. (40° F.)	0.0057	3.4	48.1	0.0079	4.6	28.1
Dair-E, 20 hrs. at 23.9° C. (75° F.)	0.0030	1.6	72.7	0.0045	2.6	59.1
Dair-E, 44 hrs. at 23.9° C. (75° F.)	0.0011	0.6	90.0	0.0038	2.2	66.3

orange juice was again practically as good a carrier of vitamin C as fresh Florida orange juice.

Loss of Vitamin C During Storage of Dairy Orange Beverages

Since many dairy plant operators ordinarily do not make up these beverages fresh every day for the trade, the loss of vitamin C upon storage was determined for two of the products. The data are tabulated in Table 3. While cold-storage temperatures prevent rapid deterioration, there is an appreciable loss in vitamin-C content even at 4.4° C. (40° F.) in 20 hours. At room temperature the losses are very great, showing that these beverages lose much of their vitamin C unless consumed soon after manufacture from the concentrate.

In general the flavor was well retained in these beverages for at least two days in the cold-storage room.

Summary

1 There is good agreement between the biological assay method on the one hand and the 2,6-dichlorophenolindophenol and iodine titration methods on the other for the determination of vitamin C, (ascorbic acid) in orange beverages. Of the two chemical methods used, iodine titration gave more constant and easily reproducible results than the dye method.

2 Twelve samples of ten different dairy orange beverages when examined for ascorbic acid content by the dye and iodine methods showed ascorbic acid values of from .003 to .093 mg. per gram, corresponding to from .2 to 53 units of vitamin C per ounce. For comparison fresh orange juice contained 228 to 258 units and canned orange juice somewhat over 200 units.

3 Reconstituted dairy orange beverages rapidly lose their vitamin C upon standing at room temperatures. This loss at cold-storage temperature is much less, but is still considerable.

Conclusions

While some dairy orange beverages are fair antiascorbutics, they contain on the average only 10 per cent as much vitamin C as fresh orange juice. Many dairy orange beverages cannot even be considered satisfactory substitutes for fresh or canned orange juice as carriers of vitamin C.

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PRACTICAL ASPECTS OF DAIRY FARM INSPECTION

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IN submitting this paper to this meeting, it is my serious desire to show those people interested in the dairy industry, and those of us concerned with department of health work, how a more uniform interpretation and enforcement of our milk ordinance will greatly benefit the industry at large. You will understand that all of the observations I will make in the time at my command today, will be based on the practical experience I have gained in dairy field work, and not, in any instance, on theory. Therefore, you will appreciate that in order to give you these observations from an actual experience standpoint, it will be necessary for me to use frequently the personal pronoun. Please understand that the recurrent references to my own work are made in order to get my ideas across, and this can not be done otherwise except to tell you in plain words about my own personal findings. There is no attempt, in the use of these personal pronouns, to suggest that others of you have not noticed similar conditions.

In explaining the urgent necessity for more uniform interpretations of ordinance by departments of health, I am going to tell you about the type of work I have been doing, how I have gone about my tasks, the many obstacles that were placed in my way through lack of cooperation by various agencies, and then summarize by suggesting to you my ideas as to how I believe dairy inspection work should be done in order to get the best results.

For the past six years I have had the opportunity of working in our midwestern, southern, and quite a little work in eastern states—a territory covering some twenty-three states in all. This work brought me in direct contact with plants, and dairies supplying these plants, which had applied for a permit to make interstate shipments of cream into the city of Newark and the state of New Jersey. Most of these plants were of the manufacturing variety, and neither they nor their supplying dairies had ever been under any inspection. Occasionally some plants were so located that their dairies intermingled with dairies that were under a city inspection, and of course they were already familiar, more or less, with inspection requirements. To say that my problems were perplexing would be putting a well known fact very mildly. To begin with, the field men employed by most of these manufacturing plants were milk buyers, and knew very little about the regulations governing the clean production of milk. Then, the majority of the milk deliveries arrives at the plants on privately owned trucks, and the drivers were more interested in tonnage than sanitation. The field men were rarely familiar with the pick-up order of the routes, and in starting the inspection of a route, it was usually necessary to have the hauler accompany us, or draw a crude map showing locations of the dairies. You can believe it or not, but I have found cases where the only occasion for a visit to the dairy of some producer by a field man, would be when the patron threatened to quit, because of some dissatisfaction about test or price, and then a complaint visit would be made. This lack of close familiarity with the territory and the patron was one of the obstacles placed in my way, although it might have been one of the least.

I will now point out to you what a survey of these dairies would show. This is being done to acquaint you with what little we had to start, and how nearly hopeless the original picture appeared. Later I will attempt to show you this same picture as it appears today, and I will do so with the thought in mind that if all of our departments of health would get behind a movement to improve their milk and cream supplies and make the same amount of progress that we have made, I know that in a short time we could all point with pride to our achievements. My first survey of the dairies would usually sum up as follows: no milk house, or if any, found to be below standards in both construction and upkeep. The utensils were very rarely of approved design, ranging in construction from shotgun cans to tin funnels with a rag for a strainer. Milk cans were of every type. Cow barns in most cases were merely general farm barns, housing a conglomeration of cattle, hogs, horses, sheep, chickens, and implements all under one roof with no partitions. The barns had dirt floors, no window light, open ceilings, manure piles inside and out, and ventilation considered only as an agency for blowing out the odors. Privies were generally bad.

I suppose by now that most of you listening are wondering why we bothered at all with supplies such as this. I want to say that with the exception of the states of New Jersey and Pennsylvania, and those other communities who are working on a program similar to that followed by the city of Newark, all of you, whether it be cities or states receiving interstate shipments of cream, are receiving a certain amount of cream from just such supplies. The conditions are just as I have related, and are just the same as our supply was before we started on our present program. Our department realized that we had to receive a certain amount of cream from outside our milkshed, and that if the plants and dairies supplying this cream did not meet our regulations, there was only one thing to do and that was build them up to a compliance level. And right here and now, thinking of the obstacles thrown in our path as I mentioned previously, I want to tell you that the biggest obstacle is the lack of cooperation by competitive companies, and in some cases the local departments of health. When I say that when a dairy was excluded for not meeting our requirements, whether for construction or insanitary and sometimes filthy methods, there were always some companies ready to take the milk and these companies were not always manufacturing companies.

I will now explain how I worked out my programs at various plants, the procedure I went through in order to get them started; and the check-up made after they were in operation to see that they were making a reasonable amount of progress. The first thing I had to realize was that I had three sets of people to consider if my work was going to be successful. First, the consumer to whom I was duty bound to get the best possible can of cream; second, the dairyman whom I was going to ask to change his entire set-up and method of producing milk, as well as the conditions he had worked under for many years; and third, the company operating a plant of a certain constructed capacity, a capacity which I realized must be nearly maintained if the plant were to remain in operation. I decided after much thought, that in order to be of real service to all concerned, I would have to add to my duties of an inspector, those of a salesman and an educator. I conceded that I would have to take with me a human understanding of the difficulties of a group of people uneducated in the ways of dairy sanitation, and sell them the proper methods. I knew that it would be useless to tell the farmer to be clean in the production of his milk when he did not have a suitable barn in which to milk, no good utensils for handling, and no milkhouse for cooling and storing. I also knew that for a company representative to tell the farmer that he had to provide all of these things, as well as a suitable toilet, or stop sending his milk to that plant, the milk would be picked up the next day by a competitive concern. This is where salesmanship and education enter. With a determination to put the programs over, I have gone into several plants which have gone the full route with me. We have rebuilt barns; we have replaced the obsolete utensils; we have provided the correct milkhouse; we are educating the farmers as to methods; we have educated the field man and the milk haulers; and I am constantly rechecking to see that progress is maintained. It is very gratifying to see the splendid results accomplished by the companies who decided to go ahead with the program. I make mention of this because I know here in our Association meeting are members of the health departments, and also representatives of the various companies who will bear me out in what I have said about these supplies. To go into detail about every phase of the actual work, would take the remainder of the day. The important thing is that we are achieving the results we went after, and the conditions I found on my surveys six years ago are improved to a remarkable degree.

So much for the actual work in the field with the subsequent successful results, and back to the attitude of the inspector himself. It is my opinion that the first and the most important thing in practical dairy inspection is that the inspector himself be sold on his ordinance. If the inspector is not sold to the extent that he believes every requirement and every regulation in his ordinance in some way pertains to the clean, safe production of milk, then how is he going to sell the regulations to the farmer? I feel that after he has sold himself on his own regulations, and is working in a territory covered by an inspector from another department of health, he should study as closely as possible this other inspector's regulations. He will, in most instances, find that the other cities and states have regulations similar to his own with minor exceptions. I have worked in territories covered by other inspectors, and have always tried to cooperate in every way with their regulations so long as they were not in direct conflict with portions of our own. Problems along this line have come up, and were handled in this way. Our requirements are that cans and utensils shall be placed on metal racks in the milkhouse, while another city asks that they be kept supposedly out for the sun to sterilize. In a case of this kind, I explain to the head of the company concerned why we require inside storage of utensils, and advise that he contact the other department to see if they will go along with us. Usually they do, and many of these so-called differences can be eliminated if diplomatically handled in this way. This refers directly back to my opening statements in which I asked for a more uniform interpretation of regulations.

In making my plea for more uniform interpretations, I take note of other examples where close cooperation will hasten an ultimate increase in quality. I know that it is the opinion of most people that when you mention the word "inspector" to a farmer, it is like waving a red flag in the face of a bull. While I will admit that this is true in some cases, and especially true in some sections, I believe it is a condition that can be eliminated if the inspector uses tact and tries to gain the confidence of the dairyman. I would suggest that in making your inspections, you meet the dairyman in the same way you would if conditions were reversed. After all the farmer is just as human as you and I.

In making the recommendations necessary for compliance, consider whether the violations were made willfully or through lack of knowledge as to their importance. Then explain to the farmer, if ignorance of methods is evident, just why the recommendation was made, and give him a reasonable amount of time to follow instructions. At the end of this time, your reinspection will indicate his true attitude. If violations are willful, I would suggest excluding the dairy until requirements are met, and I would also try to prevail on any competitive firm to refrain from buying the milk during this period. When making an inspection, and conditions are good, tell the farmer you are pleased with the way he is keeping his place. You know he is human and will appreciate a compliment. In working with the farmer in this way, you will get him to do the things required by your ordinance because he will believe that they will help him produce a better can of milk, and consequently his company will be able to make a better finished product, all of which will eventually mean increased revenue to him. If, on the other hand, the farmer does not understand your reasons for the requirements, he is very apt to comply only when he hears you are in the territory. I suggest closer cooperation and contact with field men and haulers for the same reasons. Once they know why you require certain things, they will be eager to assist. If they fail to understand, they will dodge their duty all the time you are not on their trails. Remembering that the field men and haulers are anxious to keep up the volume at all times, it becomes our task to convince them that the volume must not be maintained with inferior milk, but that it can be kept up to the maximum with a high quality product.

Gentlemen, I appreciate that in my work I have gone beyond the rôle of an inspector in the strictest sense. I have tried to be human in my understanding; I have tried to be kind, yet firm, in my contacts with producers; I have had no patience with gross negligence; I have endeavored to take on the rôle of an educator; and finally I have been a cooperator with fellow inspectors in a great effort to obtain uniform interpretations. As a result of all these things, I point with pride to the results we have achieved, and not one of you can deny the improvements that have been made. I feel that if we would all work along the lines mentioned enforcing our own ordinance and trying to understand and if possible cooperate in the enforcement of other department ordinances that are working in the same territory, we would build up a better understanding of inspection and clean milk production with the farmers, a better feeling between departments and a better feeling with the industry in general. This should tend to help us all get what we are really after, a better and safer can of milk. This talk has been a frank discussion of my attitude toward my job, and I welcome any discussion which may follow. When a better and clearer interpretation of our different ordinances is reached we all will be in better position to cooperate for mutual benefit.

METHODS COMMONLY USED TO DETERMINE THE FAT CONTENT OF FROZEN DESSERTS *

THE official method for fat determination in frozen desserts, as recognized in the Book of Methods of the Association of Official Agricultural Chemists, is commonly known as the Roese-Gottlieb procedure for fat extraction. Because the officially recognized procedure requires more time, a more careful technique and is more expensive than certain other more rapid but less accurate techniques, many regulatory laboratories have adopted some form of the latter as their procedure.

Nearly 1,000 questionnaires were sent out. Replies were received from 144, thirty-seven of which reported that they analyzed no frozen desserts. The 107 affirmative replies were received from the following sources—seventeen agricultural colleges or experiment station laboratories, two commercial industrial laboratories, eight commercial private or hospital laboratories, thirty-three provincial or state department laboratories and forty-five municipal laboratories. The committee originally planned to study the merits of each of the several modifications of the more rapid Babcock techniques. Due to the pressure of work, only a few preliminary tests were made to determine which modifications were worthy of investigation. The present report will, therefore, merely review the frequency with which some of the techniques are used. It is tentatively planned to determine the merits of the various modified Babcock techniques during the succeeding year.

The official Roese-Gottlieb method has its counter part in the mechanically-improved, and -combined Mojonnier

* Committee Report.

equipment and method. The other methods are essentially Babcock modifications under the following names—

1 Glacial acetic acid-sulfuric acid Babcock procedure
2 Lichtenburg method
3 Illinois or Garrett-Overman method
4 Minnesota method
5 Nebraska or Crowe method
6 Fucoma or Gerber method
7 Pennsylvania or Doan method
8 Special modifications (16 reported)

The subsequent table reveals the frequencies with which the above methods are employed among the 107 laboratories reporting.

TESTS COMMONLY USED TO DETERMINE THE FAT CONTENT OF FROZEN DESSERTS AS REPORTED AMONG 107 CONTROL LABORATORIES

Common Name of Test	Frequency of use in laboratories	Sorting test followed by (1) Roese-Gottlieb Method	Sorting test followed by (2) Mojonnier Method	Chocolate flavored frozen desserts tested by same method		Removal of pieces of nuts and fruits before testing		If nuts and fruits are removed, is the fat content recalculated on the basis of the original product?	
				Yes	No	Yes	No	Yes	No
Mojonnier method	17	2	0	17	0	7	8	1	6
Roese-Gottlieb method	20	0	0	18	0	9	7	1	8
Glacial acetic acid-sulfuric acid Babcock method	17	5	2	12	5	4	10	0	4
Lichtenburg method	8	2	1	6	1	5	1	1	4
Illinois-Garrett Overman method	6	4	0	6	0	1	3	0	1
Minnesota method	10	4	4	9	1	3	5	0	3
Nebraska method	1	1	0	1	0	0	1	0	0
Fucoma method (Gerber)	9	7	0	11	0	4	4	2	2
Pennsylvania method	2	2	0	2	0	1	1	0	1
Miscellaneous special modifications	16	4	1	12	2	1	7	0	1

When sending out the questionnaire, it was intended to find out (1) whether or not the more rapid methods were used as sorting tests only to determine the necessity for using the official procedure on substandard samples, (2) whether or not the same techniques were used successfully on chocolate flavored frozen desserts and (3) the procedure most commonly followed when determining the fat content of ice creams containing pieces of fruit and nuts.

Thirty-seven of the laboratories use either the Mojonnier or Roese-Gottlieb methods. Two of the seventeen using the Mojonnier check it on substandard samples with the Roese-Gottlieb method. Of the remaining seventy laboratories, thirty-seven, or slightly more than half, check the more rapid techniques on substandard samples with either the Mojonnier or Roese-Gottlieb methods. In other words the rapid techniques are used as a sorting test to eliminate unnecessary laboratory operations in about one-half of the laboratories reported as using them. Results obtained by such sorting tests should, therefore, be regarded as strictly confidential to the regulatory body because it is fully recognized that they are not as accurate as those obtained with the Roese-Gottlieb method. It is probable, however, that the remaining thirty-one per cent of the 107 laboratories who are not supplementing their rapid tests on substandard samples with the Roese-Gottlieb or Mojonnier method are reporting somewhat less accurate fat contents of the frozen desserts sold under their jurisdiction. No doubt the methods will find the products with the lowest fat content but the results would be subject to severe criticism if introduced into court testimony.

Because many municipalities are represented in this organization, I wish in particular to point out that among the forty-five municipalities returning the questionnaire, nine were using either the Mojonnier or Roese-Gottlieb technique exclusively. Only eight of the remaining thirty-six laboratories were regularly checking their unofficial testing methods,—even on substandard samples, —with the Roese-Gottlieb or Mojonnier method. Among the total of 16 miscellaneous odd techniques, twelve were being used in municipal laboratories. Purely in the interests of accuracy and uniformity, it would appear that the officially recognized techniques be employed on all substandard samples, at least, regardless of the prior use of sorting tests. The large number of samples required to be analyzed occasionally makes the use of some reliable sorting tests very desirable.

The thirty-five laboratories reporting on the use of ether extraction methods were using the same on chocolate ice creams. Two of these laboratories questioned the accuracy of the test as specific for milk fat. Because of common manufacturing practices, it is probable that the amount of cocoa fat derived from the chocolate flavoring is much less proportionately than the objectors believe it to be. Due to the difficulty with which cocoa fat is liberated from the fiber in cocoas and chocolates, it is probable that the cocoa fat in chocolate ice creams does not exceed five per cent of the total fat present.

Because of the cost of the complete Mojonnier equipment, some laboratories have purchased a few of the essentials and are able to make fat determinations of an accuracy equal to that obtained with the Roese-Gottlieb method. It is assumed first that each laboratory has an accurate analytical balance. The other essentials are Mojonnier flasks, alumnium fat dishes, weighing pipettes, weighing crosses, an electric hot plate controlled at about 135° C. to prevent too rapid boiling of the ether mixture and a hot-air oven controlled at 105° C. In the routine Mojonnier method, the ether-alcohol-water mixture is removed under vacuum at 135° C. in five minutes while in this modification the removal of the solvent requires about two hours. Always dry the fat to a constant weight. This modification of drying the fat more nearly approximates the official Roese-Gottlieb method. (Standard Methods of Milk Analysis, Bacteriological and Chemical, American Public Health Association, Sixth Edition, 1934, p. 102, or Methods of Analysis, Association of Official Agricultural Chemists, Fourth Edition, 1935, p. 296.)

It is amazing to find the continued wide use of certain modified Babcock techniques for fat in chocolate flavored ice creams. It is an established fact that some of these modified techniques are wholly unreliable for this purpose. The Gerber technique especially modified for chocolate flavored ice creams and the Pennsylvania method are at present recognized as fairly accurate as compared with some of the others,—particularly the glacial acetic acid-sulfuric acid Babcock method. At present the status of the following methods for fat in chocolate ice creams has not been established by the Committee,—(1) Lichtenburg, (2) Illinois, (3) Minnesota, (4) Nebraska, and (5) the miscellaneous special tests.

The fat determination in ice creams containing pieces of fruit and nuts invites the serious problem of securing a uniform sample. Of the eighty-two laboratories reporting, thirty-five were removing the coarse pieces of nuts and fruit by straining the melted ice cream. Both metal sieves and cloth were used for removing the coarse materials. In only four cases where pieces of fruit and nuts were removed was any attempt made to recalculate the fat percentage on the basis of the original product. A few laboratories are reporting their analysis on the basis of the "strained product." Obviously a higher fat content is obtained on the strained product unless recalculation is made on a basis to include the removed material. Straining or grinding in a food chopper or mortar is apt to cause loss of both pieces of the fruit and nuts as well as a loss of moisture,—even when the finely comminuted pieces are returned to the original mixture,—all of which tends to cause a higher fat content than present in the the original material as purchased. Straining, grinding or any other method of separation *per se* admits the removal of a portion prior to analysis, a practice which makes the analyzed portion not accurately representative of the product as purchased. When an analysis based on such a procedure is contested in court, obviously the control agency would be in a decidedly weak position to defend the method.

Most laboratories reporting no removal of the solid particles are attempting to use greater precaution by mixing to secure a representative sample. One laboratory macerates the fruit in the mixture but strains out the nuts. Several laboratories have used a stiff spatula to macerate the pieces of fruit and nuts in the original melted mixture as purchased. This involves no removal of any part of the ingredients and offers an entirely suitable means of mixing the material in the sampling container. A few laboratories following this maceration practice are using pipettes with large orifices for the removal of such small pieces of nuts and fruit as have not been entirely broken up.

It is recommended that the Committee be directed to continue its investigation.

A. H. Robertson, *Chairman*

C. K. Johns	F. P. Wilcox
R. L. Griffith	H. E. Bowman
J. H. Shrader	D. W. Horn
Horatio N. Parker	Geo. E. Bolling
F. Lee Mickle	James P. Buckley
H. O. Way	H. W. Leahy

Discussion

Mr. Horatio Parker: Dr. Robertson's Committee has put its finger on a very weak link in our control methods.

As you observed from his report, a great many municipalities are making no attempt whatever to check up the frozen desserts that are sold in their communities. One reason for this, I think, is the fact that there has been no suitable, quick method by which they could carry on their analyses.

It is true that with these quick methods it would be of doubtful utility to carry your findings into court, but the mere fact that an ice cream supply is being checked usually causes manufacturers to be careful in what they are putting out, and I think in most communities they would gladly check up and alter any errors in their formulas. I have found this to be the case.

Another reason why this matter has not been thrashed out is because such organizations as the AOAC have necessarily had to stand out for absolutely accurate methods, like the Roese-Gottlieb or the Mojonnier methods. They have not been interested in getting approximately accurate methods.

I feel that this work of Mr. Robertson should be continued. He has laid the foundation for a thorough investigation of the most promising of the short-cut methods.

