A STUDY OF THE EFFECT OF HEATED AND UNHEATED CENTRIFUGES ON THE ACCURACY OF THE BABCOCK TEST

THESIS FOR THE DEGREE OF M. S.

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Thesis

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THESIS

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INTRODUCTION

One of the most notable achievements in the advancement of dairying was the development of the Babcock test for the determination of fat in milk and milk products. It was devised by the late Dr. Stephen M. Babcock, of the Wisconsin Agricultural Experiment Station, and was first made public in 1890. Dr. Babcock was the first of many investigators making studies at that time in the designing of a practical test. His test has proven relatively simple, quick, accurate, and inexpensive.

In principle it consists of the action of one reagent, strong sulfuric acid, on the milk solids not fat and the separation of the fat brought about by centrifugal force supplied by a mechanical centrifuge. The action of the acid is to break down the protective film around the fat globules, which the milk proteins form, by so-called dissolving of the milk solids not fat. The acid, due to its great affinity for water, on mixing with milk generates a considerable amount of heat which melts the milk fat and aids in the separation. Since the acid is such a heavy liquid, nearly twice as heavy as milk, it increases the difference in specific gravity between the milk fat and the liquid surrounding it thereby aiding in the separation.

The Babcock test is now used to determine the value of many million dollars worth of products. Because of its adaptability it is used in many lines of dairying and has proven almost indispensible. Since the introduction of the test practically all milk is bought and sold on a fat basis. It is either bought at a specified price per pound of fat or

the milk is bought at a specified price per hundred pounds of milk containing a certain range of fat, say 3.2 to 3.5 per cent, and a deduction of a few cents for every one-tenth of one per cent fat the milk falls below this range or a premium added of a few cents for every one-tenth of one per cent the fat content exceeds this range. Several other modified plans are also in use. The test has been of great help to butter and cheese makers in detecting abnormal fat losses during manufacture. It has been of great assistance to the dairy farmer in the culling of the unprofitable cow. It has done much toward stopping the watering and skimming of milk which was so common before its invention. It has also made possible a new field in dairy research.

The Babcock test has long been accepted as the official test by the dairy industry and is so recognized in practically all states. There has been much investigation in attempting to prove the reliability of the test yet there are a few questions concerning the operation of the test which have not been definitely settled. One of such questions is that pertaining to the efficiency in the separation of fat in the tests when the centrifuges are operated at exceedingly low, room, and high temperatures. These conditions are known to exist in many dairy plants. Where steam centrifuges are used the temperature at which the machines operate is about 135° to 150° F.; if electric testers or hand testers are used and no heat is supplied the temperatures may range from about 70° to 100° F.; while extreme conditions may be encountered during the winter months where testing is done out of doors or in unheated rooms and unheated testers as might be the case in some cow

testing work where the tests are made in hand testers during the colder months. Recently producers and producers' organizations have interested themselves in this question, having noticed the wide variations in temperatures at which the centrifuges are operated in the testing of their products. In view of the fact that no particular temperature is specified in the standard procedure for the Babcock test a study relating to this question was undertaken.

REVIEW OF LITERATURE

The fat of milk is generally regarded as its most valuable constituent. Many milk products are sold with the price being determined by the value of the fat in the product. State and Federal standards have been set up regulating the minimum amount of fat to be contained in the various products. Fat in milk varies widely and adulteration is relatively easy. For these reasons much emphasis has been put on methods for determining the per cent of fat in milk and milk products and chemists have been endeavoring to devise simple and accurate methods for making such determinations. They were encouraged greatly by the great strides made in the dairy industry during the latter half of the 19th century. Of greatest importance was the passage of the Hatch Act (1) in 1888 which made possible the establishment of state experiment stations, and, since the need for a practicable fat test was so imperative at that particular period many investigators attacked that problem. Mojonnier and Troy (2) have compiled a list of the methods which resulted from the efforts of these early workers. Some of these early tests have merits and others are entirely impractical.

A. Tests where chemicals are not used:

1. Cream Gauges.
2. Fjord's Centrifugal cream test.
3. Heeren's pioscope.
4. Feser's lactoscope.
5. The churn test.
6. The oil churn test.