QUALITY CONTROL IN THE ICE CREAM PLANT

H. F. JUDKINS

Sealtest System Laboratories, Inc., New York City

INTRODUCTION

ALTHOUGH my position differs from yours in that I am in the employ of a commercial concern, we have a mutual interest in the production and handling of high grade dairy products under clean, sanitary conditions. I gladly accepted your President's invitation to speak to you today because I felt I could speak frankly about some of the problems of quality control the dairy plant operator faces, and, thereby, perhaps strengthen the understanding and bond of cooperation that must necessarily exist between health officer and dairy products manufacturer if real progress is to be made.

ESSENTIAL FACTORS IN THE MANUFACTURING OF HIGH GRADE ICE CREAM

1 Good Plant

It will be my purpose only to point out some of the essentials to consider in building and equipping a new plant of the 1937 model. I do not, however, want to leave the impression that it is necessary to have a 1937 model plant to produce a high quality ice cream. Sometimes a plant superintendent is inclined to use this for an alibi for some conditions that are not just right. Of course, all that can be expected of any man is to do the best he can with what he has. With proper attention to cleanliness and manufacturing methods, it will be surprising to note what can be done in a mediocre plant with equipment that may not be the most up to date.

(a) Site

The plant should be located on a well drained spot and in a section where the air is as clean and pure as possible. Room for some lawn and shrubbery adds much to the appearance, and there should be plenty of yard space to handle shipping and delivery easily.

(b) Walls

Brick walls on the outside with glazed tile on the inside make for a durable building and one that requires very little maintenance. It is a good plan to use Bull Nose tile on corners, at least up to a height of six feet. Narrow, slanting window-sills of Bull Nose tile, on which nothing can be placed, are very desirable. The juncture of the floor and wall should be properly curved to make for easy cleaning. Steel sash windows with tilting centers appear to have the call, although I think there is a chance for improvement in factory windows for a dairy plant.

(c) Floor

Tile appears to be the most satisfactory with steel grid plates laid where there is likely to be excessive wear. Floors, of course, should be properly graded to drains. There should be plenty of room around the equipment, and equipment should be kept approximately two feet away from walls and ceilings. Equipment should be set up off the floor so that one can clean underneath it. A good plan is to set the bolt head in the floor and run it up through a short piece of brass pipe filled with concrete; the piece of pipe also being set into the floor for a short distance.

(d) Ventilation

Air conditioning is highly important in the processing rooms. The time may not be far distant when the plant will be, or at least the processing room part of it will be built without any windows, either depending on artificial light or glass blocks for light. We have made a step in this direction in a large butter print room in Dubuque, which is air conditioned, soundproof and artificially lighted. It certainly makes a wonderful room in which to work. When this day comes, we, of course, shall have to change our prescription as to light and ventilation.

(e) Toilets

Toilets should not open into rooms where ice cream or its ingredients are handled. Proper outside ventilation should be provided. Toilets should be equipped with doors with an automatic closing device. Adjacent to the main toilet should be a well lighted and ventilated spacious locker room.

(f) Plumbing

P-type traps should be used in the floors and the following should be observed:

No direct pipe connection between potable water supply and sewage line

Potable water supply inlets arranged so that negative pressure in the line cannot syphon contaminated water or sewage into the potable water line

Sewer lines not to be located over pasteurizers or other processing equipment.

(g) Separate Processing Rooms

Separate processing rooms, other than for can washing and possibly receiving dairy products, add to the cost of doing business, especially in a small plant, and better work and appearance will be maintained in a plant, that is opened up with such operations as mixing, freezing and novelty operations in the same room but with plenty of space to move around. This makes it possible in smaller plants to have everything on one floor, with the possible exception of a mezzanine for ice cream mix storage. For larger plants two floors, but seldom more than two, may be desirable.

2 Equipment

(a) Metals

Generally speaking, equipment in which dairy products and ice cream are handled and manufactured should be of stainless steel. My personal judgment is that stainless steel, sanitary pipe, although very expensive, will pay in the long run. I would certainly use it on hot milk or mix lines. Stainless steel fittings are also coming into their own, although the copper nickel alloy fitting and the copper nickel alloy piping for cold lines seem to work out very well. Personally, I have seen so many leaky fittings of the standard type that I prefer the gasket type fitting, although there may be some argument on both sides of the question. If the plant and the placing of the equipment are properly planned, the sanitary piping may best be supported on pipe supports from the floor rather than on hanging supports.

(b) Receiving Equipment

More recent developments in receiving equipment include a can rinse with automatic lid loosener. The can is inverted in a grid over the weigh can. The weigh can is of single compartment type with fourteen-inch bottom outlet, the valve of which stays open while the milk is running out of the tank but automatically closes after all of the milk has left the tank. The drop tank is of small capacity and the milk is pumped out with a pump controlled automatically with a float from the drop tank about as fast as the milk enters the tank. The drop tank is tightly covered while receiving is going on and small enough so that it can be entirely taken apart and cleaned inside and out after the operation.

(c) Other Recent Developments

Other more recent equipment developments in an ice cream plant include the continuous freezer and improvements in homogenizers to facilitate cleaning.

(d) Recording Thermometers

While they need constant watching, they prevent many an argument and are really necessary to proper control on such places as hardening rooms, mix pasteurizers, storage tanks, and refrigerated stock rooms.

(e) Miscellaneous Items Tending to Make for Sanitary Production

The following items tend to make for sanitary production, such as wash troughs for sanitary pipe and fittings, metal chairs, stainless steel tables, brush holder, can cover racks, special sewer drains from machines, waste containers, steel cabinets, steel ladders, special supply trucks, rag holders, proper uniforms for employees, etc.

3 Good Raw Material

(a) Dairy Products

The same care should be taken in the purchase of milk to be used in ice cream, either directly or as cream and condensed, as is taken for a fluid milk supply. You are all familiar with the usual receiving room tests and field work that is commonly done in this connection. At this point, I might say that it appears that much time is wasted in doing field work on the raw supply due to a failure of the plant too frequently to realize that they are spending the bulk of their time with about five to ten per cent of their producers. Proper records to bring this fact to light and a working arrangement with the health department to tighten up on these producers who are actually careless or do not seem to care whether they produce good milk or not would be very helpful. A producer record card is very helpful in spotting the consistently poor producer. There seems to be plenty of evidence that the two or three days shutoff has very little effect on most of the careless producers. It would appear much more sane to shut off such a producer's milk until such time as he has made the corrections asked for, or made a start at doing it where intensive alterations are required, and then let him report to the health department when he thinks he is ready for another inspection.

Butter for use in ice cream should be churned out of pasteurized sweet cream and should score 92 or better; otherwise, results from a flavor standpoint are bound to be unsatisfactory.

(b) Miscellaneous Products

Sugar had best be purchased in cloth or paper bags or barrels, either being much more sanitary than the burlap lined bag. Gelatine should be examined for such things as odor, bacteria count, and jell strength. Eggs, fruits and nuts, fresh, powdered or frozen, should be examined for flavor and bacteria count. More attention will undoubtedly be given to the bacteria count on these items, but, of course, when it comes to cold pack fruits, there is really no way of pasteurizing them or sterilizing them without destroying the freshness of flavor. Colors can best be purchased in powdered form and sterilized after making up in water.

4 Good Formulae

Given the finest raw materials in the world, good ice cream will not be made without good formulae. There is no great difficulty in developing good formulae but it is sometimes difficult to get employees to follow them carefully; too often, they depend on memory. I can always get a kick out of asking the man in charge of making up the sherbet base, for example, to reel me off the formula—more frequently than not, one or two of the important ingredients will be forgotten.

5 Correct Manufacturing Methods

Good ice cream, in addition to depending on good raw materials and good formulae, also depends on proper manufacturing methods, some of which follow:

(a) Temperatures

(i) Mix pasteurized to at least 145 deg. F. for at least thirty minutes
(ii) Mix cooled and aged at 34 to 38 deg. F.
(iii) Refrigerated stockrooms kept at 34 to 38 deg. F.
(iv) Hardening rooms —10 to —20 deg. F. for quick hardening
(v) For can washing—as directed

(b) Proper Pressures

Compressors consistent with power and water costs.

(c) Condition of

(i) Chocolate ice cream free from specks
(ii) Dasher blades in good condition
(iii) Fruits and nuts in good condition and properly used

(iv) Ice cream returned on trucks—firm
(v) Brick making neatly done. If in slabs, layers even
(vi) Piece cans kept filled
(vii) Cans filled to proper point and covered
(viii) All cans inverted after washing (if possible) and kept this way until ready for use
(ix) Office recipe file—kept up-to-date
(x) Cups properly filled
(xi) Pies uniform in size and properly coated and wrapped
(xii) Ice cream drawn at proper consistency and freezers properly drained
(xiii) Homogenizer valves in good condition.

(d) Correctness of

(i) Recorders—checked at least once a month
(ii) Bulk overrun—as shown by can weights
(iii) Brick overrun—as shown by brick weights
(iv) Overrun tester kept correct and in constant use
(v) Ice cream placed in hardening room at once after drawn from freezer. Also piece cans in warm weather
(vi) Gallonage record properly used and other plant records accurate, so that daily manufacturing report can be made out accurately.

(e) Proper rules for use of washing powder, sterilizing solution, sampling mix before freezing, etc., nuts in syrup, etc.

(f) Workmen properly instructed

6 Laboratory and Sanitary Control

A high quality ice cream produced under sanitary conditions requires some laboratory control and a constant checking of good housekeeping. The plant should prepare a definite laboratory program, listing the tests to be made together with their frequency. Without going into detail here as to the frequency of tests and just what products they should be applied to, I can say that the tests include the Babcock fat test, Mojonnier fat and solids tests, acid test, microscopic mix examination, sediment test, flavor determination, plate counts, E-coli determination, brine examination and water examination.

As to checking the plant for good housekeeping, this should generally be tied up to the laboratory and a daily check, both while the plant is idle and while it is operating, should be made to note outstanding discrepancies; this to be followed by a thorough check at less frequent intervals. I might say that in checking plant housekeeping as well as checking conditions on farms, I, personally, do not favor the numerical score card, but, rather, some sort of "yes" and "no" or "satisfactory" and "unsatisfactory" form.

7 *Trained Personnel*

The biggest problem in the ice cream plant today in turning out a uniform product under good housekeeping conditions is in getting a personnel so trained that they will do the same thing twice alike. In the first place, if good housekeeping is to be maintained in a plant, the manager must be good housekeeping conscious and take a keen enough interest in it so that he takes the trouble to go through his plant possibly every day. Then, we must have a superintendent who knows how things ought to be done and why, one who is constantly alert to things that are not being done "according to Hoyle." He must be a leader of men, rather than a driver.

A certain amount of experienced help is necessary for smooth operation. The superintendent must spend a good deal of time in educating his help as to how to do things. This has been done with good effect at plant meetings where various things having to do with quality and good housekeeping are discussed and demonstrated. While much good can be accomplished by these meetings, the most important thing is for the superintendent or foreman to be on his toes and to correct the employee on the spot when he sees him or her doing something wrong. If, after the necessary trouble to correct a situation like this, progress can not be made with that individual, he should be let out of the organization. Much as one hates to do this, the effect on the balance of the force is generally remarkable.

Discussion

Mr. Abele: Mr. Chairman, I would like to ask Professor Judkins one or two questions about plant construction.

Can you give us any suggestions concerning types of material for ceilings, other than plaster or concrete, that will withstand the effects of condensation?

Prof. Judkins: I cannot, at this time.

Mr. Abele: Another question pertains to plant drainage. Is there any preference between open gutters, possibly around the sides of the room, provided with one or two drain openings, as compared with a number of trapped drain openings located in proximity to certain pieces of equipment?

Prof. Judkins: We think we prefer the latter, from the standpoint of all around neatness and getting the water away, with proper drainage, with the curb contact with the wall and floor.

Dr. Parker: I would like to ask Prof. Judkins if he insists on hand bolts in the toilets?

Prof. Judkins: Yes, sir.

Mr. Romberger: I would like to ask Prof. Judkins' opinion of the glass blocks—their durability, etc.?

Prof. Judkins: I do not know just how that will work out, but there is every indication that it will work out satisfactorily. Where nearly the entire wall is made of glass block you do get pretty good light. Some institutions may find it necessary to resort to more artificial light.

Mr. Estes: I happen to have seen an installation of these glass blocks in a room used for cheese making. Glass blocks have a vacuum in the center and, as such, act as an insulator to a certain extent. If the sun plays directly on the block, heat is transmitted through. In this particular instance, the entire wall was made of glass blocks and the sunlight was very plentiful in this installation.

Mr. W. B. Palmer: I was very much interested in Professor Judkins' paper. He has presented a paper on what might today be called the ideal ice cream plant. Where we will find one plant like the one described, we will find a hundred that are entirely different.

He made a beautiful outline of an ice cream plant that will compare with a modern milk plant. Very little has been mentioned about these other one hundred plants. We all know, as health officials, that ice cream is made in cellars, in rear rooms of confectionery stores, made in the stores themselves and the methods and conditions of equipment described by Professor Judkins do not prevail in those plants.

It is not unusual to go into a confectionery store, licensed by the state, and find that the ice cream is being manufactured in the cellar where there is poor light, poor ventilation and above all, very bad drainage. Many of those plants are below the street sewer level. They put in what is called a sump, which becomes nothing but open cess pools or catch basins.

That is not peculiar to any one community; it is not peculiar to any one state, and those establishments are the ones that have the "home-made" ice cream. Instead of getting 15 cents a pint or 29 cents a quart or 40 cents or 50 cents a quart for the ice cream which is usually the price of that produced in these big, modern plants with all this wonderful equipment and control, they get 60 cents and 80 cents or more per quart.

The people in charge of those plants usually own them. All of the described records for control, supervision and inspection, do not exist with this other sort of establishment. Even if they did, there is question that many of the operators would know what they were all about, anyway.

Instead of having stainless steel tables, stainless steel tanks for handling and washing the equipment and parts, very often they have no washing equipment, or it is inadequate.

All the local health departments are confronted with the proposition of supervising these plants by routine inspections. We find that they are licensed by the state. The best we can do is to demand that these concerns comply with the law, and if they don't, we can summons them to court. If they still fail to maintain proper methods and conditions, the state license is involved and thus it becomes a matter of taking the case up with the State Department of Health.

Then we run into the matter of conferences or hearings and further inspections of many of these places some of which ought to be out of business, and that never should have been licensed in the beginning. So much for the cellar plants.

Now, we may consider the store plants. They may be in confectionery stores, drug stores or other establishments. We find that the freezers and containers that are used for making the mix and the product are often in a bad condition, similar to conditions found in the soda fountain to which they are attached. If the customer has not a good nose, he will buy and eat the products but if he had a chance to look into some of the equipment in some places, even look into the fountains and into the containers and the ladles, used in dispensing ice cream, he would just lose his appetite!

There again we have the same condition and situation existing in the matter of supervision and licenses with these establishments because they are manufacturing ice cream and thus are ice cream plants.

If we attempt to set up regulations which would be comparable with all of the things that we were shown in the pictures and told in the paper by Professor Judkins, we just would not have many of the small plants in existence because they just would not make the grade.

Today with all of this knowledge that we have, the ice cream industry is possibly twenty-five years behind the milk industry in many respects because the milk industry does not have these other hundred plants such as we find in the ice cream industry. They have been eliminated except out in some of the real small rural districts.

We have a big job ahead of us, as health officials, in educating the ice cream manufacturers—and that includes some of the big ones, too; they are not all Sealtest as represented by Professor Judkins. We have this job of educating the small manufacturer to make his place better and make it at least presentable until such time as there is an evolution in the ice cream industry which will be comparable to the milk industry. Centralizing in large plants that are doing sufficient volume of business makes it possible to afford to put in the laboratory control, the inspection control by a trained staff, and the supervision of supplies.

As to the supplies that are used in the making of ice cream, the large manufacturer as described by Professor Judkins has the opportunity to look into his raw products, but the small fellow as I have described him purchases ice cream mix that has been made up in some plant that may be within the state or without the state and frequently the ice cream man knows nothing about where it came from, how it was made or anything about it.

So, therefore, we have two ice cream plants involved, the one where the mix is manufactured and the one where the final product is frozen. If he doesn't buy the ready-made mix, the only thing he can do then is to buy the milk and cream supplies that are permitted for sale under local license. Those licensed cream supplies have been processed through milk plants that are comparable with this very modern ice cream plant that has been described, but when he gets his milk and cream, being ignorant of the technical phases of the handling and processing of same, it becomes subjected to possible contamination

Going into some of these plants, it has been absolutely necessary to dump the material!

Thus, I think, we have a big problem and a lot of attention should be given to that.

Mr. Bowman: I would like to know if Prof. Judkins is familiar with the way those glass blocks are laid.

Mr. Estes: When the bricks were first installed, they were not laid in mastic. The building was made of concrete and steel and this happened to be the first installation in the city, I believe. The local contractor failed to put expansion material in, with the result that when the bricks were heated by the sun they expanded and some of them cracked. That was corrected with the installation of mastic in the joints and since that time there has been no trouble whatsoever.

REPORT OF COMMITTEE ON DAIRY FARM METHODS

IT IS recognized that quality milk begins at the dairy farm. Your Committee on Dairy Farm Methods will endeavor to point out the necessary essentials toward producing a safe, clean, milk.

At the present time there is no uniformity of requirements of dairy farm methods in municipalities or states serving the same milk shed. It can be easily understood that dairy methods for dairymen in New York State may not be adaptable for dairymen in Florida, Texas or California. It is the thought of your Committee to outline the general fundamentals.

Before taking up these fundamentals your Committee feels that it is necessary that the field inspector who regularly visits the dairy farm know and have a complete history of the milk produced by each dairyman as it is received daily, before he visits the farm. He should have complete information about the temperatures, sediment tests, bacteria records, and the reasons why a dairyman had his milk rejected for off-flavors or other conditions. If there is no individual dairy record at the plant or receiving station he should spend sufficient time where the milk is received in order to make a special effort to obtain this information. By judging the temperature of each can of milk received he is qualified to use good judgment in studying this cooling problem at the farm. Sediment tests furnish an index of the methods that are applied in the operation of producing and handling the milk. Recently the Hinman Sediment Tester has come into use and has proved to be the best for making sediment tests. The sediment test will also indicate whether the type of strainer and the material that he uses for straining milk is satisfactory. Bacteria records made by the Standard

Plate Method or by the Breed-Brew Method can be used to point out whether the high counts that are found are due either to faulty cooling, dirty equipment or to cows suffering from mastitis. By noting the records as to whether milk has been rejected from a particular farm for off-flavor or other conditions sound study and constructive criticism of certain conditions that are indicated by these facts which have been obtained from the records or by observing the milk when it is delivered to the plant or receiving station from each producer can be studied on each farm. Your Committee feels that with this information the field inspector is better qualified to carry out the work which has been assigned to him and is better able to improve the milk supply by giving special attention to the conditions that have been found to be unsatisfactory. Your Committee also feels that with this information at hand, good judgment can be used in passing on conditions surrounding the production and the methods used in handling the milk on each particular farm. Dairymen should not be penalized for insufficient ventilation, insufficient number of cubic feet of air space or where the windows are not situated in a certain location. A dairyman should be encouraged to continue with his present method when it is proved from the records that these essentials observed at the plants or receiving station covering his milk supply, are satisfactory. When four or five inspectors visit the same farm to study the methods within a period of four or five months, and all ask that the dairyman change his methods each time, confidence in the whole program of quality milk control will be destroyed. It must be emphasized again that, before any inspector visits a farm, he must have records covering that supply for as long a period as possible, or make such record immediately before he visits the farm. The individual dairy record will accomplish two things:

1. Prevent any mistake made by the inspector on changing some method on the farm when the records of milk supply have been satisfactory.

2. Gain the farmer's confidence immediately by proving to each dairyman what method he should use to correct certain objectionable conditions found in his milk as shown by his record.

Your Committee feels that in carrying out an educational program to improve dairy farm methods that they will be completely handicapped in making and investigating certain conditions on each farm without satisfactory record being made available for the field man before he contacts each producer.

In pointing out fundamentals for dairy farm methods, we believe that the following conditions are important and should be thoroughly investigated on each dairy farm.

With the introduction of new platform methods such as the strainer dipper and the Hinman sediment tester to detect objectionable milk in each can from each farmer daily, the dairy industry has reached a very important point in controlling their supplies. Before introducing these new methods very little, if any, milk was rejected because the farmer was not carrying out the proper methods on his farm daily. While we admit that the new platform methods are not complete and there may be some mistakes made we do feel that we have taken a step that is going to be very important in controlling our milk supply from the producers. It is hoped that the dairy scientists will be able to improve the new platform methods in order to detect and in that way reject every can of objectionable milk that is offered by the producers. We feel that this is going to have beneficial results in requiring all producers to maintain satisfactory standards on every dairy farm.

1 General Conditions

Your Committee feels that persons ill or recovering from milkborne diseases shall not be permitted to work on a dairy farm or come in contact with dairy farm employees until permitted by properly constituted health authorities. Typhoid fever carriers and persons affected with active tuberculosis shall be prohibited from any work concerned with the production and handling of milk. The hands and forearms of milkers shall be free from active infections and running sores. The water used for cleaning utensils shall be protected from possible source of pollution and apparently safe. No food, milk containers and other material may be set in portion of spring or well from which water supply for cleaning utensils is obtained. A sanitary flush type toilet or privy shall be provided on the dairy farm. Privies shall have flytight vaults; seats must have self-closing lids in good working condition or door must be tightly self-closing, and all other openings screened. Overflow or drainage to surface of ground should be prevented. Privies and cesspools shall not be located so as to endanger water supply; they should be at least 100 feet from water supplies.