B. Tests where chemicals are used with or without the assistance of centrifugal force:

1. Soxlet's method.
2. Short's method.
3. Parsons' method.
4. Failyer and Willard's method.
5. Cochran's method.
6. Adams' Paper coil method.
7. The Roese-Gottlieb method.
8. Neilson's Kaolin method.
9. Liebermann-Szekely's method.
10. Weibull's desiccation method.
11. Bell's Maceration method.
12. Richmond's Kieselguhr method.
13. The Storch method.
14. The Werner-Schmid method.
15. The Ritthausen method.
16. The Wanklyn method.
17. The De Laval Lactorite.
18. The De Laval Butyrometer.
19. The Leffman and Beam method.
20. The Gerber method.
21. The Russian Babcock method.
22. The Babcock method.
23. Sichler's Sin-Acid Butyrometer test.
24. Lindstom's Butyrometer test.
25. The Mojonnier method.

This list indicates the immense amount of work done in the attempts to secure satisfactory methods. The greater part of it was done during the decade 1880-1890.

Barthel (3) also gives an interesting and complete survey of the useful tests for the estimation of the per cent of fat in milk and milk products. He classifies the tests into scientific and practical tests thereby changing the above list somewhat to make the tests more understandable.

Some of the tests in the United States made possible by the funds supplied by the Hatch Act (1) were the Short test (4) devised at the Wisconsin Experiment Station in 1888, the Cochran test (5) devised at the Pennsylvania Experiment Station in 1889, the Parsons' test (6) devised at the New Hampshire Experiment Station in 1888, the Patrick test or "Iowa Station Milk Test" devised at the Iowa Experiment Station in 1890, and the Failyer and Willard's test (8) devised at the Kansas Experiment Station in 1888. Farrington (9) in summarizing the procedure of these tests and making trials with them concluded that the Cochran and Patrick methods were the simplest and easiest to operate. Frear and Holter (10) in making comparisons between the Short, Cochran, and gravimetric (the Babcock Asbestos) methods found that the Short method gave results averaging 0.15 per cent higher and the Cochran 0.06 per cent lower than the gravimetric method.

With this general summary of the early tests a survey of the chemical tests should be attempted to show their development and to indicate the status of the test used in this experiment.

The Development of Chemical Tests.

Probably the first gravimetric test using a fat solvent for extraction of the fat was the Adams method (11) reported in England in 1885. By this method a known weight of milk was deposited on a coil of white blotting paper, and, after allowing to dry, the paper was treated with anhydrous ethyl ether. The ethereal extract was regarded as all fat but it was later shown that the paper contained other ether soluble substances. The procedure was later modified so that a paper free from ether soluble substances was used. This method was long considered as the best of gravimetric determination methods.

In 1888 Roese (12) published the results of a method which he had devised and which now bears his name. The method was similar to that of the Adams' method but where the Adams' method technique required a dry extraction of the milk the Roese made use of a wet extraction method. The procedure for the Roese method is as follows (13): About 20 grams of the milk are mixed with 2 c.c. of ammonia, then 45 c.c. of alcohol and 120 c.c. of a mixture of equal parts of ether and light petroleum are added. The mixture is shaken in a stoppered burette of 250 c.c. capacity. The volume of the ethereal layer is read off, and 25 c.c. of it is evaporated in a tared flask, the fat being dried by aspirating dried air thru the flask for 10 minutes, while heating in a glycerol bath at 90°C. The residue is then cooled and weighed, and the percentage of fat is calculated. An addition of 0.015 per cent should be made for fat remaining in the aqueous layer.

In 1892 Gottlieb (14) modified the Roese method by reducing the volume of milk to 10 grams and reducing the volume of alcohol to 10 c.c.

The amount of each ether was reduced to 25 c.c. also. He pronounced the method satisfactory and stated that it compared favorably with other methods. The method was speedier than the Roese method and could be applied to other dairy products. Lang (15) in 1893 secured results with the Roese-Gottlieb method which compared favorably with other gravimetric methods.