2 Pure Milk Comes from Healthy Cows

Unhealthy animals which may endanger the milk supply shall be segregated from the dairy herd. Two empty stanchions or two stanchions containing animals not producing milk, or a tight partition at least four feet high between healthy and unhealthy animals constitute proper segregation. Milk obtained from unhealthy animals liable to impair quality, from cattle whose udder secretions are abnormal in appearance, and from cattle thirty days before calving and five days after shall be withheld from sale. It is important in making physical examination of animals producing milk to give special emphasis to the condition of the milk and the udders of each individual regarding the question of mastitis. This is a very important problem today for the veterinarian. Several methods have been found to be practical in identifying cows suffering from udder conditions which secrete abnormal milk. I believe that education should be carried on among milk producers to identify cows with unhealthy udders so that the milk can be removed immediately from the regular supply and the animal should be segregated in order to prevent the spread of this abnormal condition in other valuable cows in the herd. Your Committee feels that a program of encouraging the dairymen to give this special attention is very important. We feel that there is no other problem in the maintenance of healthy cows on the dairy farm today that is as important as the question of the control of mastitis in our dairy herds. We wish to refer you specifically to the work that has been done by Dr. D. H. Udall of Cornell University and Dr. Hucker of the Geneva Experimental Station, Geneva, N. Y. The cow's flanks, udders and teats should be clean at milking time and the hairs on flanks and udders clipped and kept short during stabling seasons.

One of the fundamentals in maintaining clean surroundings and creating a satisfactory condition on the floors and drops in the cow stable would be to use some available absorbent such as superphosphate or lime daily. It is important in the stable that the dairy animals be separated from other live stock by a partition, except where horses are kept in the same condition and cleanliness as required for cows. We feel that horses should be the only exception made in this case. They request in some states in the metropolitan market, that horses be excluded from the cow stable. We feel that this is a burden brought on the producer of milk which has no bearing on the quality of the milk produced at that dairy. I believe that with the records the inspector has when he goes to make a survey of the stables from which quality milk is produced, that he will observe to his own satisfaction that the stables where horses are kept in a clean condition, that there is no objection to this supply. It is important that cow yards be kept reasonably clean, graded and free of accumulation of liquid manure. Waste from pig pens, barns or milk houses shall not be permitted to drain into the cow yard. Manure shall be removed from the barn daily and drawn to the fields, or at least stored twenty-five feet from all dairy buildings and inaccessible to the cows. This naturally applies to the part of the country where it is necessary to confine the cows to stables during the weather when conditions will not permit them to range in the fields.

3 Utensils

The matter pertaining to milk utensils is very important. For many years no attention was given to the material used for straining. During recent years only single service straining material, firmly held in place, has proved to be giving satisfactory straining. It is felt that a thorough study should be given to be sure that the better quality of straining material be used. It is not thought by encouraging a satisfactory quality of straining material, to permit careless handling of the milk before straining, but to be sure that there is going to be no difficulty by using this material. It has also been found that another important thing is to have the straining material properly put in place in the strainer. It is felt that with the introduction of the single service strainer that one of the hazards of properly caring for straining material on the dairy farm has been eliminated. It has been recognized for many years that the care of the strainer cloths which must be washed and sterilized has been one of the sources of considerable trouble in producing quality milk on dairy farms. Many of the large buyers of milk have introduced a definite program in arranging to supply all their producers with single service straining material, which has proven from research to be satisfactory. This material is given to each producer every month and he is required to use this only.

The method of cleaning utensils and milking machines provides for a thorough rinsing, washing in an alkaline solution, rinsing and sterilizing with water at as near the boiling point as possible, or other approved method, after each milking. In case of the milking machine, all parts shall be accessible for cleaning and rubber parts sound and durable.

Utensils must be washed and scalded at the point where water is heated.

Utensils when not in use, shall be stored on suitable metal racks in milk house or straining room, in an inverted position at least twenty inches above the floor and protected from contamination. Separate racks for cans, covers and other utensils is recommended.

4 Milking

It is very important that proper precautions be given to the milking of the cows. In preparation for milking observation of the quality of milk secreted from each individual cow should be made. Hands of the milkers must be kept clean and dry during milking. Wet hand milking is prohibited.

The first few streams from each teat shall be drawn into a vessel other than the milking utensils, and discarded in a satisfactory manner. The use of the strip cup is required in the production of a superior quality of milk.

Milking stools shall be provided with at least three legs and shall be hung or stored in a clean place and kept clean.

5 Milk House

The milk house shall be as near the barn as possible, without any direct opening into the cow stable or other building used for domestic purposes. Cooling facilities shall be provided, capable of cooling and maintaining the milk at a proper temperature. This, your Committee feels, is one of the most important fundamentals in the handling and care of milk on dairy farms if it is not delivered to the receiving station or plant twice a day. Cooling tanks shall be provided with a suitable drain in order properly to drain and clean. Water should be kept fresh and clean. The tank should have a cover except where running water is used.

There shall be no privy, hog pen, manure pile, cesspool or other source of contamination close to the milk house or straining room.

6 Cooling

It is necessary that each dairyman prove that he has facilities at his farm to properly cool the milk to at least 60° F. and maintain it at that temperature until delivered to the milk plant, except where the milk is delivered promptly to the milk plant after milking. With the introduction of electric cooling devices this problem has been solved. In many sections of the country where it is impossible for the dairymen to harvest natural ice it is gratifying to know that the farmer can now obtain adequate equipment for proper cooling. The stirring of the milk with hand operated stirring rods or unnecessary delays in shipping detrimental to the quality of the milk are prohibited.

While we have given consideration to most of the fundamental requirements covering the proper methods for the dairy farm, we feel that more details could be given and outlined but due to the general makeup of this report it is not felt advisable to go into further details at this time. However we feel that after a number of years of study that the fundamentals laid down in this report are essential in the production of safe quality milk.

F. D. Holford, *Chairman*

Ernest Kelly	Richard Powell
C. P. Osgood	R. A. Johnston
L. M. Lescure	C. B. Matthews
Russell Palmer	J. J. Regan
W. E. Ward	E. O. Kleffen
W. A. Shoults	C. I. Corbin

REGULATORY PROBLEMS RELATING TO THE MANUFACTURE OF BUTTER

CHARLES S. TRIMBLE

U. S. Bureau of Dairy Industry
Washington, D. C.

IN THE light of recent increased federal and state regulatory activities pertaining to quality improvement of dairy products, particularly butter, the timeliness of considering regulatory control problems relating to the manufacture of butter at such a meeting as this International Association of Dairy and Milk Inspectors would seem to be apparent. The problems involved are many and varied. The legal manufacture and uses of butter often differ so little from the illegal manufacture and uses of the same product that it is difficult to define the line of demarcation. It would likewise seem imperative that the regulatory activities pertaining to butter manufacture and uses be coordinated in order that the ultimate objective, namely, real quality improvement, be attained. The mere enforcement of certain rules, laws, or regulations do not, as I see it, constitute real regulatory attainment.

If, however, through the combined efforts of all regulatory agencies involved, such rules and regulations as may be prescribed are enforced to an extent that a cleaner, safer, and more healthful product reaches the consumer, then regulatory work is justified. It is with the thought of presenting some of the problems that arise in the manufacture and uses of butter that should logically concern all regulatory agencies and which would seem to be appropriate for discussion that this paper is prepared. No attempt has been made to answer the questions raised, as most of them would seem to call for further study and research.

Butter occupies a unique position among food products in that it is the only food specifically defined as to its composition and standard by an act of Congress. Not only is it defined by the Act of March 4, 1923, setting up a specific fat standard of 80 per cent all tolerance allowed for, but as early as August 2, 1886, it is defined for purposes of taxing illegal and adulterated products. It is significant, also, that the wording in the two laws is practically identical. The phrase relative to butterfat content in the latter law is the only difference in the two laws. Either by separate enactment or by regulation, practically every state has adopted the federal butter fat standard for butter. Some states also have moisture requirements in addition to a butter fat standard.

There are several federal agencies concerned with the enforcement of butter laws. The activities of the Food and Drug Administration in regard to butter are so well known to this Association that it is not necessary to discuss them in detail. The Food and Drug Administration is necessarily limited by law in its enforcement work in that interstate shipment must be involved before that agency can act. The splendid cooperation rendered by state and local regulatory agencies in assisting in the recent cream quality improvement project of the Food and Drug Administration likewise needs little comment. But for such assistance the results obtained to date would not have been so far-reaching in effect as they have been. All of the provisions of the Federal Food and Drug Law in regard to adulteration, misbranding, and labeling applicable generally to all foods are, of course, applicable to butter and are so enforced by the Food and Drug Administration.

There is another federal agency concerned in enforcing butter laws of which less is generally known. I refer specifically to the Bureau of Internal Revenue of the Treasury Department. To the Miscellaneous Tax Unit of this Bureau is assigned the administration of the adulterated butter law of May 9, 1902. This law, primarily enacted as a tax law, is therefore as a revenue measure not restricted to state lines in its administration or enforcement. By enlisting the aid of the Bureau of Internal Revenue many cases of violation of local and state laws can readily be made subject to this specific law with the resultant increased penalty. The sale of adulterated butter within a state or city is often, on conviction under state regulation or city ordinance, subject to only a nominal fine. Conviction under Internal Revenue Law of manufacturing and selling adulterated butter, however, becomes a tax-evasion violation and renders the manufacturer or dealer subject to assessments of possibly thousands of dollars. To cite a concrete case, several dealers in reworked butter in one of our large eastern cities had been repeatedly fined under state law from $50.00 to $75.00 for selling adulterated butter. One of the same dealers when picked up by a revenue agent was forced to pay several thousand dollars for the same offense. A few such convictions under the revenue law has a much more convincing and far-reaching effect on violators than a small minor fine even though repeatedly assessed. May I suggest to you inspectors that you get in touch with a revenue agent in case such violators are operating in your territory.

The Bureau of Dairy Industry, while primarily a research bureau, is charged under the direction of the Secretary of Agriculture with the administration of regulations pertaining to process of renovated butter and with the inspection and certification of all dairy products including butter intended for export. The sanitary inspection of process or renovated butter factories and of materials entering into the manufacture of the finished product, as well as the approval of brands, is conducted by our Bureau. The Bureau also cooperates with other federal regulatory agencies in investigating suspected cases of violation of the process or renovated butter law of May 9, 1902. It was through the regulatory investigational activity of our Bureau that the first samples of melted strained butter were presented to the Food and Drug Administration of the Department. The development, perfection, and adaptation of this principle has resulted in a method whereby contamination of butter and of cream can be detected. The use of this method in cream and butter quality improvement campaigns is well known and needs no comment. It is scarcely necessary to state that our Bureau has been particularly interested in the progress made by such campaigns and has assisted in furthering the promotion of such commendable work in every way it could.

In addition to state standards for butter, the state and local regulatory agencies in practically all states do, of course, have general regulations applicable to butter as a food product. In many cases specific regulations pertaining to sanitation of creameries and cream stations, to pasteurization requirements, to cream grading, to cream testing, and other factors are in effect and are enforced. Cream grading laws have recently been enacted in several states, as well. The manufacturer of creamery butter is, therefore, by no means operating without regulatory inspection. Some indeed might feel that they have too many regulations to comply with at the present time. There are, however, certain classes or grades of butter which seem to be stepchildren of the dairy industry which are not subject to much, if any, regulation or inspection. Farm-made butter, while gradually declining in total volume, is still an important source of income to the farmer. There is hardly a city in the south where farm-made or country butter is not sold in city markets. In 1929, according to United States Census figures, twenty-two states each reported sales of farm-made butter of at last 2,000,000 pounds or over per year, and fifteen states report sales of farm butter greater than the amount of creamery butter produced. In these fifteen states 65,000,000 pounds of farm butter was sold as compared with 36,000,000 pounds of creamery butter produced. Bureau of Agricultural Economics estimates of farm butter sold for 1932, for example, show an increase of approximately 5,500,000 pounds over the 1929 census figures. The 1934 census shows that twenty-three states produced more farm-made butter than they did creamery butter. Moreover, twenty-eight states show an increase of approximately 37,000,000 pounds more farm butter made than was made in these same states in 1929. In citing these figures the point I wish to make from a regulatory angle is that such butter is usually made from sour cream churned raw and often handled in a careless or insanitary manner. Thus from the inspector's viewpoint logically arises such questions as manufacturing methods used, the health of the cows and of the people doing the actual churning, and the legality of the finished butter as to composition. Recently four investigational samples of farm-made butter were purchased from stalls in a southern city. The analyses of these four samples gave some interesting results:

	per cent moisture	*Indicated by analyses*
Sample No. 1	8.69	Legal butter
Sample No. 2	15.80	Renovated butter
Sample No. 3	34.50	Adulterated butter
Sample No. 4	21.07	Adulterated and renovated butter

Incidentally, none of these samples were marked or branded in any way as to weight or name of producer.

Packing-stock butter is simply a trade name usually applied to miscellaneous lots of country or other butter. It is the normal source of supply of the process or renovated butter manufacturer but not all packing-stock butter marketed in the United States reaches a legitimate and licensed manufacturer of process or renovated butter. Its utilization other than in the production of process or renovated butter—a legitimate taxable product authorized by act of Congress—affords a field for regulatory officials to investigate, for but little, if any, of it is a clean, safe, or satisfactory food product when sold as packing-stock butter. When used by the process butter manufacturer, it is melted, clarified, and refined, and the finished product, like butter made from questionable cream, is at least free from visible evidence of contamination. That packing-stock butter is used without such treatment is shown by the fact that a large baking company in the South is reported to be buying from 75,000 to 100,000 pounds of packing-stock butter yearly for use in its bakery products.

Ladle butter and so-called cooking butter made from raw cream are other butters of minor importance, yet, as sold, are subject to little or no regulation.

These and other less known grades of butter are sold with but little specific knowledge of their manufacturing background and are at least worthy of consideration as a regulatory control problem.

In considering the manufacture of butter from a regulatory viewpoint, I wish to present it in comparison with milk inspection practices. In so presenting the problems involved from either a control or health angle there is no thought of advocating similar methods for controlling butter manufacture, nor would it necessarily be practical to do so. There are, however, basic similarities in the problems involved which for purposes of discussion can perhaps best be brought out by such comparisons.

Milk for human consumption is undoubtedly subject to more regulation and inspection than any other food product. Such inspection applies to the dairy farm and the cow, and through all the intermediate processes until a bottle of milk reaches the consumer's doorstep.

The paramount purpose of such regulation and inspection is to insure to the consumer of milk a clean, safe quality product. With such a purpose, surely no one can quarrel, for in the achievement of such a goal all interested parties, without exception, benefit.

Surely butter, a highly perishable commodity and a universal food, should be carefully guarded throughout its production background on the farm and its manufacturing progress through the creamery to the consumer; yet, it, as a product of milk, has not been subject to any of the stringent regulations or inspections that apply to milk.

It is true, of course, that in some cases, at least, rigid rules are enforced in the creamery itself regarding plant sanitation, kind of equipment, such as flush type valves, etc., recording thermometers for regulating pasteurization, health inspection of employees, and other worthwhile regulations.

In many cases, also, the butter manufacturer has spared neither time nor expense to build and equip a model sanitary plant and one which from a regulatory angle little or no criticism could be made. The manufacturer likewise has spared neither time nor money in attempting to accomplish the butter maker's dream of making an "extra" butter out of all cream delivered or purchased by the creamery. Since the advent of the hand separator the quality of cream has been, if we look at the question without bias, subject to criticism. The smaller volume of cream as compared with milk, the length of time required to obtain a full can, especially if only a few cows are milked, distance from market, and above all the more or less accepted policy through the years on the part of the cream purchaser that "cream is cream" if it will still stay in the can—though often the can had to be tightly sealed in order to keep the cream in—have not been conducive to allaying such criticism of the cream most commonly used to make butter. To anyone familiar with butter making practices during the last twenty-five or thirty years, such cream as has recently been seized and condemned by state and federal agencies is not materially different in quality from cream that has been purchased and made into butter in the past. To word the situation differently, the gospel of quality improvement of cream has been preached by state and federal educational agencies for twenty-five years or longer; but with the manufacturer "putting the cart before the horse" by continuing to purchase cream of doubtful character and grade, in an effort to obtain volume, not much real progress was made. However, with the advent of regulatory agencies intent on remedying conditions, material progress is now being made. Further and still much needed progress will be made only by control agencies remaining in the picture as a necessary evil—if one cares to put it that way. To keep the picture from "blurring" coordinated activity is essential. When buyers persist in buying bad cream no amount of educational work among cream producers will remedy the situation. It must then be the duty of regulatory agencies to take a hand, not only as a means of protecting the public, but also to impress on such buyers their responsibilities as handlers of a food product that is ultimately to go into consumptive channels. The cream producer can not be seriously criticized for delivering poor cream when such a policy prevails on the part of the buyer. I have often wondered, however, what the average cream producer really thought of such a system of selling cream in comparison with the marketing of his other farm products. Cotton, corn, tobacco, wheat, wool, or livestock are all sold on a graded basis and unless the quality is up to accepted standards the producer fully expects to receive a lower price.

The establishment of Grade A and Grade B milk has been accomplished through regulation. No doubt you milk inspectors can vouch for the statement that such an accomplishment was not brought about without opposition. It does not necessarily imply that similar grades for butter are advocated when it is stated that butter made from fresh wholesome cream with a low count, free from filth or protein decomposition, yeasts and molds, and untreated chemically, surely more nearly approaches Grade A milk as a safe product to offer the consumer than does butter made from cream with opposite characteristics.

Likewise, some sort of a grade designation comparable to the Grade A or Grade B on a milk cap, if part of a trade brand, would surely mean more to the consumer than would national and local radio and newspaper advertising of such will-o'-the-wisp statements as "made from cream richer than whipping cream," "choicest dairy sections," "full cream," and "June flavor." The average purchaser may not know that milk can be churned and butter made from it; that flavor is not particularly characterized by any one month, or that a "choice dairy section," unless the cream is choice, means nothing, but surely the manufacturer of butter knows that such terms are meaningless from a quality standpoint.

Another example of advertising butter to the consumer is that of a certain brand being offered that, like the blending of coffee, tobacco, or the colors in milady's hat, was represented as being a judicious blending of sweet and sour cream at no extra cost to the buyer. Incidentally, the relative percentages of sweet and sour cream used were not stated. In citing these examples the value of a brand name for advertising purposes is fully recognized, but the use of statements which tend to mislead the consumer as to the quality of butter contained therein is questioned. Improper or misleading labeling or branding of butter is logically as much of a regulatory problem as the marking of any other food product.

In the past, at least, regulatory inspection of butter manufacture has, I believe, overlooked one vital point, and that is that while sanitary manufacturing methods have been enforced the kind and quality of the materials being processed, as well as certain manufacturing practices followed, have been largely overlooked. It is an established premise in milk control work that abnormal or subnormal milk should not be used as fluid milk. Rules and regulations based on this premise have been adopted and enforced to apply to the dairy farm, the cow, and to the milk processing plant. In other words, milk for human consumption must be fresh and clean and derived from healthy animals and nothing may be added or taken away from it. This is the basic principle on which milk control work is founded.

Conceivably, slightly sour, tainted, or abnormal milk could be so treated that from the standpoint of safety it could still be used. I leave with your inspectors the question of whether you would permit such practices to be followed. Simply for comparative purposes, then, the question naturally arises as to what extent such milk as is not acceptable for consumption as milk should be used in the form of cream for making butter and to what extent should such cream be permitted to be chemically or otherwise treated before it is made into butter for the consumer.

Butter is defined by law as being made exclusively from milk or cream. Then, from a control angle, the problem would seem to resolve into a practical question of how exclusively, and what should be the age and character of the milk or cream used. I leave this question, also, with you inspectors as to how closely you have in your inspection work gone into the background of materials used or as to actual processing methods followed in the creamery. From time to time there have appeared discussions in the trade press of the industry advocating that butter be made from milk from tuberculin-tested cows. Assuming that such regulations were in force, is it not equally important from a control angle that the age and condition of the cream derived from such approved herds be given inspectional supervision?

Much has been written on the question of sweet cream for butter making. The problem of whether "controlled souring" by ripening cream after it is received at the processing plant for flavor and aroma characteristics of the finished product is not specifically a regulatory problem, but depends almost entirely on the desire of the manufacturer to use or not to use a good commercial butter culture or "starter." The contention that cream should be purchased sour in order to obtain the desired flavor and aroma in the finished butter, however, is fallacious in that when starters are used they are added after pasteurization so that all cream, be it sweet or sour originally, "starts from scratch," so to speak, when starters are added. From either a chemical, bacteriological, or practical viewpoint, it is much more logical to assume that fresh sweet cream after pasteurization affords the desirable acid and flavor producing bacteria of the added starter a less restricted field of activity than when the same starter is added to sour several-day-old cream after neutralization and pasteurization. There is abundant evidence in the literature of the industry to show that butter made from sweet cream or cream of relatively low acidity possesses certain very definite keeping quality advantages over sour cream butter. As early as 1859 Henry Ward Beecher [1] severely criticized the quality of butter found on the market and recommended that the cream be churned while still sweet. Proteolysis in cream as determined in amino acid nitrogen begins as soon as cream develops 0.2 to 0.3 per cent acid and continues with increase of acidity.[2] Cream that contains from 0.8 to 1.0 per cent acid, and even higher, is commonly used for making butter at the present time. Irrespective of whether or not sour cream of any acidity be of fairly good flavor and capable of being made into a salable butter, it has most certainly started on the downward path of deterioration (proteolysis). Despite this rather obvious fact the following "prediction" is quoted from a recent trade paper article [3] relative to sour cream: "Thus sour cream produced under those conditions of temperature control which have been found most desirable for good butter *cultures* (60° to 70° F.) can be expected to be superior for the raw material to be used in the manufacture of creamery butter and experience will doubtlessly justify this prediction." If this prediction be true then the creamery so unfortunate as to receive fine well cooled sweet cream can remedy the situation by letting it stand at room temperatures until it sours before making it into butter.

The problem from the control angle in regard to sour cream would seem to be to decide when cream that is sour, old, rancid, moldy, yeasty, or fermented has reached such a stage of deterioration that it is no longer fit to be used for butter-making purposes, and this problem should be given serious consideration by regulatory agencies. Much cream that is not edible as cream has been used in the past, and is being used at present, for making butter which is at least salable. From the regulatory viewpoint, should such cream be permitted to be made into butter? The so-called four-day plan of delivery of cream is in operation in some sections and is sponsored by many manufacturers and even educational agencies at the present time. If cream is kept at from 60 to 70° F., as the above-mentioned trade paper article suggests, and is then delivered four days later and made into butter, I leave with you inspectors the question as to the proportion of desirable flavor and aroma products produced as compared to the undesirable products and the quality of the finished product. To advocates of such a plan I would cite the following: ". . . . and this cream so gathered (in crocks and covered) you shall not keep above two days in summer, and not above four days in the winter if you will have the sweetest and best butter" and ". . . . your cream being neatly and sweet kept you shall churn it . . . ." The above quotation is from an Old English book published in 1631.[4] Thus, do we make progress in 300 years.

In the actual processing of cream for butter making there is, of course, no criticism forthcoming against any legitimate method that will tend to make the finished product a safer, cleaner product. When, however, such methods as are used are merely a means of covering up or removing the visible evidence of contamination without any serious effort being put forth to eradicate the source of contamination, then, logically it would seem to be the concern of control agencies to look into these methods. While it is no doubt true that the use of new and improved pressure and gravity filters and strainers will, and does, remove practically all visible and insoluble evidence of filth contamination of cream, it is likewise equally true that the removal of such evidence does not in itself solve the question of quality improvement of cream, or even constitute more than a small forward step. Indeed, the net effect may be undesirable.

The soluble material is still present in such filtered cream and is in part at least incorporated in the finished product. The residue on the filter pad after some cream has been so processed would hardly be inviting if displayed to the consumer of butter.

The partial neutralization of the acid of sour cream in order to accomplish pasteurization is a necessary and accepted practice in the butter making industry and no one at all familiar with the industry would be so impractical as to advocate its discontinuance. I fully realize that I am treading on dangerous ground even in merely opening this question for discussion. However, when some butter manufacturers do not consider well known neutralizing preparations chemically strong enough to use in the grade of cream they wish to process, then it would seem time at least to consider this question from a control angle. That any alkali will neutralize an acid is a chemical fact, and the stronger the alkali used for such a relatively weak acid as lactic acid the sooner will neutralization be effected. The use of a strong and active neutralizing agent or possibly one combined with other agents that possess deodorizing properties in addition to their neutralizing properties, thus enabling the manufacturer to use some cream for butter making purposes which he otherwise could not use, raises a question of control that I wish to leave with you. Reports from certain sections indicate that strong chlorine preparations are used not only as neutralization agents, but also for their effect in overcoming such defects as garlic or other flavors caused by weeds or feed. Should such practices be considered legitimate from the regulatory viewpoint even though the finished product be still a safe product? Conceivably, similar treatment of fluid milk would remedy similar defects, but I am of the opinion that you milk inspectors would very soon be "on the neck" of a milk processor attempting such practices. When neutralizers are advertised to give an increased score, to carry off undesirable odors, and to improve the flavor of the butter, the question logically arises, would these benefits occur by simply neutralizing the lactic acid of sour cream sufficiently to enable such cream to be pasteurized? The trend in some quarters, at least, is to use stronger agents than lime or soda as recognized by a study on "the effect of certain neutralizers on the churning loss and the keeping quality of butter," [5] reported at the last annual meeting of the American Dairy Science Association. In this paper the results of using trisodium phosphate, sodium hydroxide, sodium carbonate, and sodium sesquicarbonate, in addition to sodium bicarbonate and lime, were reported. The fact that such other neutralizers were being studied would seem to show that they are used and that their use was being studied as a service to the industry. Ammonia, lye, and other caustics have also been reported as used for neutralizing cream for butter making, and from the standpoint of dissolving curd and effecting straining of cream would probably be much more effective than the use of lime, for example. Lime is the most commonly accepted and the one neutralizing agent specifically mentioned as being permissible under Internal Revenue regulations governing adulterated butter.

The use of lime, soda, and other akaline reagents for the purpose of "sweetening up" cream still sufficiently sweet to permit pasteurization without their use is also a question to consider from the control angle. Should butter made from cream so treated be properly labeled sweet cream butter?

There is one phase of butter manufacturing, however, where there should be no question raised as to the obvious duty of regulatory agencies. The more or less prevalent use of old, rusty, dented, cracked, and otherwise unfit cream cans for delivery of cream should be prohibited by regulations stringently enforced. The creamery operators, as well as control officials, should concern themselves with this problem as a forward and much needed step in cream quality improvement. It is hardly necessary to state that the ordinary gallon or two gallon tin bucket should be eliminated as a container of cream. The "bucket brigade" stands as a menace to cream quality.

Much could be written on the legitimate and illegitimate uses of butter in such industries as the ice cream, baking, candy, cheese, and other industries, but it is felt that the question of cream quality is sufficient to consider at this time and meeting. Such other questions as the reworking of odd lots of butter, the whipping of butter, the mixture of butter with such products as honey, chocolate, or maple syrup, the commercial sale of butterfat, the adulteration of butter by mixing with oleomargarine, the use of mechanical deodorizers, the use of the hands in packing butter, and many other questions are ones which could logically be considered as proper subjects for consideration as control problems, but time does not permit their adequate presentation.

To summarize briefly the whole question of cream and butter quality improvement can probably best be done by quoting Dr. M. J. Rosenau, Professor-Emeritus of Preventive Medicine and Hygiene, of Harvard University, in paraphrasing Shakespeare's Portia in her dissertation on the virtues of mercy: "The quality of milk (and cream) is not strained. Quality is twice blest; it certifies him that sells and profits him that buys. Quality is the proudest prize of the producer and the surest comfort of the consumer. It is an attribute that glorifies business to a dignified, helpful and important public service. Quality is mighty for good and mightiest when good."

References

1 Technical Bulletin No. 159—U.S.D.A.
2 D. H. Jacobsen. *Journal of Dairy Science,* Feb. 1936, pp. 125-126.
3 M. E. Parker. *Food Industries,* Vol. 8, No. 8, Aug. 1936, p. 432.
4 Markham, G. M.—A Way to Get Wealth. 1631.
5 D. F. Breazeele, N. E. Fabricius, and E. W. Bird. *Journal of Dairy Science.* Vol. XIX, No. 7, pp. 505-507.

Discussion

Mr. Palmer: Mr. Trimble has presented a paper stating that the matter of regulations and requirements is left to the control officials. That is repeated many times in the paper.

There are control officials federal, state and municipal. It has been suggested in the paper that adequate and proper legislation governing butter or milk and cream for butter are needed and that they be set up. Those regulations are proposed to go back to the dairy farm, on through to the creameries and the distribution of the product. That suggestion brings to mind the fact that there may be a lot of complications develop unless the proper procedure is followed in promulgating such regulations, requirements and unless it is stipulated as to how they shall be enforced and by whom.

As explanation of that, he suggests that we as regulatory officials go back to our own states or communities and set up regulations and requirements of our own choice or suggest the requirements which might be promulgated by some central agency, and thereby tend to make uniform regulations.

But that immediately means enforcement!

In the eastern section of the country they are not manufacturing butter. It comes from the so-called buttermaking states and the butter industry and the dairy farmers producing the milk and cream for making this butter would immediately have an army of inspectors and regulatory officials swamping them with inspections and instructions, many of which would be conflicting.

I would like to ask Mr. Trimble what his suggestion would be to get a proper, organized supervision of the butter industry under the conditions cited.

Mr. Trimble: I really have none.

Mr. Palmer: Just to what regulatory officials were you leaving this matter?

Mr. Trimble: State, federal and local. It called for an exhaustive program of coordination just the same as has been worked out in milk control under public health agencies.

Mr. Cameron: May I be permitted to add something to the discussion? There may be some of the men here who would be interested in some laws we have in Canada with regard to the selling of butter to the consumer.

There is a section of the Federal Act which states that all butter sold to consumers must show on the package of the butter the grade of the butter contained in that package, and in order for that section to become operative in any Province it is necessary for that Province to pass the necessary legislation. Five of the Provinces of the Dominion have passed that necessary legislation so that now all print butter (that is, all print creamery butter) sold to consumers must show whether it is first grade, second grade, third grade or no grade, and no other terms but those terms must be used in describing the quality.

It is illegal to use any false, misleading or exaggerated terms in describing the quality of butter. The Province of Quebec, with regard to the buying of cream, has a regulation which states that second grade cream (and they have a definition describing second grade cream) must be sent back to the producer. Immediately this cream is received at the factory, the local or provincial creamery instructor is notified that this particular shipper has sent in No. 2 cream to this particular factory, and no other factory may receive that cream from this shipper during the period of a month.

In all the Provinces there are cream grading regulations.

Mr. Trimble: May I ask the gentleman a question: Have you increased your regulatory force to any extent?

Mr. Cameron: Due to the great distances and scattered population, it was necessary to increase our inspectors of dairy products. We have twenty men in the field now,—twenty Federal Inspectors of Dairy Products. They walk into a store and pick up a pound of butter, the quality is judged on scoring. The man who has the butter in his possession is responsible at the time, so that it means that all people selling butter, all merchants, are primarily concerned with having conditions such that they will maintain the quality of the butter as received from the manufacturer.

President Grim: Mr. Chairman, I think the gentleman is doing a good job on this quality butter, with respect to control of cream and butter; at least he is getting a start. One thing that has always disappointed me about the situation is that we have shipped in interstate commerce, continually, butter labeled "churned from pure, sweet, pasteurized cream." Every year we have the opportunity of looking over a good many creameries churning butter in the state of Minnesota. In the neighborhood of Philadelphia I think 80 or 85 per cent of all the butter that is consumed comes from a territory within a radius of a hundred miles of Minneapolis. We repeatedly see cream come into those creameries that is quite sour, and they use that cream in the churning of butter and distribute it in the East as butter churned "from pure, sweet, pasteurized cream."

The Federal Food and Drug Act was designed to prevent mislabeling of food products, and there is much ado about the mislabeling of other articles of food which, in my estimation, is not nearly as important as the mislabeling of butter. For that reason I have been urging, for several years back, that the enforcement agencies get on their jobs and do something about the labeling of cartons of butter which indicates that the butter comes from sweet cream. There is very, very little butter that we have been able to find that is churned from sweet cream. I know of one supply that is made from milk which is produced under conditions similar to that under which our fluid milk supply is produced, and where churning is accomplished shortly after pasteurization, the cream being entirely sweet. But the butter situation and conditions under which butter is manufactured that is sold in and around Philadelphia have been pretty bad. In fact, they were so bad that we decided it was necessary to institute some control over it. We have made just a start, but it is a start.

We are doing something like the city of Cleveland did sometime ago, only we will go farther. We ask them to label the carton and wrapper to the effect that this butter was made from cream that was pasteurized and that the milk was produced from cows which were tuberculin tested, and also require the label to contain the name and location of the creamery where the particular butter was churned. Once we had this information we set out to look over these creameries. We, at least, had a registration of all the creameries making butter sold in our territory. One thing that surprised us was to find that a good many of the buildings in which this butter was made were first class buildings. The Farm Board or somebody had given those co-ops a lot of money and they put up some good buildings in which to receive the cream and churn the butter. Their equipment was poor, although reports of the investigation this year indicate there is some improvement.

We find that all our butter is handled by jobbers and, aside from two of the chain store organizations, the people who sell the butter know little about the product. They put labels on the butter, on the wrappers and on the cartons. We first had an arrangement that if the butter was not printed at the creamery where it was churned the labels would be put on the tub and then later printed on the wrapper. We think there is the same situation with respect to these butter brokers that we had some years ago with respect to the cream brokers. They require the closest supervision. Of five creameries checked this year, we found that four of them were not getting the butter from the creamery where the label stated the butter was manufactured; also, the creamery operators did not know anything about the regulations. Still, I could go out in my town and pick up the butter with the names of these creameries on it. One organization in particular had been churning butter and selling it to a large chain store for at least six months without properly identifying the creamery. This was done even after a fine of fifty dollars for misbranding had been paid.

If we could get further work on the part of the Federal Government in the matter of branding and labeling, particularly those products that move in interstate traffic, and if then we could go back to these creameries and know that they were the places where the butter is being churned, we would have a pretty good start toward some kind of control over the conditions in which our butter is made.

Certainly all the things that have been presented in this most excellent paper are of much interest to us, and it is our job to go out and do it. If we are going to use butter in ice cream manufacture we are faced with a big problem. Where we can get enough inspected butter to require cream-inspected conditions for butter for households we can make a good start—so let's do it.

NEW PROBLEMS IN ICE CREAM SANITATION *

Introduction

THE INTEREST manifested in dairy products other than milk has been particularly noticeable of late. Products such as butter and cheese that have hitherto been accepted without question have come in for official scrutiny. The sanitary interest in ice cream, which has always been secondary to that in milk, has been increased. Some of the contributing causes of this interest is the tendency on the part of health officials to have the same requirements for the products used in making ice cream, butter and cheese as for market milk. In other words these dairy products are no longer the dumping ground for undesirable milk. Some health officials feel that their milk program is far ahead of the procession and that they should bring other dairy products abreast. Furthermore a sufficient number of epidemics of disease have been definitely traced to ice cream to cause those entrusted with the health of the people to scrutinize it more carefully.

The Counter Freezer

The advent of the counter freezer has likewise brought new problems to the public health official. The question immediately arises, is it a manufacturing process or is it a special merchandising process? Should its users be subjected to the same rules and regulations as are imposed on ice cream manufacturers or should exceptions be made? If you will examine the rules and regulations governing the counter freezer, you find that there are two different ways of handling the same thing. Some cities such as Ardmore, Pa., Baltimore, Md., Jacksonville,

* Committee Report.

Fla., and Birmingham, Ala., consider them small manufacturing units and require them to meet the same requirements as the larger ice cream manufacturing plants. They make no distinction whatsoever between the two.

Other cities have sanitary rules and regulations governing the larger ice cream manufacturing plants but specifically exempt counter freezers. And, of course, we have a third group of cities that has no regulation whatsoever for either counter freezers or large ice cream plants.

Without entering into the controversial side of the question, what are some indisputable facts regarding the situation? The installation of counter freezers in any number greatly increases the sanitary inspection load. It is much more difficult to watch and control a number of small units than it is a few large ones. This was learned early in the market milk industry and steps taken to correct the condition. We should profit by that experience. If you visit any city where there are a number of counter freezers, you will find some of them placed in sanitary well protected surroundings and manned by a clean intelligent personnel, while others are located in dirty undesirable places and operated by those whose training and knowledge are in keeping with their surroundings.

Many health officials think that because the counter freezer handles a small volume of ice cream as compared to the large manufacturing plants that they can afford to be less exacting or even ignore them entirely. They little appreciate the importance of small details in the control of disease. Virulent streptococci in one quarter of a cow's udder can and have caused epidemics of septic sore throat with the consequent illnesses and deaths, when milk from the diseased quarter was incorporated in the raw milk supply of a city. In fact the history of every epidemic shows the neglect of details, as well as ignorance and carelessness on the part of someone. Disease, the master, does not take these things into account so the public health official, the servant, can not do less.

Raw Products for Ice Cream

It is a safe assertion to say that each year there is an advance made in the sanitary quality of the raw products going into the ice cream mix. Tuberculin testing of cattle, begun in 1917, progressed steadily until 1934 when it received renewed impetus through funds made available by the Agricultural Adjustment Administration. In 1935 an all-time record was made when more than 25,000,000 cattle were tested. During the spring of that year nearly 100,000 cattle were being tested daily. The net result of this intensive campaign has been to reduce the average degree of prevalence of bovine tuberculosis from four per cent in 1922 to 0.6 per cent in 1935.

Extensive federal aid has likewise been given during recent years to the combating of Bang's disease and to the controlling of mastitis. These efforts are highly commendable both from an economic and health standpoint and most certainly will improve the quality of the raw products.

A few years ago it was common to find gelatin containing thousands and frequently millions of bacteria per gram. Now, most gelatin used contains few or no bacteria. This great reduction in number was brought about during the manufacture of gelatin by the simple expedient of acidulating the product just before it entered the dehydrating chamber. Sugar as now made has few or no bacteria present. Egg products whether imported or domestic show an improvement in sanitary quality.

Fruits, nuts, flavoring extracts and coloring matter are now receiving the attention of public health officials. This is because they are added to the mix after it has been pasteurized. All other ingredients are pasteurized. However, the materials added after pasteurization have no sanitary safeguard such as pasteurization. Therefore, if they contain pathogenic bacteria, they go direct to the consumer since there is no further treatment of the finished product. In other words why go to all the trouble and expense of pasteurizing and then add non-pasteurized materials to the finish product.

Newman and Reynolds [12] and Fabian [5] in 1930 showed these materials, especially the coloring materials, to be a source of bacteria. Fabian [5] found *Escherichia coli* in some of the samples examined. Later studies by Smallfield [17] showed large numbers of bacteria present in liquid colors and recently Tracy and Prucha [18] in a more comprehensive survey of the whole subject found that 10 per cent of the samples of fruits, nuts and coloring matter gave a positive test for *E. coli*. The source of the *E. coli* was not determined but they point out that the source was undoubtedly of human origin due to conditions surrounding their preparation. They state, "That a sanitary problem exists is evidenced by the data and also inspections of the premises where those materials are prepared for market." Already experiments are under way to find methods for correcting these conditions. However, until they are corrected a problem exists.

Sanitary Problems in Manufacturing Methods

Since pasteurization is the only process in the manufacture of ice cream that actually reduces the bacterial content and kills the asporogenic pathogens, it is essential that the temperature be adequate to accomplish this. That there is a wide divergence in time and temperature used by different companies was shown by Zoller's [19] survey in 1928 when an inquiry to 500 companies, 179 of whom replied, showed a range of 140° F. for thirty minutes to 185° F. for ten minutes. Seventy firms used 145° F.; thirty-three used 150° F. and twelve used 160° F. for thirty minutes with the others using a miscellaneous assortment of time and temperatures. A study of the legislative requirements of states and cities shows the same wide divergence of time and temperature.

What Is Correct for Pasteurizing Ice Cream Mix?

With this great assortment of legislative requirements and manufacturing practices for pasteurizing ice cream mix one might well ask, is not the whole subject in chaos? The reply is, "No." The time and temperature which you use depends on what it is desired to accomplish. For example: Oldenbusch, Frobisher and Shrader [13] found that cultures of *Eberthella typhi*, beta hemolytic streptococci, *Corynebacterium diphtheriae* and bovine tubercle bacilli were killed in ice cream mix within six minutes at 145° F. and within three minutes at 150° F. On the basis of this work the Committee on Dairy Products and Eggs [15] of the American Public Health Association concluded that 143.5° F. for thirty minutes recommended by them allowed an ample margin of safety for the pasteurization of commercial ice cream mix. The Committee states, "Direct work with pathogenic organisms certainly shows that a temperature of 145° F. for thirty minutes is a proper procedure for ice cream mix pasteurization."

Pasteurization for Bacteriological Standards

At present there are twelve states and a great many cities that have bacteriological standards for ice cream. While there is some variation in the standards, a majority of them have adopted 100,000 per gram or cc. as the standard. This figure has been established since a number of investigators as Fay and Olson,[8] Olson and Fay [14] and Fabian[6] have shown this to be a reasonable standard, and possible to attain consistently if the mix is pasteurized at 150° F. for thirty minutes. Lower temperatures may be used but greater care is necessary consistently to produce low count ice cream. It is for this reason that we have come to associate pasteurizing at 150° F. for thirty minutes with a bacterial standard of 100,000 per gram.

PASTEURIZATION FOR ESCHERICHIA–AEROBACTER GROUP

The use of the *E. coli* test as an index of milk pasteurizer efficiency and as a test to detect recontamination of milk after pasteurization is fast gaining acceptance. A few years ago there was strenuous objection on the part of some to the use of this test because they were putting the same emphasis on the test for milk as for water. The *E. coli* test has been used so long for detecting sewage pollution of water that it is hard to think of it as being used in milk for any other purpose than to detect manurial pollution. However, those who employ the test in the dairy industry for pasteurizer control are not concerned with its natural habitat or with the fact that these organisms may occasionally be pathogenic either for humans or animals. They are interested rather in the characteristics of the Escherichia-Aerobacter group in their relation to milk. Since they are present in most samples of raw milk, they multiply rapidly when present and outgrow many other types of bacteria. They are practically all killed by the usual pasteurization procedures and can be detected by simple laboratory tests when present in small numbers. These characteristics make them of value in milk control work.

However, in ice cream we have a somewhat different picture. Beavens,[2] Fay[9] and Fabian and Coulter[7] have shown that the sugars, lactose and sucrose, present in ice cream have a protective action on *E. coli*. The last named authors[7] also showed that there were resistant strains of *E. coli* that were not killed at 150° F. at thirty minutes but required 155° F. for thirty minutes for killing. In actual practice many factories pasteurize at

160° F. for thirty minutes to be absolutely sure of a colon-free ice cream.

Another consideration, in connection with using the *E. coli* test to determine the efficiency of pasteurization, is the fact that, as previously stated in this paper, fruits, nuts, flavoring and extracts may have *E. coli* present. Since these ingredients are added after pasteurization, this would destroy the value of *E. coli* as a test for pasteurizing efficiency in ice cream unless these substances were tested and found free of bacteria, or treated to destroy *E. coli* before they were added. Therefore, the Escherichia-Aerobacter test for pasteurizer efficiency and to detect recontamination of ice cream should be used with caution.