Weibull (16) and Kuhn (17) showed that the Roese-Gottlieb method gave more accurate results than other methods used by them. Popp (18) working with Siegfeld obtained satisfactory results by the Roese-Gottlieb method on both whole and skimmed milk. They made a series of tests on whole and skimmed milk letting the ether stand in the milk for $\frac{1}{2}$, 1, 2, 3 and 6 hours. By allowing this solution to stand for 6 hours they obtained an increase of 0.07 per cent of fat for the whole milk and 0.02 per cent increase for the skimmed milk. They varied the strength of the ammonia solution used but found that this had no effect.

In 1904 Popp (19) announced a revised method for the Roese-Gottlieb test as follows: Place 10 c.c. of the milk in a 100 c.c. tube graduated to 0.5 c.c. In this order add 1 c.c. of ammonia of proper concentration, 10 c.c. of ethyl alcohol, 25 c.c. of ethyl and 25 c.c. of petroleum ether. After shaking on each addition let stand for 1 hour. After last addition, draw off the ethereal fat solution until 1.5 c.c. of it remains in the tube. Wash the fat left in the tube with ether and add to the fat solution, evaporate the ethers, dry, and weigh the fat. Multiply the weight of fat found by 10 to give direct per cent. Rohrig (20) simplified the removing of the ethereal solution by devising a graduated stoppered cylinder which had a spigot on the side at the 25 c.c. mark.

This spiget allowed the drawing off of aliquot portions of the ethereal solution into weighed flasks.

Thomsen (21) made tests with the Roese-Gottlieb method by peptising the proteins in the milk and then testing the milk by the Roese-Gottlieb and Adams' method. Both methods gave satisfactory results although results were somewhat lower on the unpeptized milk with the Adams' method. Burr (22) carried on experiments to find the saponifying effect of the ammonia on the fat in the Roese-Gottlieb method. He found that there was no such effect. He theorized that in the case of milk the chances for saponification were much less as a considerable portion of the ammonia is combined with the casein.

Gordon (23) verified the accuracy of the Roese-Gottlieb method results by using the Rohrig tube. Results obtained from several samples of cream, milk, and skimmed milk compared favorably with other methods. He explained that the ethyl-petroleum ether proportion is very important in securing accurate determinations. When 10 c.c. of ethyl ether and 50 c.c. of petroleum ether were used, results much too low were obtained. The ratio according to Gordon should be nearly that recommended in the standard procedure.

The Roese-Gottlieb method gained considerable prominence in later years. Richmond (24) makes this statement: "On the whole, the Gottlieb method is the best, though those due to Adams, Storch, Werner-Schmidt, and Heel are little, if at all inferior in accuracy." Thru the efforts of the late G. E. Patrick, former head of the Dairy Laboratory of the United States Department of Agriculture, the Roese-Gottlieb method was first brought to the attention of American chemists. It is now used

quite extensively and is included as the official method by the Association of Official Agricultural Chemists and other organizations.

Realizing that the Roese-Gottlieb method required too much time to be of practical value in the dairy industry, J. J. Mojonnier (25) in 1915 was successful in devising apparatus which materially shortened the time for manipulation of the test. By the use of the centrifuge, vacuum oven, water-cooled desiccator, etc., much time could be saved without sacrifice of accuracy.

Mojonnier and Troy (26) report work on the accuracy of the method in comparison with the Adams and Babcock methods. They found close agreement between the Adams and Mojonnier methods when applied to fresh milk but considerable disagreement between the Babcock and the other two methods.

The only literature that could be found dealing precisely with the comparison of the Mojonnier and Roese-Gottlieb methods was that which was reported by Dahlberg (27). From the averages of six samples tested in duplicate he secured an average of 4.59 per cent for the official Roese-Gottlieb and 4.61 per cent for the modified Roese-Gottlieb or Mojonnier.

The Mojonnier is a modified Roese-Gottlieb method and is so considered by Mojonnier and Troy (28). Other writers seem to concede the same point when they make comparisons with the Mojonnier as the Roese-Gottlieb method. Phillips (29) makes no explanation but calls the Mojonnier method the Roese-Gottlieb method. Hoyt (30) says: "The Roese-Gottlieb is an official method of the Association of Official Agricultural Chemists. It was run on the Mojonnier apparatus." Fisher

and Walts (31) make this statement:

"The directions for carrying out the Roese-Gottlieb determinations using the Mojonnier apparatus were followed exactly as given by Mojonnier and Troy in 'Technical Control of Dairy Products (page 109)'".