Pasteurizing for Economy

It has been shown by several workers, Dahl and Barnhart [3] and Hening [10] and others, that high pasteurizing temperatures reduce the viscosity of the mix, increase protein stability and shorten the freezing time. These last named factors are important from an economical as well as a bacteriological standpoint since they do away with or greatly reduce the aging period.

In summary then it can be said that the pasteurizing temperature of the ice cream mix has been gradually increasing in most modern factories not for any sanitary reason but due to physical and manufacturing advantages. It would, therefore, seem that we have little to worry about if all those manufacturing ice cream follow the general trend. It is interesting to note in this connection that at the higher pasteurizing and homogenizing temperatures, there is a tendency for thermophilic bacteria to grow if they are present. This has been noted by Abele.[1] However, since these bacteria are practically inert and possess no sanitary significance, this is not an important consideration but one that should be noted.

Precautions After Pasteurization

Extreme precautions should be taken with the mix after it has been pasteurized since this is the last sanitary safeguard standing between the final product and the consumer. For this reason certain sanitary precautions have been advocated. For example few public health officials who had the best interests of their people in mind would permit milk to be pasteurized at a plant and then be placed in cans and hauled to drug stores, meat markets, grocery stores, confectionaries or restaurants for bottling. However, exactly this is permitted with ice cream mix. It is even shipped long distances from one state to another. This *per se* is not necessarily objectionable. It is how it is handled after arriving at its destination that is important. Important considerations are: Is there sufficient refrigerating space? What happens to partially used cans of mix? Is the mix tampered with such as by adding more unpasteurized material in case there is a shortage and no additional supply immediately available? These and other questions cannot be passed over too lightly.

Suggested Remedies

Some of the ways by which the above objections may be corrected would be to place the mix in sterile sealed containers sufficient for one freezing or the use of sterile single service containers. This would solve part of the problem.

Another way would be to require that all mix be frozen at the point of pasteurization. Unless the mix is handled in a sanitary manner within the factory, even this method is open to criticism.

The ideal method would be to require the mix to flow in a continuous sanitary and sterile pipe from pasteurizer to freezer. This method offers no possible sanitary objection and is in actual operation in two cities, Birmingham and Tuscaloosa, Alabama.

DEFINING AND LABELING FROZEN PRODUCTS

In recent years there have appeared on the market a great many frozen desserts and confections. The temporary success which they have enjoyed was in a measure due to the reflected glory of ice cream. The best way to control such products and likewise the quality of different ice creams is by proper and comprehensive definitions and labeling. Space does not permit the defining of all such frozen products. However, it would seem desirable to frame a uniform set of definitions and make them available to all health departments.

Formerly the emphasis was placed on the chemical composition of ice cream especially butter fat. This as well as the other ingredients has been fairly well standardized. The present emphasis is on the physical aspects rather than the chemical. Certain abuses have developed among the unscrupulous manufacturers in an attempt to gain business. Chief of these is the incorporating of excessive amounts of air. There are three ways by which this may be controlled. The simplest way is to specify the amount of overrun permitted by volume. Two states, Illinois and Wisconsin have this requirement. According to Shaw [16] it is not satisfactory and is not being enforced in Illinois. Another method is the weight per gallon method, the specifications for which usually range from 4.25 to 4.5 pounds. There are two objections to this method. Water, one of the heaviest ingredients of ice cream, may be used to make up the necessary weight. Another and more cogent reason from the sanitary standpoint is that this method would necessitate the weighing of all package goods, calculating the price according to the weight and marking the price on each package. This of course would discourage the manufacture of package goods, a practice which should be encouraged rather than discouraged. So far Ohio, Indiana, North Dakota and South Carolina have a requirement of 4.25 pounds per gallon and Virginia and Maryland require 4.5 pounds per gallon.

A third method and one which apparently has certain advantages over the others is a standard based on food solids per gallon. The food solids content is calculated by determining the percentage of total food solids and multiplying the average weight of a gallon of ice cream by the percentage of food solids. This law is gradually gaining favor as evidenced by the number of states that have included it in their legislation. At present Alabama, California, New York, Michigan, Idaho, South Dakota, Connecticut, Florida and Massachusetts, South Carolina and Utah have as the standards 1.6 pounds of total food solids per gallon while Pennsylvania has 1.8 pounds total food solids or 4.75 pounds per gallon as the standard.

The matter of proper labeling is likewise important. All packaged ice cream should be required to be correctly labeled as to kind and name of the manufacturer. This would eliminate nondescript and inferior ice cream from the market. Some officials advocate the dating of ice cream when frozen and placing a time restriction on its sale. There is a tendency in this direction as shown by Michigan's law which requires the mix to be frozen within a period not more than seven days after pasteurization. This is the first step toward placing a time limit on frozen products. Practically all are of the opinion that dating of the finished product would definitely curtail consumption and cause increased manufacturing and distributing costs.

Uniformity of Regulations

All health departments, whether state or city, have the same objective in mind, *viz.*, the health of the people. A great deal of confusion, unnecessary duplication and expense could be saved if there were greater uniformity in the regulations governing the manufacture and sale of ice cream. Frequently the same farm or plant is inspected by several inspectors, each with his own pet ideas which must be carried out. These ideas often have no scientific basis and are proposed merely to be different or to show that the inspector is on the job. When such conditions exist, they should be corrected to the mutual benefit and satisfaction of all.

Grading Ice Cream

There is a suggestion by some public health officials that ice cream should be graded the same as milk. The question immediately arises, what basis should be used for grading? So far as the basis proposed has been the quality and freshness of the constituents used in the mix. Certainly another important consideration is the sanitary condition of the plant in which it is made.

A recent frozen desserts ordinance enacted by Memphis, Tennessee, provides for two grades of ice cream and frozen desserts. There are two fundamental considerations used as their basis of grading, *viz*, the quality of the raw dairy products and the plant where the product is made.

Grade A frozen desserts shall be made from Grade A or Grade B raw milk or milk products produced under standards set in the Memphis milk ordinance as Grade A or Grade B raw milk. They must be made in a plant meeting certain requirements such as concrete or other impervious floors and smooth, tight, light washable walls. These and many other sanitary safeguards on plant construction, operation and personnel are specified. The finished product shall not have a bacterial count exceeding 30,000 per gram.

Grade B frozen desserts differs from Grade A only as regards the quality of the milk products and bacterial numbers. The requirements for plant construction, operation and personnel are the same. For making Grade B frozen desserts, Grade A, B or C raw milk or milk products may be used. A bacterial plate count of 50,000 is permitted.

The interesting features of the Memphis ordinance is the grading of ice cream on the basis of the quality of the raw products and the sanitary aspects of the plant.

Sterilizing Machinery and Equipment

The question of sterilizing machinery and equipment is always with us. There are just two means of sterilizing, physical and chemical. Experience and practicability have eliminated all the physical methods except hot water and steam. Some health departments have no use for steam in an ice cream plant. They maintain that steam is ineffective due to the large amount of refrigeration. There is some basis for this contention. Steam as soon as it contacts a cold surface condenses into water at a much lower temperature. However, in so doing it gives up its latent heat. Therefore, steam in order to be effective must come in contact with a surface sufficiently long to raise the temperature high enough to kill bacteria. This is seldom done by those using it unless they are educated to the necessity of this procedure. Under most conditions the contact period for steam should be from three to five minutes. Steam is also unsuitable for sterilizing certain pieces of machinery. It is always necessary to have plenty of cold and hot water for cleaning and rinsing the machinery and other equipment so these health departments contend that all the sterilizing might as well be done with hot water. If it were possible to have the steam under pressure, then it would be much more effective. Steam has the advantage of drying as well as sterilizing if properly used.

Hot water is favored by many as being a satisfactory method for sterilizing dairy equipment. Just as with steam, hot water must be used intelligently. The first requisite is an abundance of hot water. The hot water must contact the parts to be sterilized. For example if piping is being sterilized, the pipe must be completely filled. The chief difficulty in sterilizing by this method is in keeping the water hot enough to be effective. Most codes that specify a time and temperature for hot water sterilization require a temperature of at least 180° F. for a period of two minutes or more. Dahlberg and Marquardt [4] found that the hot water available for sterilizing purposes in ice cream plants was generally below 160° F. They found hot water impractical for sterilizing freezers because of the excessive quantities required at a temperature too high for commercial operation. One important consideration in this method not usually appreciated is the fact that the bacterial reduction resulting from inefficient hot water sterilization is due either to washing the bacteria out of the machinery or to the dilution factor rather than to bacterial destruction. Hot water has the disadvantage of leaving the equipment moist. If the equipment is not thoroughly clean and sterile, bacterial growth may result under these conditions.

Chemical sterilization is recommended by most public health officials only as a supplement to physical sterilization. This is a wise provision since any one familiar with the dairy industry knows the absolute necessity of an abundance of hot water and steam for cleaning the equipment. One of the objections to counter freezers is the fact that they are usually situated in places where hot water is at a premium and steam is absent.

In the process of cleaning dairy equipment some detergent such a sodium hydroxide, carbonate, metasilicate or triphosphate is used. These may have a germicidal effect if used in sufficient concentration in hot water. However, the one chemical agent that has replaced all others as a germicide in the dairy industry is chlorine. In most respects it is the ideal chemical for this purpose. However, as every one familiar with chlorine knows, it is a very elusive substance. In the presence of acids or organic matter, it disappears very quickly. In talking with the layman or the uninformed it is apparent that almost without exception they have the impression that chlorine is a germicidal panacea. They believe that all that is necessary is to add chlorine and all their sterilizing troubles are over. This false sense of security leads to carelessness and indifference in caring for the equipment.

It should be borne in mind that chlorine should be used as a sterilizing agent only on clean equipment. This being the case, why not require the use of steam and hot water which are necessary to clean the equipment as primary sterilizing agents and chlorine as a supplementary sterilizing agent? This is what health departments familiar with the situation are doing with satisfactory results.

The work of Dahlberg and Marquardt [4] on freezer sterilization is very enlightening. They found that it took excessive amounts of hot water to sterilize a freezer. It was possible to sterilize a freezer with steam but it was a slow process. Chlorine did not penetrate the bearings of the freezer so that it was not possible to sterilize them by this means. Their results indicate that for this one piece of ice cream equipment there is only one satisfactory sterilizing agent and that is steam. They recommend steam with chlorine as a supplementary sterilizing agent. On the basis of this work it is hard to reconcile the option of using steam, hot water or chlorine as the sterilizing agent given by some health departments.

The abstract of the work of Dahlberg and Marquardt [4] is given herewith. "The problem of sterilization of ice cream freezers has not been studied experimentally to any extent as it has been assumed that ordinary methods used in the dairy industry would be effective and freezers have usually not played an important part in ice cream contamination.

"In the present study freezers were sterilized by steam, hot water, and chlorine solution. It was found that chlorine solution did not penetrate the bearings and that bacteria subsequently developed in the wet freezer. The cold refrigerant around the freezer chilled hot water so that excessively large amounts at very high temperatures were required to sterilize freezers by this means. Heating by steam was slow, but it was entirely possible to sterilize satisfactorily by steam.

"Sterilization of freezers with steam was particularly effective as it dried them and sterilized the bearings also. Rinsing with chlorine solution prior to use was found to be desirable as a supplement to steam sterilization."

Fountain Sanitation

The weakest link in the ice cream chain today is in retailing the product rather than in manufacturing it. Most ice cream companies have so much at stake that they can not afford to produce anything but the best. All the latest and best that research has produced in sanitation, machinery and materials are utilized in producing the finest possible product. Frequently, however, much that the manufacturer has done is undone or nullified to a certain extent by the dispenser of ice cream. Ice cream that has received every possible sanitary consideration in its manufacture may be delivered to a retail store where little or no attention is paid to sanitation. The place is dirty, the attendants are careless and sometimes dirty and slovenly. The dipper is kept in a container from which the water is emptied only at infrequent intervals. This permits bacteria to grow in large numbers. Everytime the dipper is used to dip ice cream, the ice cream is covered with a film of water containing many millions of bacteria.

Horn [11] has made a detailed study of dipper contamination in retail establishments over a six and one-half year period and has reached some very interesting conclusions. He found very little monthly or seasonal variation. Samples from restaurants were best while those from pharmacies, confectionaries and stores were in this order less satisfactory. This indicated that experience in food handling was valuable in helping to reduce this source of contamination. He states, "It was discouraging to find druggists, who have received in College of Pharmacy more or less instruction in bacteriology, were as a class not the most cleanly in this matter of dipper water." His figures showed education to be the most important factor in dealing successfully with this problem.

Other Problems

The time is not far distant when we are going to require the licensing of all dairy workers. This will insure a more intelligent and better trained type of worker handling dairy products. Other artisans such as plumbers, barbers, etc. whose work does not affect the public nearly so vitally as does that of dairy workers are now licensed. Some cities such as Baltimore, Maryland, and Portland, Oregon, are giving courses with this in mind.

In conclusion it should be stated that the ice cream industry has made rapid progress in sanitation. There are certain conditions which still exist which need attention and can be improved. These conditions have been pointed out together with the solution of them where a solution is known.

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REPORT OF COMMITTEE ON METHODS OF IMPROVING MILK SUPPLIES IN SMALL COMMUNITIES

THE STATUS OF MILK CONTROL IN MUNICIPALITIES OF 1,000 TO 10,000 POPULATION

DURING the past year the Committee on Methods of Improving Milk Supplies in Small Communities has attempted to secure additional information on the extent and character as of 1935 of milk control in small communities of from 1,000 to 10,000 population.

The information in this report has been secured entirely by questionnaire and correspondence, and while it is realized that the questionnaire method has limitations the Committee believes that in the present instance considerable information of value has been secured. Whenever questions arose as to the completeness or accuracy of the information received recourse was had to direct correspondence. The total number of such direct communications has probably been upward of 1,000. To the great majority satisfactory responses were received.

The first work of the Committee was the preparation of the local and state questionnaire forms shown in Figure 1 and Figure 2.

The first or local form was multigraphed in large quantities and a communication inviting cooperation was sent to each state milk control authority. Each state authority was invited either to collect the information from the individual municipalities or to authorize the Office of Milk Investigations of the Public Health Service to do so. The great majority of states asked the Public Health Service to collect the information.

EXTENT AND ORGANIZATION OF STATE CONTROL

The first question to which an answer was sought was the following: *(1) To what extent is state milk control exercised and how is it organized?*

An analysis of the general state questionnaires which were filled out and submitted by 43 of the states made it possible to determine answers to the following sub-questions.

(a) Which state department does the milk control work?

Table 1 gives the frequency with which various state departments are concerned with milk sanitation work.

FIGURE 1

U. S. Public Health Service — Office of Milk Investigations

QUESTIONNAIRE ON GENERAL STATE MILK SANITATION WORK

(To be filled in by State milk control authority and returned to Office of Milk Investigations, U. S. Public Health Service, Washington, D. C.)

Do State laws or milk regulations require:

(1) TB-testing for all milk?..........for all milk consumed raw?..........

(2) Abortion testing for all milk?........for all milk consumed raw?........

for grade A raw milk?..

Does State inspect raw distributors?......pastz'n plants?......plant shippers ......

Under which department?......................division?......................

Whole-time milk inspectors: number..........average annual salary $..........

Part-time milk inspectors: number..........average annual salary $..........

Average % of time on milk........%. What else do they do?................

Average travel allowance per inspector per year $.............................

No. of inspectors with college degrees (state degrees)..........................

Method of appointing inspectors: civil service?......political?......other?......

Are State milk samples examined in: State central laboratory....................

State branch laboratories?................other laboratories?................

Does any other State department do milk sanitation work?......................

If so, please have another copy of this questionnaire filled out by that department.

State .... (Signed) ....

Date ...., 193... (Title) ....

FIGURE 2

U. S. Public Health Service Office of Milk Investigations

QUESTIONNAIRE ON MILK CONTROL IN MUNICIPALITIES OVER 1,000

(To be filled in for each municipality over 1,000, and returned to Office of Milk Investigations, U. S. Public Health Service, Washington, D. C.)

City.................................. State..................................

SECTION A. GENERAL DATA ON MUNICIPAL MILK SUPPLY

No. of: raw milk distributors........pastz'n plants........plant shippers........
Gallons sold daily: fluid market milk......cream......buttermilk......total......
Please list all grades of pasteurized milk and of raw milk sold, estimate for each grade the % of the total supply, and give the price per quart delivered to homes:

Grade.......... pastzd:......% of total; delivered price........c per quart
" .... pastzd:......% " " " " ....c " "
" certified raw: ....% " " " " ....c " "
" .... raw: ......% " " " " ....c " "
" .... raw: ......% " " " " ....c " "

% of total municipal milk supply which is pasteurized.........................%
% of pasteurized milk from TB-tested herds....%; from abortion-tested herds....%
% of raw milk from TB-tested herds......%; from abortion-tested herds......%
Avge. of 1935 counts (or red. hrs.): retail raw....pastz'd....prepastz'd raw....

SECTION B. MILK CONTROL BY LOCAL AUTHORITIES

Is there a local milk ordinance?....Are State regulations enforced by city?....
Does local milk ordinance or regulations require:
(1) Pasteurization of all milk?............of all except certified?............
(2) TB-testing for all milk?............for all milk consumed raw?..........
(3) Abortion testing for all milk?........for all milk consumed raw?........
for Grade A raw milk?..
Are dairies and plants inspected by city?......by county?......by district?........
Under which department?......................division?......................
Whole-time local milk inspectors: number........average annual salary $........
Part-time local milk inspectors: number........average annual salary $........
Av'ge. % of time on milk........%. What else do they do?..................
Average travel expense per local inspector per year $............................
No. of inspectors with college degrees (state degrees)............................
Method of appointing inspectors: civil service?......political?......other?......
Av'ge. no. inspections per year by local authority of each raw milk distributor....
each pasteurization plant................each plant shipper................
Av'ge. no. count or reductase samples per year taken by local authority from each raw milk distributor.......each pastz'n. plant.......each plant shipper.......
Are the last composites?......If so, give av'ge. no. shippers per composite?......
Check which laboratory examines milk: City health dept.?......City general?......
Water dept.?.....County health dept.?.....State?.....Private?.....Other?.....
Estimated total local expenditure for milk control per year $....................
% of these funds derived from: city tax..%; county tax..%; fees..%; other..%
If any funds are derived from "other" sources, or from permit, license, or inspection fees, please give sources, percentages, and other details on reverse side.

SECTION C.* MILK SANITATION WORK BY STATE

(To be filled in by State if State does any milk sanitation work in this city.)
Total man-days annually on milk sanitation in this municipality................
Av'ge. no. inspections per year by State of each raw milk distributor............
each pasteurization plant.................each plant shipper.................
Av'ge. no. count or reductase samples per year taken by State from each raw milk distributor..........each pastz'n. plant..........each plant shipper..........
Are the last composites?....If so, give av'ge. no. shippers per composite....
Estimated State expenditure per year for milk sanitation in this city $............
Please place a cross mark (x) before each question answered by State.

Data by (State)................., ..., 1936
(Signature) (Title) (Date)

Data by (local)................., ..., 1936
(Signature) (Title) (Date)

(3046)

* Note. Section C of the questionnaire on milk control in municipalities over 1,000 was so planned as to supply detailed information regarding the milk sanitation work done by the State in each municipality, thus supplementing the information on local control given in Section B of the questionnaire. The data called for included total man-days per year, the number of inspections, the number of samples, and the estimated cost of State work in each municipality. Since only about one-fourth of the States answered the questions in Section C, and since the probability of even approaching completeness by further correspondence seemed remote, no effort has been made to compile and analyze the data in Section C.

Table 1

WHICH STATE DEPARTMENT DOES MILK SANITATION WORK?

Number of states in which milk sanitation done by state health department	22
Number of states in which milk sanitation done by state agriculture department	12
Number of states in which both health department and some other agency do milk sanitation work	10
Number of states in which milk sanitation done by department other than health or agriculture	4
	48

It will be noted that the state department most frequently concerned with milk control work is the state health department, and the one next most frequently the state department of agriculture, twenty-two states coming in the first category and twelve in the second. In ten other states both health and agriculture departments are concerned with milk control work.

The next question to which an answer was sought was as follows:

(b) By what subdivision of the state health department or the state agriculture department is milk control work done?

This question is answered in Tables 2 and 3 below.

Table 2

STATE HEALTH DEPARTMENT DIVISIONS DOING MILK WORK

Division	Number of States
Sanitary Engineering	17
Food and Drug	7
Other	8

It will be noted that the most frequent usage in state health departments is to place milk control in the sanitary engineering division and the most frequent usage in state agricultural departments is to place milk control in the dairy and food division.

Table 3

STATE AGRICULTURAL DEPARTMENT DIVISIONS DOING MILK WORK

Division	Number of States
Dairy or Dairy and Food	14
Animal Industry	2
Veterinary	1
Other	4

The next question to which an answer was sought was the following:

(c) To what extent do state laws or regulations require tuberculin testing or abortion testing?

Table 4 gives the number of states in which the requirements indicated in the table are being made, out of a total of forty-three states reporting.

Table 4

STATE REQUIREMENTS WITH REFERENCE TO TUBERCULIN TESTING AND ABORTION TESTING

Number of states requiring tuberculin testing for all milk	23
Number of states requiring tuberculin testing for all raw milk only*	2
Number of states reporting tuberculin testing as not mandatory for even raw milk*	18
Number of states requiring abortion testing for all milk	3
Number of states requiring abortion testing for all milk consumed in the raw state	1
Number of states requiring abortion testing for all grade A raw milk	8
Number of states reporting abortion testing as not mandatory for even grade A raw milk	31

The next question to which an answer was sought was the following:

(d) How many whole and part time inspectors were employed by the state department?

Table 5 gives this information with reference to the inspectors employed whole time on milk.

Many of the states employ inspectors whose time is devoted only in part to milk. It was thought unprofit-

* It should be noted that tuberculin testing is much more extensive than is indicated by the State laws, as 43 States and the District of Columbia have now been admitted as modified accredited areas.

able, however, to attempt to present the figures on part time inspectors independently as there was so great a variation in the percentage of time devoted to milk by the various inspectors. Instead, therefore, whole-time and part-time service has been combined in Table 6.

Table 5

NUMBER OF STATE INSPECTORS WHOLE TIME ON MILK

Number of States	Number of Inspectors
18	0
6	1
5	2
6	3–5
7	More than 5

How much work each of these state inspectors would be required to do if the state milk control authority attempted to control the entire milk sanitation problem in all municipalities with a population of 1,000 to 10,000

Table 6

NUMBER OF WHOLE-TIME AND PART-TIME STATE INSPECTORS

Number of States	Number of inspectors (expressed as equivalent whole-time inspectors)
2	0
10	0–1
20	1+–5
3	5+–10
5	Over 10
8	No report

but did nothing in larger communities is indicated in Table 7, which gives the number of municipalities of from 1,000 to 10,000 population per equivalent full-time state inspector.

The average number of municipalities per equivalent whole-time inspector is 39.

The information given in Table 7 is significant as it indicates clearly that the great majority of state authorities are not now even nearly sufficiently manned to provide adequate milk control for all communities of from 1,000 to 10,000 population. The maximum number of municipalities which a single state inspector could handle efficiently if there were no local control would be about ten, whereas the average for all states is thirty-nine.

Table 7

NUMBER OF MUNICIPALITIES FROM 1,000 TO 10,000 POPULATION PER EQUIVALENT WHOLE-TIME STATE INSPECTOR

Number of States	Number of Municipalities per inspector
8	No report
8	Under 10
5	10–25
6	25–50
9	50–100
12	Over 100

All but eight of the forty states which reported on this point may be considered as at present not even approximately sufficiently manned to control milk supplies in all municipalities of from 1,000 to 10,000 population, even if it be assumed that all of their time is devoted to this population group and none devoted to municipalities of more than 10,000 population.

The next question for which an answer was sought is

(e) What is the professional training of State milk inspectors?

Table 8 shows the extent to which various professions are represented among the state milk inspectors:

The information given in the above table shows that veterinarians are more frequently employed than any other profession, but that they include only about 13 per cent of the total number of state inspectors. Over half of the state inspectors were reported as having no thorough professional training resulting in a degree.

The next question to which an answer was sought was *(f) How are state milk inspectors appointed?*

Only eight of the states reported that their milk inspectors were appointed on a civil service basis. Ten of the states reported that appointment was political. Twenty-three of the states reported that appointments were neither political nor by civil service, and the remaining seven states failed to reply to this part of the questionnaire.

Table 8

PROFESSIONAL TRAINING OF STATE MILK INSPECTORS

Profession	No. of inspectors	Per cent of inspectors
Medicine	1	0.4
Sanitary engineering	7	2.5
Veterinary medicine	37	13.2
Agriculture	15	5.3
Miscellaneous degrees	65	23.0
No degree	157	55.6
	282	100.0

EXTENT AND ORGANIZATION OF LOCAL CONTROL

The next series of questions considered in this report relate to local milk control. The first of these questions is as follows:

(2) To what extent is local milk control work done by municipalities of from 1,000 to 10,000 population?

Forty-one of the state milk control authorities answered this question, and Table 9 gives the total number of municipalities of from 1,000 to 10,000 in each state and the number and percentage in which *no* local milk control work is done.

It will be noted that the percentage of such communities in which no local milk control work is being done varies from 29.6 per cent in Minnesota to 100 per cent in Delaware and Illinois. For the country as a whole the returns indicate that about 80 per cent of the communi-

Table 9

Number and Percentage of Municipalities between 1,000 and 10,000 Population in which no Local Milk Control Work Was Done in 1935
(as reported by state milk control authorities)

State	Total No. of municipalities 1,000-10,000 (1930 census)	No. in which no local milk control	Percentage in which no local milk control
Alabama	103	66	64.1
Arizona	21	12	57.1
Arkansas	98	86	87.8
California	183	77	42.1
Delaware	15	15	100.0
Florida	96	68	70.8
Georgia	140	129	92.1
Idaho	41	32	78.0
Illinois	345	345	100.0
Kansas	127	113	89.0
Kentucky	114	67	58.8
Louisiana	93	75	80.6
Maine	25	24	96.0
Maryland	41	30	73.2
Massachusetts	198	171	86.4
Minnesota	152	45	29.6
Mississippi	81	59	72.8
Missouri	172	156	90.7
Montana	36	32	88.9
Nebraska	100	97	97.0
Nevada	9	5	55.6
New Hampshire	76	72	94.7
New Jersey	188	175	93.1
New Mexico	24	16	66.7
North Carolina	138	74	53.6
North Dakota	37	32	86.5
Ohio	275	193	70.2
Oklahoma	151	140	92.7
Oregon	51	49	96.1
Rhode Island	23	21	91.3
South Carolina	85	66	77.6
South Dakota	51	47	92.2
Tennessee	89	70	78.7
Texas	313	238	76.0
Utah	52	45	86 5
Vermont	31	26	83.9
Virginia	71	61	85.9
Washington	65	63	96.9
West Virginia	91	72	79.1
Wisconsin	143	120	83.9
Wyoming	23	22	95.7
*41 States	4,167	3,306	79.3

* There were seven states from which no reports were received.

ties under 10,000 population do no local milk control work. In one or two of the states, as in Delaware, an attempt is made to handle the entire milk control problem on a state basis, but for the great majority of states it must be concluded that most communities of from 1,000 to 10,000 population are either entirely without milk control or only very occasionally visited by a state milk inspector.

These state reports on the proportion of all municipalities between 1,000 and 10,000 population having local milk control are approximately checked by the municipal questionnaire returns. Out of a total of 1907 returns from cities between 1,000 and 10,000, 743 (or 39.2 per cent) reported having local milk control. On the assumption that none of the municipalities which failed to return questionnaires have local milk control, this figure would indicate that 14 per cent of all municipalities in this population group in the U. S. have local milk control. Assuming that the state reports are correct the difference between this percentage and the twenty per cent given by the state reports (Table 9) is due to the fact that 311, or 5.5 per cent of the municipalities had local control but did not return the questionnaire. Some of these undoubtedly are small municipalities which are adjacent to large cities and which receive milk from them. Some of these municipalities were undoubtedly considered by the states as having local milk control.

The next question to which an answer was sought was as follows:

(3) To what extent do municipalities between 1,000 and 10,000 population have local milk ordinances?

This part of the questionnaire was answered by 1,907 municipalities of between 1,000 and 10,000 population, and 852, or 44.8 per cent, stated that there was a local milk ordinance. Of these 206, or 24.2 per cent, reported that the local milk ordinance is the Public Health Service Milk Ordinance.

If it were assumed that the 1,907 municipalities which answered the questionnaire included practically all of those which have local milk ordinances it would follow that only 15.4 per cent of all municipalities of 1,000 to 10,000 population in the United States are provided with milk ordinances.

The next question for which an answer was sought was the following:

(4) What are the local ordinance requirements relative to pasteurization, tuberculin testing, and abortion testing?

The information relative to this question is given in Table 10.

Table 10

LOCAL ORDINANCE REQUIREMENTS RELATIVE TO PASTEURIZATION, TUBERCULIN TESTING, AND ABORTION TESTING

Ordinance requirement	Cities making requirement	
	Number	Per cent
Pasteurization of all milk	36	4.2
Pasterization of all except certified milk	11	1.3
Tuberculin testing of herds for all milk	697	81.8
Tuberculin testing of herds only for all milk consumed raw	61	7.2
Abortion testing of herds for all milk	150	17.6
Abortion testing of herds only for all milk consumed raw	55	6.5
Abortion testing of herds only for all Grade A raw milk or equivalent grade	33	3.9
Both pasteurization and tuberculin testing for all milk	28	3.3
Both pasteurization and tuberculin testing for all milk except certified	9	1.1
Total no. of cities reporting on this item	852	

The next question to which an answer was sought was:

(5) How is the local inspection service organized?

This question was divided into a number of subquestions as follows:

(a) What local political subdivision is responsible for milk control?

The responses to this part of the survey (742) indicated that in 45.8 per cent of the communities of 1,000 to 10,000 population having local milk control this activity is a municipal function, in 44.2 per cent a county function, and in 10 per cent a district function.

(b) Which local department inspects?

In 95 per cent of the 739 communities which answered this question milk control is a health department function.

(c) How is milk control organized under the health department?

The responses to this question (697) indicated that in 50.5 per cent of these municipalities the local milk sanitation work is done by the county or district health department inspector, in 30.3 per cent by the city health department inspector, and in 14.2 per cent by the health officer personally. In only 5 per cent of these municipalities was local milk control organized as a separate division of the health department.

(6) To what extent are local inspectors employed on milk control in municipalities which have local milk control?

Of the municipalities which reported having local milk control and which answered this part of the questionnaire (742) only six, or less than 1 per cent, stated that an inspector was devoting his full time to milk control. Approximately 84 per cent of these municipalities had one inspector part time on milk, 10 per cent had two inspectors part time on milk, and the remaining 6 per cent had three or four inspectors devoting part time to milk. In many cases these inspectors were employed full time but devoted part of their time to other duties or to milk control in more than one community.

Since 618 municipalities reported the percentage of the total time devoted to milk control by local inspectors spending only part of their time on this work, and since six other communities each employed a full-time local milk inspector, it was possible to compute the number of whole-time or equivalent part-time local milk inspectors in these 624 communities, as given in Table 10-A.

Table 10-A

NUMBER OF WHOLE-TIME OR EQUIVALENT PART-TIME LOCAL MILK INSPECTORS

No. of W. T. or equivalent P. T. local milk inspectors	Municipalities	
	Number	Per cent
0.2 or less	497	79.7
0.21–0.4	81	13.0
0.41–0.6	32	5.1
0.61–0.8	4	.6
0.81–1.0	6	1.0
1.01–1.2	2	.3
Over 1.2	2	.3
Total	624	100.0

Mean number of whole-time or equivalent part-time local milk inspectors per city=0.17

The above table indicates that in about 80 per cent of the communities having milk control there is available less than one-fifth of one man's time on milk control, and that the mean for all cities is about one-sixth of one man's time.

(7) What salaries are received by milk inspectors who are employed either full time or part time on milk in municipalities of 1,000 to 10,000 population?

Since only six of the municipalities reported employing inspectors devoting full time to milk there is given below in Table 11 the distribution of salaries of whole-time inspectors employed either full time or part time on milk.

It will be noted from the above table that nearly 80 per cent of the salaries lie between $1,100 and $2,000 per year and that less than 20 per cent of the salaries are above $2,000 per year.

(8) What other duties do the part-time local milk inspectors combine with milk sanitation?

Table 11

SALARIES OF WHOLE-TIME LOCAL INSPECTORS DEVOTING ALL OR PART TIME TO MILK

Salary range	Municipalities	
	Number	Per cent
Less than 800	1	0.4
800 –1100	4	1.8
1101–1400	66	29.1
1401–1700	65	28.6
1701–2000	49	21.6
2001–2300	18	7.9
2301–2600	9	4.0
2601–2900	0	.0
2901–3200	14	6.2
3201–3500	0	.0
3501–3800	1	0.4
Over 3800	0	.0
Total	227	100.0
Mean salary=$1698 per year		

Table 12 gives the distribution of duties other than milk sanitation performed by the local part-time inspectors.

It is apparent from the above tabulation that the most frequent single combination is milk and general sanitary inspection. In 12 per cent of the cases the part-time milk inspector engages in private veterinary practice.

(9) What is the professional training of local milk inspectors?

Table 13 gives the frequency with which small municipalities report having inspectors with the various professional degrees indicated.

It will be noted that 45.4 per cent of the municipalities reported having milk inspectors with no degrees. This may be compared with the fact shown in an earlier table that 55.6 per cent of state milk inspectors have no degrees.

Table 12

OTHER DUTIES OF PART-TIME LOCAL MILK INSPECTORS

Nature of other duties	Frequency of occurrence in percentage
Meat inspection	5.8
Food inspection	4.1
General sanitary inspection	34.1
Laboratory work	1.2
Combinations of the above	6.3
General duties of city or county health officer	14.4
Other city work not public health	6.7
Private veterinary practice	12.0
Other private work	4.0
Miscellaneous	11.1

Table 13

PROFESSIONAL DEGREES OF LOCAL MILK INSPECTORS

Professional degree	Municipalities reporting	
	No.	Per cent
Medicine (nearly all are health Officers)	100	14.2
Veterinary medicine	161	22.8
Sanitary engineering	17	2.4
Miscellaneous degrees	107	15.2
No degrees	321	45.4
Total reporting	706	100.0

(10) How are local inspectors appointed?

Of the 697 municipalities reporting on this item 252, or 36.2 per cent, stated that appointment was political, 101, or 14.5 per cent, stated that appointment was by civil service, and 343, or 49.2 per cent, stated that other methods of appointment were used, such as by the health officer or by the board of health.

(11) How frequently are inspections made by local inspectors?

Table 14 gives the frequency of inspection of raw milk distributors, pasteurization plants, and plant shippers by local inspectors. It will be noted that on the average, for municipalities having local milk control, raw milk distributors are inspected twelve times per year, pasteurization plants eighteen times per year, and plant shippers 7.4 times per year.

Table 14

FREQUENCY OF LOCAL INSPECTIONS

Raw milk distributors			Pasteurization plants			Plant shippers		
	Municipalities			Municipalities			Municipalities	
No. of inspections per year	No.	Per cent	No. of inspections per year	No.	Per cent	No. of inspections per year	No.	Per cent
0	20	3.0	0	15	3.4	0	82	19.2
Over 0– 3.9	131	19.8	Over 0– 9.9	141	31.7	Over 0– 2.9	107	25.1
4– 6.9	121	18.3	10–19.9	154	34.6	3– 5.9	46	10.8
7– 9.9	20	3.0	20–29.9	88	19.8	6– 8.9	53	12.4
10–12.9	216	32.7	30–39.9	13	2.9	9–11.9	8	1.9
13–15.9	20	3.0	40–49.9	6	1.3	12–14.9	86	20.1
16–18.9	15	2.3	50–59.9	17	3.9	15–17.9	9	2.1
19–21.9	8	1.2	60–69.9	0	.0	18–20.9	10	2.3
22–24.9	42	6.4	70–79.9	6	1.3	21–23.9	2	0.5
25–27.9	7	1.1	80–89.9	0	.0	24–26.9	12	2.8
28 or more	61	9.2	90 or more	5	1.1	27 or more	12	2.8
Total municipalities which reported	661	100		445	100		427	100
Mean=12 inspections per year per farm.			Mean=18 inspections per year per plant.			Mean=7.4 inspections per year per farm.		

(12) How frequently are milk samples taken by local authorities?

Table 15 gives the frequency with which retail raw milk, pasteurized milk, and milk received by pasteurization plants are sampled by local authorities in municipalities having local milk control. It will be noted that on the average retail raw milk supplies are sampled 12.5 times per year each, pasteurized milk supplies 16.4 times per year each, and milk received by pasteurization plants 6.8 times per year each.

It should also be noted that in nearly half of the municipalities having local milk control no samples of milk received by pasteurization plants are examined by local authorities; again, that in nearly 21 per cent of these municipalities no samples of retail raw milk are examined; and that in 16.7 per cent no samples of pasteurized milk are examined.

Table 15

FREQUENCY OF SAMPLING IN CITIES HAVING LOCAL CONTROL

Raw milk distributors			Pasteurization plants			Plant shippers		
	Municipalities			Municipalities			Municipalities	
No. of samples per year	No.	Per cent	No. of samples per year	No.	Per cent	No. of samples per year	No.	Per cent
0	136	20.8	0	76	16.7	0	206	48.7
Over 0– 5.9	115	17.5	Over 0– 9.9	96	21.1	Over 0– 5.9	47	11.1
6–10.9	81	12.4	10–19.9	126	27.6	6–10.9	32	7.6
11–15.9	139	21.2	20–29.9	104	22.8	11–15.9	93	22.0
16–20.9	31	4.7	30–39.9	15	3.3	16–20.9	15	3.6
21–25.9	74	11.3	40–49.9	25	5.5	21–25.9	17	4.0
26–30.9	34	5.2	50–59.9	10	2.2	26–30.9	4	0.9
31–35.9	1	0.2	60–69.9	1	0.2	31–35.9	2	0.5
36–40.9	3	0.5	70–79.9	0	0.0	36–40.9	4	0.9
41–45.9	8	1.2	80–89.9	3	0.6	41 or more	3	0.7
46 or more	33	5.0	90 or more	0	.0			
Total municipalities reporting	655	100		456	100		423	100
Mean=12.5 per year.			Mean=16.4 per year.			Mean=6.8 per year.		

For those municipalities in which local authorities do examine milk samples the mean frequency of sampling is 15.8 times per year for raw milk distributors, 19.7 times per year for pasteurization plants, and 13.2 times per year for plant shippers.

(13) What laboratory examines local milk samples?

Table 16 lists the frequency with which local authorities use the various kinds of laboratory facilities indicated for the examination of milk supplies.

Table 16

KIND OF LABORATORY IN WHICH LOCAL SAMPLES EXAMINED

Kind of laboratory	Municipalities using No.	Municipalities using Per Cent
City health dept. laboratory	92	12.7
County or district health dept. laboratory	208	28.8
State laboratory	147	20.4
Private laboratory	45	6.2
Water dept. laboratory	17	2.4
Miscellaneous	88	12.1
No samples collected	126	17.4
Total	723	100

It will be noted that the kind of laboratory most frequently used in municipalities of from 1,000 to 10,000 population is the county or district health department laboratory, with the state and city health department laboratories running second and third respectively. It is also of interest to note that 17.4 per cent of the cities having local milk control reported that they collected no milk samples.

(14) What is the per capita expenditure for local milk control?

Table 17 gives the per capita expenditure for local milk control in cents per capita per year, for municipalities having local milk control.

It will be noted that 76.3 per cent of the municipalities having local milk control spent less than ten cents per capita per year for milk control, and that the mean per capita expenditure for all such municipalities was 7.9 cents per year. This figure should be compared with the per capita expenditure for milk control in small-sized municipalities which are rigidly enforcing the Public

Table 17

PER CAPITA EXPENDITURE

Cents per capita per year	Municipalities No.	Municipalities Per Cent
0	0	0
Over 0 – 2	113	18.5
2.1– 4	113	18.5
4.1– 6	90	14.8
6.1– 8	90	14.8
8.1–10	59	9.7
10.1–12	34	5.6
12.1–14	23	3.8
14.1–16	12	1.9
16.1–18	13	2.1
Over 18	63	10.3
Total	610	100

Mean 7.9 cents per capita per year.

Health Service Milk Ordinance, namely 9.5 cents per year (see Reprint 1723 from the Public Health Reports of December 13, 1935). The difference is probably accounted for by the fact that no distinction was drawn between good and poor enforcement in the case of the 610 municipalities here reported, whereas in the previous study only those Standard Ordinance municipalities were included which had been enforcing the ordinance sufficiently rigidly to deserve ratings of 90 per cent or higher.

(15) Whence are local milk control funds derived?

This information is given in Table 18 below:

Table 18

SOURCE OF LOCAL MILK CONTROL FUNDS

Source of funds	Average per cent for 658 municipalities reporting
Per cent derived from:	
City tax	41.6
County or district tax	30.8
Fees	10.9*
Other sources	16.7
	100.0 per cent

* This figure represents an understatement as it has been found that a number of cities which reported that 100 per cent of their funds were derived from city tax were nevertheless receiving some part from inspection or license fees which had gone into the general city treasury.

The above figures are *averages*. For example the first figure means that of all revenues for all municipalities combined 41.6 per cent arise from city taxes. It does not mean that 41.6 per cent of the municipalities derive *all* of their revenues from city tax.

The questionnaire returns indicated that 226 or 34.3 per cent of the 658 municipalities which reported on this question received all of their milk control revenue from city tax, that 147 or 22.3 per cent of the municipalities received all of their revenue from county or district tax, that thirty-six or 5.4 per cent of the municipalities received all of their revenue from fees, and that eighty-two or 12.4 per cent of the municipalities received all of their revenue from other sources. This means that 25.9 per cent of the municipalities received their revenue from mixed sources.

GENERAL DATA ON MUNICIPAL MILK SUPPLIES

The remaining questions considered in this report relate to general data on municipal milk supplies.

(16) How many raw milk distributors, pasteurization plants, and plant shippers are there per 1,000 population?

Table 19 gives the answer to this question:

It will be noted that the average number of raw milk distributors per 1,000 population is 2.4, the average number of pasteurization plants 0.27, and the average number of plant shippers 3.0. It will further be noted that 8 per cent of the cities had no raw milk distributors and 51.5 per cent of the cities had no pasteurization plants. If this figure seems inconsistent with the fact that 62.6 per cent of the cities reported having no plant shippers, it should be noted that only 1,365 municipalities gave information on plant shippers whereas 1,660 gave information on pasteurization plants. Evidently among the approximately 300 municipalities which failed to report on plant shippers the percentage which had no pasteurized milk was sufficiently lower than 62.6 per cent to bring the average down to 51.5 per cent.