Dahle, Swope, and Doan (32), Chase and King (33), and Bird and Sands (34) use the Mojonnier method as a standard of comparison in their work.

The Mojonnier method, then, has been and is generally recognised as a standard chemical test for the determination of the per cent of fat in milk and milk products.

Previous Studies on the Babcock Test.

Studies on the Accuracy of the Babcock Test. Babcock (35) first described his test for the per cent of fat in milk and milk products in 1890 and again (36) in 1892. He checked the method against the Babcock asbestos gravimetric method which at that time was the official test of the Association of Official Agricultural Chemists. Thirty samples of milk were tested and practically exact agreement was found between the average values.

Immediately on the introduction of the Babcock method many experimenters took up the task of proving its worthiness. In 1891 Snyder (37) on comparing the average results from 100 samples of milk found that the gravimetric method was 0.016 per cent higher than the Babcock method.

Patterson (38) in 1891 ran a series of tests by the Babcock, Adams Paper Coil, Beimling, and Patrick methods. He states that the Beimling and Patrick methods more nearly compare with the gravimetric method

while the Babcock fell below. However, he attributed this as partially due to the slipping of the belt on the Babcock centrifuge.

Hite (39) in 1891 made a series of tests by the Babcock and the Adams Paper Coil methods, as well as a few others. It was noted on three analyses of whole milk by the Babcock and Adams methods, operated according to directions, that difficulty was encountered in obtaining fat free from casein and the results varied widely from the results obtained by the Adams method.

In 1891 some work was reported at the Connecticut Agricultural Experiment Station (40) showing that on 32 comparative tests the Babcock averaged 0.10 per cent above the "standard method used in chemical laboratories."

Bailey (41) has conveniently compiled a table of the results secured by some of the early workers and this is reported in Table A. These results show close agreement between gravimetric method results.

Barthel (42) in reporting some of his own investigations says that the Babcock method gives results 0.06 to 0.08 per cent lower than the Roese-Gottlieb.

Mojonnier and Troy (43) report 52 tests being made on whole milk by the Babcock and Mojonnier method. Two operators made the Babcock determinations. Out of the 104 tests compared with the Mojonnier results they state that 51.9 per cent of the tests were overread and 43.3 per cent were underread. The same authors also report (44) the testing of 14 samples of milk by the Babcock, Adams, and Mojonnier methods. They noticed a close agreement between the Mojonnier and Adams methods on fresh milk but the Babcock tests showed considerable disagreement between these

Table A.

Comparisons Between the Babcock and Gravimetric Methods on Whole Milk

Authority	Number of comparisons	Average of all Babcock readings above average of all gravimetric results	Average of differences between Babcock readings and the gravimetric results	Absorbent used in gravimetric method
Babcock	30	0.011	±0.089	Asbestos
Snyder	45	-0.026	±0.062	Asbestos
Farrington	12	0.050	±0.088	Asbestos
Farrington	12	-0.075	±0.093	Sand
Farrington	12	-0.129	±0.149	Paper
Connecticut Experiment Station	32	Within 0.01	6 differ over ±0.10	
Patterson	20	-0.132	±0.153	Paper
Schutt	32	-0.088	±0.105	
Heinrich	27	-0.05		
Zehenter	34	73.5 per cent within 0.05	3 differ over ±0.10	
Schrott-Fiechtl	100	0.001	±0.076	Sand
Shiver	49	0.067	±0.095	Paper

other two methods. The difference was not constant in any direction.

In 1917 Bailey (45) reported that on the average of 190 comparisons made by reading the Babcock milk test from the bottom of the lower meniscus to the extreme top of the upper meniscus, results were obtained with the Babcock method averaging 0.060 per cent higher than the Roese-Gottlieb method. Hortvet (46) in 1917 reports the work done by ten collaborators making similar comparisons. Their results show the average of the tests by the Babcock method to be 0.04 per cent lower than the average tests by the Roese-Gottlieb procedure.