It should be further noted that the fact that 51.5 per cent of the cities reported that they had no pasteurization plants does not necessarily mean that 51.5 per cent of the cities have no pasteurized milk. Many of the smaller municipalities lie adjacent to large municipalities and

Table 19

NUMBER OF DAIRY FARMS AND PLANTS

Frequency distribution of municipalities from 1,000 to 10,000 population according to number of raw milk distributors, pasteurization plants, and plant shippers, per 1,000 population

Raw milk distributors			Pasteurization plants			Plant shippers		
No. per 1,000 pop.	No. of municipalities	Per cent	No. per 1,000 pop.	No. of municipalities	Per cent	No. per 1,000 pop.	No. of municipalities	Per cent
0	126	8.0	0	854	51.5	0	855	62.6
Over 0– .9	294	18.6	Over 0–.09	4	0.2	Over 0– 9.9	447	32.8
1–1.9	432	27.3	.1–.19	90	5.4	10–19.9	21	1.5
2–2.9	302	19.1	.2–.29	156	9.4	20–29.9	18	1.3
3–3.9	168	10.6	.3–.39	120	7.2	30–39.9	12	0.9
4–4.9	86	5.4	.4–.49	93	5.6	40–49.9	6	0.4
5–5.9	58	3.7	.5–.59	83	5.0	50–59.9	4	0.3
6–6.9	53	3.3	.6–.69	63	3.8	60–69.9	1	0.1
7–7.9	21	1.3	.7–.79	44	2.7	70–79.9	1	0.1
8–8.9	8	0.5	.8–.89	44	2.7	80–89.9	0	0
9–9.9	15	0.9	.9–.99	32	1.9	90–99.9	0	0
10 and over	20	1.3	1.0 and over	77	4.6	100 and over	0	0
Mean=2.4 Max.=18.0	1,583	100.0	Mean=.27 Max.=3.59	1,660	100.0	Mean=3.0 Max.=79	1,365	100.0

receive some pasteurzed milk from them even though no pasteurization plants are located within the smaller municipalities. Thus, it will be noted from a later table that only 43.4 per cent of municipalities in this population group reported that they had no pasteurized milk. Evidently about 7 per cent of municipalities under 10,000 population have no pasteurization plants but receive pasteurized milk from adjacent municipalities.

(17) What is the per capita consumption of market milk, cream and buttermilk?

Table 20 gives the answer to this question for municipalities of from 1,000 to 10,000 population.

Table 20

PER CAPITA CONSUMPTION

Frequency distribution of municipalities from 1,000 to 10,000 population, according to the consumption of fluid market milk, cream, and buttermilk, in pints per capita per day.

Fluid market milk			Cream			Buttermilk		
Pints per capita	No. of municipalities	Per cent	Pints per capita	No. of municipalities	Per cent	Pints per capita	No. of municipalities	Per cent
0 –.09	18	1.6	0 –.009	114	11.8	0 –.009	263	29.7
.1–.19	64	5.6	.01–.019	260	26.8	.01–.019	143	16.1
.2–.29	133	11.7	.02–.029	213	21.9	.02–.029	114	12.9
.3–.39	129	11.4	.03–.039	153	15.8	.03–.039	106	12.0
.4–.49	168	14.8	.04–.049	83	8.5	.04–.049	51	5.8
.5–.59	173	15.3	.05–.059	39	4.0	.05–.059	40	4.5
.6–.69	125	11.0	.06–.069	25	2.6	.06–.069	36	4.1
.7–.79	103	9.1	.07–.079	19	2.0	.07–.079	29	3.3
.8–.89	89	7.8	.08–.089	14	1.4	.08–.089	18	2.0
.9–.99	51	4.5	.09–.099	10	1.0	.09–.099	11	1.2
1.0 and over	81	7.2	.10 and over	41	4.2	.10 and over	74	8.4
Mean=.58 Max.=4.25	1134	100.0	Mean=.033 Max.=1.0	971	100.0	Mean=.041 Max.=1.0	885	100.0

Total (milk, cream, and buttermilk)=0.65 pint.

It will be noted that the average per capita consumption in municipalities of this population group is 0.65 pints per day; 0.58 pints of this amount is fluid milk; .033 fluid cream; .041 fluid buttermilk. It should be noted that 7.2 per cent of the municipalities in this population group consume over one pint per capita per day of fluid market milk.

(18) To what extent is certified milk sold and at what price?

Table 21 gives the answer to this question:

It will be noted that the average percentage of milk sold as certified in cities of 1,000 to 10,000 population is 0.1 per cent and that the average price charged is 17.8

Table 21

AMOUNT AND PRICE OF CERTIFIED MILK

Frequency distribution of municipalities from 1,000 to 10,000 population, according to percentage of the total milk supply that is certified (raw) and according to the price (cents per quart) delivered to homes.

Per cent of total supply	No. of municipalities	Per cent of municipalities	Cents per quart	No. of municipalities	Per cent of municipalities
0	1,524	93.3	15–16	47	46.1
Over 0–1	61	3.7	17–18	17	16.7
1.1–2	29	1.8	19–20	30	29.4
2.1–3	9	0.5	21–22	3	2.9
3.1–4	1	0.1	23–24	0	0
4.1–5	3	0.2	25–26	3	2.9
5.1–6	0	0	27–28	0	0
6.1–7	0	0	29–30	2	2.0
7.1–8	0	0	Mean=17.8	102	100.0
Over 8	7	0.4	Max.=30		
Mean=0.1 Max.=13	1,634	100.0			

Certified Vitamin D raw is sold by 1 city.

Certified pasteurized is sold in 22 cities, in which it constitutes 0.75 per cent (mean) of the total supply. The mean price is 22 cents per quart.

cents per quart. It will be further noted that certified pasteurized milk is now sold in 22 municipalities of from 1,000 to 10,000, and constitutes 0.75 per cent of the total supply of these cities. The average price of certified pasteurized milk is reported at twenty-two cents per quart.

It is further interesting to note that whereas a few years ago certified raw milk was almost universally sold at 25 cents per quart, 47 municipalities, or 46.1 per cent of the 102 which reported they had certified milk, indicated that the price was between fifteen and sixteen cents per quart.

(19) To what extent and at what price are such high grades of pasteurized milk as Grade A Pasteurized, Select Pasteurized, Inspected Pasteurized, Guaranteed Pasteurized, Special Pasteurized, and similar grades sold?

The answer to this question is given in Table 22:

Table 22

AMOUNT AND PRICE OF HIGH GRADE PASTEURIZED MILK

Frequency distribution of municipalities from 1,000 to 10,000 population, according to percentage of the total milk supply that is sold as Grade A Pasteurized, Select Pasteurized, Inspected Pasteurized, Guaranteed Pasteurized, Special Pasteurized, and similar grades, and according to the price in cents per quart delivered to homes.

Per cent of total supply	No. of municipalities	Per cent of municipalities	Cents per quart	No. of municipalities	Per cent of municipalities
			Under 6	0	0.0
0	1,129	71.4	6–7	2	0.4
Over 0–9	59	3.7	8–9	31	6.8
10–19	53	3.4	10–11	221	48.5
20–29	67	4.2	12–13	84	18.4
30–39	34	2.2	14–15	50	11.0
40–49	40	2.5	16–17	57	12.5
50–59	52	3.3	18–19	11	2.4
60–69	40	2.5	Over 19	0	0.0
70–79	38	2.4			
80–89	15	1.0			
90–100	54	3.4			
Mean=12.9	1.581	100.0	Mean=12.1	456	100.0

It will be noted that for the 1,581 municipalities reporting the mean percentage of the total supply which was classed as one of the above high grades of pasteurized milk was 12.9 per cent, and that the mean price was 12.1 cents per quart. Twelve municipalities reported the sale of Vitamin D pasteurized milk.

(20) To what extent and at what price are such lower grades of pasteurized milk as Market, Family, Grade B, Grade C, and ungraded pasteurized milk sold?

It will be noted that the percentage of the total supply of municipalities of 1,000 to 10,000 population represented by such lower grades of pasteurized milk is 19.8 per cent, and that such milk is sold at an average of 10.3 cents per quart.

Table 23

AMOUNT AND PRICE OF LOWER GRADES OF PASTEURIZED MILK

Frequency distribution of municipalities of 1,000 to 10,000 population according to the percentage of the total milk supply which is sold as such lower grades of pasteurized milk as Market, Family, Grade B, Grade C, and ungraded pasteurized milk, and according to price.

Per cent sold	No. of municipalities	Per cent of municipalities	Price in cents per quart	No. of municipalities	Per cent of municipalities
			under 6	2	0.4
0	1,038	65.6	6	0	0
Over 0– 9	20	1.3	7	8	1.5
10–19	41	2.6	8	64	12.2
20–29	55	3.5	9	74	14.1
30–39	46	2.9	10	208	39.5
40–49	37	2.3	11	37	7.0
50–59	98	6.2	12	56	10.6
60–69	32	2.0	13	59	11.2
70–79	83	5.2	14	3	0.6
80–89	40	2.5	15	11	2.1
90–100	93	5.9	Above 15	4	0.8
Total	1,583	100		526	100

Mean=19.8 per cent of supply. Mean=10.3 cents per quart.

(21) To what extent and at what price are such high grades of raw milk as Grade A, Select, Baby, Inspected, Guaranteed, Special, and similar grades of raw milk sold?

Table 24 gives the answer to this question.

It will be noted that an average of 17.9 per cent of the milk supply of municipalities of 1,000 to 10,000 population is designated as one of the listed high grades of raw milk and the mean price at which such milk is sold is 11.8 cents per quart.

(22) To what extent and at what price are such lower grades of raw milk as Market, Family, Grade B, Grade C, and ungraded raw milk sold?

Table 24

AMOUNT AND PRICE OF HIGH GRADES OF RAW MILK EXCEPT CERTIFIED

Frequency distribution of municipalities of 1,000 to 10,000 population according to the percentage of the total milk supply which is sold as such high grades of raw milk as Grade A, Select, Baby, Inspected, Guaranteed, Special, and similar grades of raw milk, and according to the price.

Per cent sold	No. of municipalities	Per cent of municipalities	Price in cents per quart	No. of municipalities	Per cent of municipalities
0	1,107	69.7	6–7	2	0.4
Over 0–9	52	3.3	8–9	46	9.6
10–19	31	1.9	10–11	221	46.3
20–29	39	2.5	12–13	127	26.6
30–39	39	2.5	14–15	42	8.8
40–49	33	2.1	16–17	14	2.9
50–59	40	2.5	18–19	23	4.8
60–69	27	1.7	20–21	1	0.2
70–79	38	2.4	22–23	0	0
80–89	29	1.8	24–25	2	0.4
90–100	153	9.6			
Total	1,588	100		478	100

Mean=17.9 per cent of supply Mean price=11.8 cents per quart.

Table 25 gives the answer to this question.

It will be noted that the average percentage of the total milk supply of municipalities of 1,000 to 10,000 represented by such grades of milk is 48.7 per cent, and that such milk sells at an average price of 9.6 cents per quart.

(23) What percentage of milk is pasteurized in cities of 1,000 to 10,000 population?

The answer to this question is given in Table 26.

It will be noted that the average percentage of milk pasteurized in municipalities of 1,000 to 10,000 popula-

Table 25

Amount and Price of Lower Grades of Raw Milk

Frequency distribution of municipalities of 1,000 to 10,000 population according to the percentage of the total milk supply which is sold as such lower grades of raw milk as Market, Family, Grade B, Grade C, Grade D, Ungraded, and similar grades of raw milk.

Per cent sold	No. of municipalities	Per cent of municipalities	Price in cents per quart	No. of municipalities	Per cent of municipalities
0	463	29.2	5	5	0.6
Over 0–9	63	4.0	6	12	1.3
10–19	64	4.1	7	54	5.9
20–29	94	5.9	8	176	19.3
30–39	48	3.0	9	152	16.7
40–49	52	3.3	10	358	39.3
50–59	81	5.1	11	46	5.0
60–69	62	3.9	12	46	5.0
70–79	56	3.5	13	28	3.1
80–89	51	3.2	14	3	0.3
90–100	551	34.8	Over 14	32	3.5
Total	1,585	100		912	100
Mean=48.7 per cent sold			Mean=9.6 cents per quart		

Table 26

Percentage of Milk Which Is Pasteurized

Frequency distribution of municipalities of 1,000 to 10,000 population according to the percentage of the total supply which is pasteurized.

Per cent pasteurized	No. of municipalities	Per cent of municipalities
0	689	43.4
Over 0–9	41	2.6
10–19	74	4.6
20–29	89	5.6
30–39	72	4.5
40–49	62	3.9
50–59	130	8.2
60–69	78	4.9
70–79	102	6.4
80–89	55	3.5
90–99	117	7.4
100	79	5.0
Total	1,588	100
Mean=38.6 per cent pasteurized		

tion is 38.6 per cent; 43.4 per cent of the municipalities reported having no pasteurized milk.

The information submitted in the questionnaire was also subdivided according to three population groups under 10,000 in order to determine how the percentage of milk pasteurized varied with the size of the city. It was found that in municipalities of 5,000 to 10,000 the mean percentage of milk pasteurized was 50.0, that for cities of

Table 27

PERCENTAGE OF PASTEURIZED MILK WHICH COMES FROM TUBERCULIN TESTED HERDS

Frequency distribution of municipalities of 1,000 to 10,000 population according to the percentage of the pasteurized milk which comes from tuberculin-tested herds.

Per cent from tuberculin tested herds	No. of municipalities	Percentage of municipalities
0	1	0.1
Over 0–9	2	0.2
10–19	1	0.1
20–29	1	0.1
30–39	0	0.0
40–49	0	0.0
50–59	1	0.1
60–69	0	0.0
70–79	0	0.0
80–89	10	1.0
90–99	23	2.4
100	929	96.0
Total	968	100.0

Mean=97.1 per cent of pasteurized milk is from tuberculin tested herds.

2,500 to 5,000 population the mean percentage of milk pasteurized was 40.0, and that for cities of 1,000 to 2,500 population the mean percentage of milk pasteurized was 23.4 per cent.

(24) What percentage of pasteurized milk comes from tuberculin tested herds?

The answer to this question is given in Table 27.

It will be noted that 97.1 per cent of pasteurized milk is reported as coming from tuberculin-tested herds as the average for the group of 968 municipalities which reported on this item; 929, or 96 per cent of the municipalities, reported that all pasteurized milk is from tuberculin-tested herds.

(25) What percentage of raw milk comes from tuberculin tested herds?

The replies to the questionnaire on this point include 1690 cities and indicated that 99.9 per cent of raw milk sold in municipalities in this population group is from tuberculin tested herds; 99.4 per cent of these cities indicated that 100 per cent of the raw milk is from tuberculin tested herds and there were a few scattered returns which indicated over 99 per cent, but not quite 100 per cent tuberculin testing.

(26) What percentage of the total milk supply is protected by tuberculin testing?

As 38.6 per cent of the milk supply in municipalities of 1,000 to 10,000 population is pasteurized, of which 97.1 per cent is from tuberculin-tested herds, and as 61.4 per cent of the supply is raw, of which 99.9 per cent is from tuberculin-tested herds, the percentage of the total milk supply, both raw and pasteurized, protected by tuberculin testing may be computed to be 98.8 per cent.

Completeness of Returns

A study was made of the completeness of returns and Table 28 gives the number and percentage of questionnaires returned by municipalities of from 1,000 to 10,000 population, by population groups.

It will be noted that the total number of municipalities in this group is 5,505 and that 1,907, or 34.6 per cent of them returned the questionnaires. It seems reasonable to believe that the vast majority of the communities which failed to return the questionnaire are doing little or no milk control work.

It will be noted further that while there is some increase in the percentage of returns as the size of municipality increases, nevertheless the returns even from the smallest municipalities were as high as 32.1 per cent as

Table 28

NUMBER AND PER CENT OF QUESTIONNAIRES RETURNED BY MUNICIPALITIES FROM 1,000 TO 10,000 POPULATION, BY POPULATION GROUPS *

Population group	No. of questionnaires returned	Total number of municipalities 1,000 to 10,000 population in 1930	Per cent returned
1,000–2,499	1,041	3,248	32.1
2,500–4,999	497	1,394	35.7
5,000–9,999	369	863	42.8
Total	1,907	5,505	34.6

* To the municipalities included in the U. S. Census Report there have been added 235 townships in New England which were considered to be in the same category as municipalities of 1,000 to 10,000.

compared with 42.8 per cent for the largest municipalities. It is believed that this has given the Committee a very good cross section of the entire group of cities between 1,000 and 10,000 population.

Table 29 gives the completeness of returns by states and geographic divisions.

It is believed that it may fairly be concluded from the evidence given by the above table that the distribution of returns has been sufficiently general geographically to make them dependable from that standpoint.

SUMMARY

A survey of the present status of milk control of American municipalities of 1,000 to 10,000 population for the year 1935 gave the following information:

Table 29

NUMBER AND PER CENT OF QUESTIONNAIRES RETURNED BY MUNICIPALITIES FROM 1,000 TO 10,000 POPULATION, BY STATES AND GEOGRAPHIC DIVISIONS

Geographic division and state	No. of questionnaires returned	Total no. municipalities 1,000 to 10,000 pop. in 1930	Per cent returned
New England:			
Maine	1	25	4.0
Vermont	30	31	96.7
Massachusetts	40	198	20.2
Rhode Island	4	23	17.4
Connecticut	3	16	18.8
Middle Atlantic:			
New York	57	272	21.0
New Jersey	81	188	43.1
East North Central:			
Ohio	152	275	55.3
Indiana	90	158	57.0
Illinois	179	345	51.9
Michigan	97	185	52.4
Wisconsin	86	143	60.1
West North Central:			
Minnesota	67	152	44.1
Iowa	101	183	55.2
Missouri	97	172	56.4
North Dakota	2	37	5.4
South Dakota	2	51	3.9
Nebraska	47	100	47.0
Kansas	74	127	58.3
South Atlantic:			
Delaware	14	15	93.3
Maryland	4	41	9.8
West Virginia	18	91	19.8
North Carolina	59	138	42.8
South Carolina	40	85	47.1
Georgia	59	140	42.1
Florida	26	96	27.1
East South Central:			
Kentucky	63	114	55.3
Tennessee	17	89	19.1
Alabama	39	103	37.9
Mississippi	14	81	17.3
West South Central:			
Arkansas	7	98	7.1
Louisiana	6	93	6.5
Oklahoma	5	151	3.3
Texas	42	313	13.4

Table 29—*Concluded*

NUMBER AND PER CENT OF QUESTIONNAIRES RETURNED BY MUNICIPALITIES FROM 1,000 TF 10,000 POPULATION, BY STATES AND GEOGRAPHIC DIVISIONS

Geographic division and state	No. of questionnaires returned	Total no. municipalities 1,000 to 10,000 pop. in 1930	Per cent returned
Mountain:			
Montana	19	36	52.8
Idaho	25	41	61.0
Wyoming	6	23	26.1
Colorado	36	61	59.0
New Mexico	7	24	29.2
Arizona	8	21	38.1
Utah	23	52	44.2
Nevada	6	9	66.7
Pacific:			
Washington	40	65	61.5
Oregon	40	51	78.4
California	97	183	53.0
No reports from 3 states	0	615	0
Total	1,930 *	5,510 †	35.0

* Of these 23 came in too late in statistical computations.
† This figure represents a total of 5 more than the total number of cities in Table 28 because 5 municipalities are included in each of two states.

(1) Local milk control is carried out by only approximately one of every five municipalities in this population group.

(2) The present staff of the state milk control authorities is entirely inadequate to cope with the problem. It would be necessary to employ approximately four to five times as many state milk inspectors as are now employed in order to make possible effective state supervision of the milk supplies of the 5500 municipalities in this group.

(3) The state department most frequently reported as doing state milk sanitation work is the State Department of Health, with the State Department of Agriculture second. The divisions of these state departments by which the milk work is most frequently done is the sanitary engineering division in the State Department of Health and the food and drug division in the State Department of Agriculture.

(4) About half of the states make tuberculin testing mandatory by state law. Very few states as yet make abortion testing mandatory for all milk though eight states report making such testing mandatory for Grade A raw milk.

(5) The total number of whole time and part time inspectors employed on milk control by the state milk control authorities of the 40 states which reported on this item is 282. Of these 37 are veterinarians, 15 agricultural graduates, and 7 sanitary engineers; 157 have no degrees. They are equivalent in number to about 180 whole time inspectors.

(6) Only 852 of the 5500 municipalities in this population group were reported as having local milk ordinances. Of these 206 had adopted the Public Health Service Milk Ordinance.

(7) Nearly 90 per cent of the local ordinances require tuberculin testing for all milk consumed raw, and over 80 per cent require tuberculin testing for both raw and pasteurized milk.

(8) In 90 per cent of the local communities milk control is a municipal or county function, about equally divided. In 10 per cent it is a district function. In 95 per cent of the communities local milk control is under the health department.

(9) Less than 1 per cent of the municipalities in this population group employ an inspector full time in milk. In nearly all cases the inspector devotes only part of his time to milk (the average being 17 per cent), devoting the balance of his time to general sanitary inspection, general duties of health officer, private veterinary practice, meat inspection, food inspection, and laboratory work, in that order of frequency.

(10) Nearly half of the local milk inspectors have no professional college degrees. Veterinarians are the milk

inspectors in 22.8 per cent of the cities having local milk control, and sanitary engineers in only 2.4 per cent. In a surprising percentage of cases, 14.2 per cent, the local health officer does his own milk inspection work.

(11) Over one-third of the municipalities report that the appointment of inspectors is on a political basis, only one-sixth by civil service.

(12) For those municipalities in this population group which have local milk control the mean frequency of inspection is twelve times per year for raw milk distributors, eighteen times per year for pasteurization plants, and 7.4 times per year for plant shippers. The mean frequency of sampling in those municipalities which take samples, is 15.8 samples per year for raw milk distributors, 19.7 samples per year for pasteurization plants, and 13.2 samples per year for plant shippers. Local samples are most frequently examined in a county or district health department laboratory, next most frequently in a state laboratory, and in only about 12.7 per cent of the cases in a city health department laboratory.

(13) In municipalities having local milk control the mean expenditure for this work is 7.9 cents per capita per year.

(14) Local milk control funds are derived for the most part from the general tax funds. Eleven per cent or more of local funds is derived from inspection and license fees.