Again in 1923 several investigators reported their work. Hoyt (47) tested samples of milk by the Babcock, Roese-Gottlieb (Mojonnier), Adams, and Asbestos methods. The average readings of the Babcock tests, reading from the extreme of one to the extreme of the other meniscus, was 0.079 per cent above the Roese-Gottlieb (Mojonnier) figures, 0.091 per cent above the Adams figures, and 0.173 per cent above the Asbestos figures. By using glymol to flatten the meniscus on the milk test results were obtained with the Babcock test figures being 0.058 per cent below those of the Roese-Gottlieb, 0.046 per cent below the Adams, and 0.036 per cent above the results of the Asbestos. Hoyt therefore favors changing the procedure for the reading of the Babcock test in order that the test will more nearly conform to the figures obtained by the gravimetric methods, but only if other investigators confirm his results.

Phillips (48) reported that from the average of 50 comparative tests with the Babcock tests being read from the bottom of the lower meniscus to the extreme top of the upper meniscus, the Babcock method gave results averaging 0.0588 per cent higher than the Roese-Gottlieb (Mojonnier)

method. The Babcock test was higher in every case, the minimum variation being 0.005 per cent and the maximum variation 0.126 per cent. When he used glymol on the tests the Babcock method gave results 0.087 per cent lower than the Roese-Gottlieb (Mojonnier) method.

When 32 samples of milk were run by the Babcock and Roese-Gottlieb methods, Dahlberg (49) found that the average results by the Babcock method was 0.10 per cent higher than the Roese-Gottlieb method. The Babcock tests were read in the usual manner.

Fisher and Walts (50) on comparing the results from 16 samples of milk run by the Babcock, Gerber, and Roese-Gottlieb (Mojonnier) methods found that for milk the average variation from the Roese-Gottlieb method was $\pm$0.137 per cent for the Babcock method and $\pm$0.122 per cent for the Gerber method.

Dahlberg, Holm, and Troy (51) made 925 tests of milk and cream in conjunction with workers in three different research laboratories and four different dairy control laboratories. They concluded that the Babcock and Gerber methods were just as accurate as the chemical test and that the Babcock test did not yield higher results than the Roese-Gottlieb test.

Hunziker (52) showed the effect of adding glymol to milk tests before reading. By destroying the meniscus with glymol the results were uniformly 0.2 per cent too low showing that the meniscus must necessarily be included to compensate for the residual fat left in the bulb of the test bottle.

Doan, Fields, and England (53) made a study on cream tests and found that by the use of glymol the cream test by the Babcock method was 0.28 per cent higher than the chemical test. When the Babcock

tests were read from the bottom of the lower meniscus to the bottom of the upper meniscus the Babcock test was 0.32 per cent higher than the chemical test. These results are similar to those presented by Hunziker, et. al. (54) and confirmed by Spitzer and Epple (55). No part of the meniscus should be included in the reading of cream tests. The use of glymol is strongly urged.

Dahle, Swope, and Doan (56) in 1930 report a modified Babcock test for butterfat in condensed and evaporated milk. In order for the Babcock test to conform to the results by the Mojonnier method the test must be read from the bottom of the lower meniscus to the bottom of the upper meniscus.

Chase and King (57) on making a comparison of the modified Babcock method for butterfat in ice cream and the Mojonnier method, concluded that the modified Babcock tests gave results averaging 0.04 per cent higher than the Mojonnier tests.

Some explanation as to why the results of the Babcock tests are lower than the chemical or gravimetric tests might be obtained from the work of Thurston and Petersen (58), and others. They studied the Babcock test for fat in buttermilk and also the Gerber, butyl alcohol, and Mojonnier methods for fat in buttermilk. They concluded that the Babcock test was the most accurate of the tests considered. They based this conclusion on the fact that buttermilk has a lecithin content nearly as high as the fat content and when reagents are used for the extraction of the fat which also dissolve lecithin, such as ether, butyl alcohol, etc., the fat content is greatly exaggerated. The Babcock test for fat in buttermilk yields nearly true butterfat while ether extraction methods yield

both butterfat and lecithin. Similarly, in the cases of other milk products the lecithin content might introduce an error when extraction methods are used. The lecithin content of various milk products are given by Chapman (59) and are included in Table B. From this table an idea may be obtained of the probable inaccuracies occurring in methods which use reagents, in which lecithin is soluble, for the extraction of the fat.

Table B

Per Cent of Lecithin in Milk Products.

Author	Milk	Cream	Skimmed Milk	Buttermilk
Stocklassa	0.1015			
Burow	0.0535			
Koch and Woods	0.0797			
Nerking and Haensel	0.0629			
Glikin	0.0765			
Chapman	0.0447	0.1981	0.0165	0.1302

Studies on Heated and Unheated Centrifuges. No detailed study has been made regarding the effect of heated or unheated centrifuges on the accuracy of the Babcock test. Babcock in his first descriptions of the test did not specify whether the centrifuges should be maintained at any certain temperature. However, provision was made for a water jacket on the testers, and this to be filled with hot water in order to keep the centrifuge warm. When the manufacturing companies began building steam turbine centrifuges it was noted by Woll (60) that due to their con-

struction some acquired a very high temperature. One type of turbine tester had an opening above the spindle which admitted cool air and reduced the temperature in the tester to about 140°F. The other type was closed on top. No cool air being drawn in, this centrifuge sometimes reached a temperature of about 200°F. Woll made tests in both types of centrifuges and compared them with tests made by the gravimetric method. The difference varied from 0.10 to 0.30 per cent, varying according to the richness of the milk. When the tests were read direct from the tester at 200°F the reading was 0.16 per cent too high for 5 per cent milk and 0.11 per cent too high for 3 per cent milk. When the tests were read from the centrifuge at 140°F. the results were comparable to the gravimetric test. This increase in volume of fat may have been due to the temperature at which the tests were read and not necessarily to more efficient separation of the fat.

Farrington (61) was able to increase the efficiency of the Babcock test for skimmed milk by adding an excess of acid and by whirling the tests longer and in a hot centrifuge (about 200°F.). He secured no different readings in the skimmed milk tests whether read at 120°F. or 200°F. Hence, the higher results were due to more efficient removal of the residual fat.

Bailey (62) reported the results of 18 tests run in an unheated tester. He concluded that the effect of testing in an unheated tester depended on the temperature of the room, the length of time the tests are exposed to room temperature after mixing, particularly in a cold room, and possibly on the type of tester. At ordinary room temperature tests gave the same reading whether run in a heated factory tester or in a hand tester if they were centrifuged directly after mixing and the

water added with a temperature above 180°F. Very little difference was noted between the results obtained in the heated turbine tester and the hand tester even when the room temperature was down to 50°F. It should be noted however that the temperature of the water added to the test was well above that recommended by standard technique.

Nelson (63) made a study of the Babcock test in 1926. He noticed that the temperature of the room in which the tests were read caused no appreciable changes. That is, when the tests were read with the room temperature at 19°F. the resulting readings were 0.019 per cent lower than when read in a room at 84°F. When the temperature of the centrifuge was 100°F., 32 samples averaged 0.049 per cent higher than the Mojonnier results but when the temperature of the centrifuge was 150°F. the samples averaged 0.07 per cent higher than the Mojonnier results.

From the literature reviewed it is readily seen that a variety of results and contradictory conclusions as to the accuracy of the Babcock test are available.

Studies on Residual Fat. Search of the literature revealed but little work on residual fat determinations. Halverson (64) devised a method for the determination of what he termed "residual fat" but not residual fat as usually considered. His method was that of extracting the sugar solution discarded from a modified ice cream test to determine the per cent of fat that would be lost thru such a procedure.

Hunziker, et al. (65) made a rather complete study of the residual fat in cream tests. They noticed two sources of residual fat, namely, that which adheres to the glass and that which is contained in the liquid below the fat column. From a series of 26 cream tests the residual fat adhering to the glass amounted to 0.041 per cent, that in

the liquid portion amounted to 0.226 per cent, and for all tests the total residual fat amounted to 0.280 per cent. Their procedure was as follows:

"Six test bottles were used for each determination. The necks of the bottles were removed by scratching with a file and breaking them off at their base. The contents of the bottles were transferred to 500 c.c. beakers. The empty bottles were rinsed with hot water and the rinsings added to the solution in the beakers. This solution was then neutralised with potassium hydroxide, care being taken to avoid excessive evolution of heat. The neutralised solution was then slightly acidified to hasten the filtration and also to convert any soluble soap that may have formed into insoluble acid. The liquid was filtered through a wetted fat-free filter paper and the residual fat washed with distilled water. The filter paper was dried, extracted with ether and weighed in the usual way. The results multiplied by $\frac{100}{18}$ represent the per cent residual fat in the liquid.