(15) For each 1,000 population the communities in this group have an average of between two and three retail raw milk distributors and three plant shippers. There is one pasteurization plant for every 3,700 people.

(16) The per capita consumption of market milk in communities of this size averages 0.65 pint per person per day, of which 0.58 pint is fluid milk, .033 fluid cream, and .041 fluid buttermilk.

(17) In communities of this size 0.1 per cent of the milk is certified, 13 per cent high grade pasteurized, 20

per cent lower grade pasteurized, 18 per cent high grade raw, and 49 per cent lower grade raw. These classes of milk are delivered on the average for 17.8 cents, 12.1 cents, 10.3 cents, 11.8 cents, and 9.6 cents per quart, respectively.

(18) An average of only 38.6 per cent of the milk sold in cities of this population group is pasteurized. In seventy-nine municipalities, or 5 per cent of those which reported, all milk is pasteurized.

(19) Ninety-seven per cent of the pasteurized milk is from tuberculin tested herds, 45.7 per cent from abortion tested herds.

(20) Ninety-nine and nine-tenths per cent of the raw milk sold in communities of this group is from tuberculin tested herds and 52.5 per cent from abortion tested herds.

Acknowledgments

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The Committee wishes also to acknowledge the valuable assistance given by the various state and city milk control authorities. Many of them devoted much time to the work of collecting and verifying the questionnaires.

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MILK CONTROL IN SMALL COMMUNITIES ON A MANDATORY VERSUS A VOLUNTARY BASIS

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THE subject I have chosen for discussion is of a somewhat philosophical nature. The views expressed have been acquired as a result of more than a decade of experience and observation in the enforcement of milk quality control legislation in small communities. These views are purely personal, and do not represent official departmental policies nor do they indicate, because of the speaker's official or professional connection, any known tendency in milk quality control policy. The subject was chosen, however, because of its practical interest.

For a number of years this Association has had a standing committee on Methods for Improving Milk Quality Control in Small Communities.

The speaker has been a member of this Committee for a number of years, having served as its chairman in 1933 and 1934. Since 1934 the Committee has been endeavoring to learn how many—or what proportion of the small communities of the country are at present making any effort whatever to improve or control the quality of their milk supplies. There having been no report in 1935, and the 1936 report not being available, the findings of the 1934 Committee, which, as far as they went, were rather revealing, appear to constitute the most recent reference data.

Those of you who have good memories may recall that 34 per cent of the communities from which replies were received were conducting no milk control activities. A number of communities had adopted a milk control ordinance but admittedly were not enforcing it. Still another group were enforcing their ordinances only nominally. The percentages represented in these categories, because of the relatively small sample obtained, may be inapplicable to the country wide situation—I trust the more complete survey of the 1936 Committee yields more favorable and hopeful data—but the actual percentages are really immaterial. We all know that milk quality control is not as prevalent an activity in small communities as we deem desirable.

What are the reasons for, or causes of, this situation?

Is ignorance of the danger of unregulated milk supplies a factor? Yes, to a large extent, although the better read citizens in most communities know of the disease-spreading possibilities of milk. But that applies to the milk supplies of other communities, not theirs!

Is mass indifference to the potentialities of unsafe milk supplies a cause? No. Indifference to a danger implies a full knowledge of it. This the mass of the citizens of small communities do not have, in advance of a local or nearby outbreak of milkborne disease. The rôle of milk as a vector of disease is a subject of purely academic, if any, interest to the mass of the adult population. It is rarely a subject of local newspaper comment or discussion, except during a period of propaganda.

Is civic inertia a cause? We who are professionally interested in milk quality control might term it that, or civic unprogressiveness. But even though it be agreed by less biased judges that the charge of civic unprogressiveness is just, who is culpable? The municipal authorities? The citizens? The health authorities?

Is the cost of milk quality control a handicap to the more general inauguration of control activities? Yes, to some extent. But wherever there is a will there is a way, and example after example of the surmounting of financial obstacles to municipal milk quality control can be cited for the guidance of those communities which evince an interest.

What, then, is the basic reason for the lack of interest—official and private—in milk quality control in small communities? In my opinion it is all too frequently the same factor which interferes with effective milk quality control in many small communities which have taken the necessary legal steps to provide it—the self-interest of individual citizens and officials.

I am not a widely traveled citizen. My experience and observation have been limited to a rather circumscribed area. Reasoning from so small an example may be leading me to erroneous conclusions. But, if human nature is as homogenous throughout this whole nation as I suspect it to be, my diagnosis of the pith of our problem may hold for yours.

Have you ever been responsible for the grading of milk supplies, or have you had to institute legal action against a violator of some provision of the milk ordinance, in a community in which the mayor, or several councilmen, or the probate judge, or a member of the board of county commissioners owned a family cow and sold milk to neighbors? Have you ever undertaken to grade milk supplies, or to enforce any restrictions upon the producer-distributors of market milk supplies, in communities in which the total market milk sales did not constitute over 25 per cent of the total milk consumption? Unless you have, I fear you have not a true concept of the milk quality control problem in small communities—communities with populations as high as 5,000 to 10,000.

I do not mean to imply that the mayor is invariably the owner of a family cow; but it is a rare community in this population range—under 10,000—at least in the south and southwest, in which some one or more of the municipal or county governmental officialdom, or citizens for other reasons widely influential, do not own family cows, *and sell milk to their neighbors.* It is obvious that Mayor Smith will be reluctant to convict and fine Councilman Jones or Judge Brown for violating the milk ordinance. As a matter of fact, it would be an intrepid inspector who would hazard his immediate position, and the appropriation for the health department of which he is a member, by hailing Councilman Jones or Judge Brown into court, unless he is bent on bringing some particular issue to a head. So Mrs. Smith and Mrs. Jones and Mrs. Brown, and numerous other home managers, continue to earn a little pin money through the sale of surplus milk from the family cow at the expense of the milk producer-distributors, who alone are subjected to the provisions of the milk odinance.

Every member of this Association who is in the least acquainted with rural and semiurban areas, can call to mind communities in which there are only one, two, or three commercial milk supplies; the remainder of the milk consumed being produced by family and neighborhood cows. There must be, in this country, literally hundreds of towns in which the commercial milk supplies constitute less than 25 per cent of the total milk consumption, and which are too isolated to justify the distribution of milk from larger centers of population. What is the remedy for this condition? We can not ignore the problem in such communities, it is not logical to control a small percentage of the total supply and ignore the remainder —even the expediency of this policy begins to appear doubtful, and we apparently can not enforce control over the family and neighborhood cows, under the favorable conditions for their ownership which exist in small communities.

I am not setting up straw men to impress you with my prowess in tumbling them down. In Alabama we have had to discontinue milk control activities of a mandatory nature in a half dozen communities because they were becoming preposterous and ridiculous. It is preposterous to require the one milk distributor of a small town to label his milk Grade B or Grade C, because the average temperature was high or the vessels were found unclean, when during the same period a fourth of the housewives of the community were selling uncooled milk to their neighbors, and no one knows how clean or soiled the utensils were. Such Grade B milk probably is safer than a majority of the neighborhood milk sold. In one community served by two commercial dairies, efforts of the sanitation officer-dairy inspector to enforce the milk ordinance upon neighborhood milk producers resulted in an effort by the council to legalize the sale of milk by one- and two-cow dairies, without supervision or grading. When the fallacy of this proposal was impressed on them, they called a referendum, and the popular vote for repeal of the milk ordinance was seven to one!

We have undertaken to solve this problem in one county in a manner which may be regarded as unorthodox, and which, it may be claimed, has still to prove its efficacy. But we are satisfied that we are proceeding in the right direction.

The Alabama milk regulations, inoperative in any community until adopted by the County Board of Health, include a provision that:

> It shall be unlawful to use on bottles or other containers of milk or milk products sold in .... County, any caps or other device bearing any legend indicating that the contents have been graded in accordance with the provisions of these regulations, unless the contents have been graded and the producer or distributor holds an unrevoked permit from the health officer, as prescribed in Section 3 of these Regulations.

With this curb on the unauthorized use of Grade A bottle caps, we have undertaken to interest the milk distributors of three small communities in this county in the production of Grade A milk, with the understanding that their competitors will not be required to comply with the Grade A specifications, and that no effort will be made compulsory to curb the sale of ungraded milk; but, that no one will be permitted to use Grade A bottle caps except those entitled to do so, and that placards will be posted in all soda founts, cafes, and stores advertising the use or sale of Grade A milk, when milk of that grade only is purchased. And, that when the quality of any supply falls below Grade A, no penalty is involved except the immediate discontinuance of the use of Grade A caps, and the removal of the placards from the establishments to which that particular supply of milk is being sold.

There is an adage to the effect that "the proof of the pudding is in the eating thereof." Our "pudding" is in the course of preparation and gives promise of being quite tasty; but, because of unavoidable interruption of our program in this county during the recent summer, occasioned by transfer of health department personnel, the pudding is not quite ready for "eating," in the way of comparative figures. However, if I could take you into two comparable areas, which we shall term Counties A and B, in one of which, (A), this voluntary program is being tried out, and in the other, (B), in which compliance with the milk ordinance is supposed to be mandatory, I believe the difference, in favor of the former, would be apparent.

For instance, from the standpoint of enforcement, even though control activities were at a low ebb in County A during the summer months, out of four dairy farms the milk output of which has been graded since November, 1935, two supplies were degraded in the spring, and soon thereafter regraded to Grade A, and one supply was degraded in March and has not since been regraded. During these periods of degrading Grade A bottle caps were not used.

In County B, with four commercial milk supplies in three towns, one of the supplies was graded D last December, and B in February, but continued to appear on the streets under Grade A caps, because the dairy operator is a county commissioner, and controls to some extent the purse strings of the appropriation to the County Health Department.

With respect to actual conditions under which milk is produced in County A, conditions were in full compliance with the specifications for Grade A Raw milk at the time of 60 per cent of the inspections; in County B this was true of only 35.1 per cent of the inspections.

Furthermore, identical violations of the Grade A Raw Milk specifications were repeatedly found on consecutive inspections, sometimes as many as four times.

The numbers of samples for bacteriological examination were rather small to serve as bases for conclusions, but, such as they are, they are submitted:

	Total samples	50,000 cc. or less Per cent	51,000 to 200,000 cc. Per cent	210,000 to 1,000,000 cc. Per cent	Bacterial Plate Count Rating
County A	..33	93.9		6.1	94.7
County B	..55	85.5	7.3	7.2	88.9

It may be claimed that (1) the health officer of County B has been delinquent in the enforcement of the milk regulations, and (2) the policy of encouraging purely voluntary production of Grade A raw milk does not protect the whole population, and is, therefore, only a partial approach to the prevention of milkborne disease.

It is readily granted that the milk regulations have not been enforced in County B. The whole point of this discussion is that the obstacles to rigid enforcement are disproportionate to the public health value of such control of milkborne disease, in semi-urban populations, as it is possible to attain by raw milk sanitation, with the personnel usually available. It would be manifestly unwise to jeopardize the whole public health program in a county for the sake of absolute literal enforcement of regulations on less than 25 per cent of the total milk consumption.

It is also readily granted that the policy of encouragement of voluntary production of Grade A Raw milk does not protect the entire population. But it has several distinct advantages over the policy of mandatory compliance with milk regulations. These, in my opinion, are

(1) Competition forces more and more producer-distributors to produce Grade A Raw milk. It has been our experience that within a few months after the first Grade A milk is on the market, producers who were cold to the proposal are asking for instructions as to the construction of dairy buildings to comply with the Grade A specifications.

(2) Appeal to the courts, and pressure upon the municipal authorities are not necessary. The most indifferent public will support a health officer in the withdrawal of a privilege, whereas it might question the need for enforcing the use of lower grade caps.

(3) The health officer is in a far more tenable position. He is no longer obviously inconsistent with respect to the control of commercial and neighborhood milk. He can advise the use of Grade A milk without implying that producers of neighborhood milk are law violators and public enemies.

In conclusion, permit me to state that I realize full well that this voluntary policy is far from a perfect milk control program. In the first place, its success is equally subject to the vagaries of local health department personnel as is the mandatory policy. Secondly, the milk control activities of a community in which such a policy is in effect would hardly be entitled to a public health service milk sanitation rating.

Nevertheless, I feel that it is always preferable to face the facts, and cut the cloth to fit the pattern. Were I a county health officer faced with such a problem, I would far rather admit that I had adopted a policy which permitted those consumers who desired it to obtain Grade A milk, than to state that the communities in my county all had adopted milk control ordinances, but that I was unable to enforce them, and that the Grade A label was relatively meaningless.

Discussion

Mr. Jennings: I would like to make just one comment. Though we have not the same situation, we have curbed it in the outlying districts of Louisville, where we have had the family cow. We have just arbitrarily ruled that if people would come to the home and get the milk no regulation would be required, but cow owners must not deliver milk, or all requirements must be in effect. We have reduced the problem very materially in this way.

Mr. Frank: Mr. Abele has put his finger upon one of the sorest spots in milk control. Most of our epidemics are occurring in the smaller communities, the very ones in which milk control is most difficult, and we should welcome such research work as Mr. Abele is doing in such communities in Alabama.

I am only sorry that he was not able to present results from two larger groups of counties. He should expand the work so as to ascertain whether the difference between the two counties thus far compared may not be due to the difference between the personalities of the two health officers.

It seems to me that the voluntary plan has one weakness in that while it permits the use of the Grade A label by the distributor who complies with the Grade A requirements, it does not prohibit the use of the Grade A label by the distributor who fails to comply. I have always felt that ultimately any voluntary plan will tend to fail in that it does not represent an enforcible rule. Perhaps if the enforcement of the original ordinance had been limited to the so-called legitimate dairies, and the family cow ignored as they are in the majority of communities, there would have been no difficulty.

At any rate I think Mr. Abele should go on with this work as we certainly need an answer to this most vexing of problems. Perhaps he should include in his future studies the possible neutralizing effect of an educational program by means of which the consumer will learn what constitutes safe milk and will demand the Grade A milk of the legitimate dairies and refuse the ungraded milk from the neighborhood cows.

Mr. Abele: I do not think I have much to add to the statements made in the paper, except to answer Mr. Frank's question: There was very little opportunity for educational work in the community in which the referendum was held, for two reasons. First, the time was short, and we had no knowledge of the contemplated referendum until we read the newspaper account of the result. Second, the county health officer felt that he had stressed the desirability of safe and controlled milk at every opportunity, and that he would now leave it to the people decide. It appears to have been a case in which he anticipated the result, and decided the potato was too hot to handle.

International Association of Milk Sanitarians

CONSTITUTION AND BY-LAWS

CONSTITUTION

ADOPTED OCTOBER 16, 1911*

NAME

This Association shall be known as the International Association of Milk Sanitarians.

OBJECT

The object of this Association shall be to develop uniform and efficient inspection of dairy farms, milk establishments, milk and milk products, and to place the inspection of the same in the hands of men who have a thorough knowledge of dairy work.

MEMBERSHIP

There shall be two classes of membership in this Association: Active and Associate.

The active membership shall be composed of persons who are officially engaged in dairy or milk inspection, or the laboratory control of, or the administration of such function for any country or any subdivision thereof, and of persons who are officially engaged in research or educational work related to dairy or milk inspection for any country or subdivision thereof, provided, however, that all persons who at the time of the adoption of this amendment are members of the Association, shall be active members.

The associate membership shall be composed of any persons not eligible for active membership, who are interested in the promotion of dairy sanitation. Associate members shall not be eligible to vote, serve as officers, hold the chairmanship of any committee, serve on the Resolutions Committee, or serve as majority members of any committee of this Association.

Any properly qualified person may make application for active or associate membership to the Secretary-Treasurer and if application is

* Amended Oct. 20, 1932 and Oct. 15, 1936.

accepted by the Membership Committee, said applicant may become an active or associate member, as the case may be, upon payment of the annual dues of five dollars ($5.00).

OFFICERS

The officers of this Association shall be a President, three Vice-Presidents, a Secretary-Treasurer, and two Auditors, who shall be elected by a majority ballot at the Annual Meeting of the Association, and shall hold office for one year or until their successors are elected. An Executive Board, which shall direct the affairs of the Association when not in Annual Session, shall consist of the President, the three Vice-Presidents, and the Secretary-Treasurer.

AMENDMENTS

This Constitution may be amended by a two-thirds affirmative vote of those active members of the Association who register their votes with the Secretary. Any member proposing amendments must submit the same in writing to the Secretary-Treasurer at least sixty days before the date of the Annual Meeting, and the Secretary-Treasurer shall at once notify all members that the proposed amendments will be open for discussion at the Annual Meeting immediately succeeding such notification. After discussion at the Annual Meeting such amendments, upon a majority affirmative vote of the members in attendance shall be, within 90 days, submitted to the entire membership of the Association by the Secretary-Treasurer. All members voting on such amendments shall, within 60 days after receipt of such notification, register their vote in writing with the Secretary-Treasurer on blanks furnished by the Association. These ballots shall be opened and recorded by the Executive Committee, and the results shall be reported by the Secretary-Treasurer at the next Annual Meeting: and if the amendments are passed they shall become a part of the Constitution from the date of such report by the Secretary-Treasurer at the Annual Meeting.

BY-LAWS

ADOPTED OCTOBER 25, 1913

ORGANIZATION

The Constitution shall be the basis of government of this Association.

ARTICLE 1

MEMBERSHIP

SECTION 1. Any person eligible for membership under the Constitution who shall file an official application, accompanied by the first annual membership dues of five dollars, and whose application for membership shall have the approval of the Membership Committee, may become a member of the Association for one year.

SECTION 2. Any person having once become a member may continue membership in the Association so long as the annual membership dues are paid. Any member who shall fail to pay annual dues within thirty days after having been notified by the Secretary that said dues are due and payable, shall be dropped from membership. Any member so dropped may, within ninety days, be reinstated by the Membership Committee, upon application filed in due form and accompanied by the annual membership dues for that year.

SECTION 3. A member of the Association may be expelled for due cause upon recommendation of the Membership Committee, and a majority vote of the members at any annual meeting. Any member so expelled shall have refunded such *pro rata* part of his membership dues as may not be covered by his term of membership.

HONORARY MEMBERS

SECTION 4. Members of the Association may elect as honorary members, at any stated meeting, on the recommendation of the Membership Committee, those whose labors have substantially added to the scientific knowledge of milk supply betterment, or those who have been of pronounced practical influence in the improvement of the milk industry. From such members no dues shall be required. They shall have the privilege of attending the meetings of the Association, but they shall not be entitled to vote.

ARTICLE 2

OFFICERS

SECTION 1. The officers of this Association shall be a President, a First, Second, and Third Vice-President, a Secretary-Treasurer, and two Auditors, who shall be chosen by ballot at the annual meeting of the Association, and shall hold office for one year, or until their successors are duly elected.

SECTION 2. The Executive Board shall consist of the President, the three Vice-Presidents, and the Secretary-Treasurer.

SECTION 3. The Membership Committee shall consist of the President, the three Vice-Presidents, and the Secretary-Treasurer.

ARTICLE 3

DUTIES OF OFFICERS

SECTION 1. It shall be the duty of the President to preside at all meetings of the Association. He shall examine and approve all bills previous to their payment, appoint all committees unless otherwise directed by vote of the Association, and perform such other duties as usually devolve upon a presiding officer, or are required of him by the Association.

SECTION 2. The Vice-Presidents, in the order of their selection, shall perform the duties of the President in his absence.

SECTION 3. The Secretary-Treasurer shall record the proceedings of the Association. He shall keep a list of members, and collect all moneys due the Association, giving his receipt therefor. He shall record the amount of each payment, with the name and address of the person so paying. He shall faithfully care for all moneys entrusted to his keeping, paying out the same only with the approval of the President, and taking a receipt therefor. He shall, immediately after his election to office, file with the President of the Association a bond in the sum of five hundred dollars, the expense of which shall be borne by the Association. He shall, at the annual meeting, make a detailed statement of the financial condition of the Asssociation.

It shall also be the duty of the Secretary-Treasurer to assist in making arrangements and preparing a program for the annual meeting, and to compile and prepare for publication all papers, addresses, discussions and other matter worthy of publication, as soon as possible after the annual meeting.

SECTION 4. The full management of the affairs of the Association when the Association is not in session shall be in the hands of the Executive Board, as provided in the Constitution.

SECTION 5. It shall be the duty of the Auditors to examine and audit the accounts of the Secretary-Treasurer and all other financial accounts of the Association, and to make a full report of the condition of the same at the annual meeting.

ARTICLE 4

MEETINGS

SECTION 1. The annual meeting of the Association shall be held at such time and place during the month of October of each year or at such other time as shall be designated by the Executive Board.

SECTION 2. Special meetings of the Association may be called by the Executive Board, of which due notice shall be given to the members by the Secretary.

SECTION 3. Quorum.—Twenty-five per cent of the membership shall constitute a quorum for transaction of business at any annual meeting. Voting by proxy shall not be permitted.

ARTICLE 5

These By-Laws may be altered or amended at any annual meeting of the Association. Any member proposing amendments must seasonably submit the same in writing to the Secretary-Treasurer, who shall then give notice of the proposed amendments by mail to each member of the Association at least thirty days previous to the date of the annual meeting.

MEMBERS

Abele, C. A., Director of Inspection, State Dept. of Public Health, 519 Dexter Ave., Montgomery, Ala.

Allard, E. U., Chief Milk Inspector, City Hall, Quebec.

Arrell, Dr. T. J., Dairy Farm Inspector, Health Dept., Hamilton, Ont.

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Bremer, H. E., Supervisor of Creamery Inspection, Vermont Department of Agriculture, Montpelier, Vt.

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HONORARY MEMBERS

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Woodward, Dr. W. C., American Medical Association, Bureau of Legal Medicine and Legislation, 535 N. Dearborn St., Chicago, Ill.

ASSOCIATE MEMBERS

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