"The test bottles after rinsing with hot water, were dried and rinsed with ether. The rinsings were evaporated and the fat weighed. The results multiplied by $\frac{100}{18}$ yield the per cent residual fat adhering to the glass."

Bailey (66) reported residual fat tests made on milk. His procedure and comments are as follows:

"To determine the residual fat the necks of four bottles were broken off and the liquid below the fat column poured into a separatory funnel. This liquid was extracted with two portions of ethyl ether, first 150 c.c. and then 75 c.c. the ethereal extract washed twice with water, evaporated to dryness, the residue taken up with petroleum ether (boiling point be-

low 60°C.) filtered, and the weight of the fat determined. A similar method has been used for the same purpose with ice cream tests (64).

"This method for determining the residual fat was checked up by subjecting some skim milk to the Babcock procedure and then determining all the fat as above. The fat was also determined by extracting the same amount of skim milk in a separatory funnel by the Roese-Gottlieb method in order to determine the actual amount present. On three comparisons in duplicate the per cent recovered by the above method ranged from 90.5 to 98.8 with an average of 94.8.

"The residual fat found in 38 samples of milk varied from 0.066 per cent to 0.233 per cent calculated as reading on the bottle graduation, and averaged 0.132 per cent. While this variation is large, there are very few extreme values. The variation is probably due to a variation in the size of the fat globules."

PURPOSE OF THE EXPERIMENT

Since there is such a variation in the procedure for the operation of the Babcock test with particular reference to the temperatures at which the tests should be centrifuged and, since there is quite a demand that this point be clarified, this experimental work was undertaken. The chief object was to ascertain whether there is any material difference in the results from milk tests when centrifuged at low temperatures (55°-40°F.), at medium or room temperatures (70°F.), and at high temperatures (135°-150°F.). If a considerable difference be found in the efficiency of the fat separation in heated and unheated centrifuges, then the procedure for the Babcock test should be altered and the requirement be made that centrifuges be maintained at a prescribed temperature.

In further pursuit of the above purpose, chemical tests were made in conjunction with the Babcock tests in order to secure a recognized standard for comparison.

If a difference in the efficiency of separation of fat due to whirling at various temperatures exists, this difference should be accounted for in the amount of residual fat remaining in the body of the Babcock test bottle. Consequently, it was the object of this experiment to determine the residual fat remaining in the tests when centrifuged at low, medium, and high temperatures.

Lastly, it was thought to be of interest that the temperature resulting from the heat generated by the action of the sulfuric acid on the milk be recorded and also the drop in temperature after whirling at the various temperatures be ascertained.

PROCEDURE

Procedure for the Babcock Test

The procedure used in this experiment for the estimation of fat in milk by the Babcock method was similar to that outlined by the Association of Official Agricultural Chemists (67) and, the American Dairy Science Association prepared by O. F. Hunziker and committee (68) and (69). The procedure outlined by these two organizations differ but slightly. It is interesting to note that the former states that the centrifuge should be maintained at a temperature of at least 55°C. (131°F.) during the whirling period while the latter makes no such statement. Of course, the final word in the testing procedure which concerns the Babcock test operator in the dairy plant rests in the regulations and procedures set up by the individual states. These state regulations vary too. In order that a clearer understanding might be had concerning a standard procedure the official procedure of the Association of Official Agricultural Chemists (67) is here given since it offers a more detailed description.

Official Method.

"Reagent. Sulfuric acid -- Specific gravity 1.82-1.83 at 20°C.

"Apparatus. The standard centrifuge, however driven, shall be constructed thruout and so mounted as to be capable, when filled to capacity, of rotating at the necessary speed with a minimum of vibration and without liability of causing injury or accident. It shall be heated, electrically or otherwise, to a temperature of at least 55°C during the process of centrifugalizing. It shall be provided with a speed indicator, permanently attached, if possible. The proper rate of rotation

may be ascertained by reference to the table below. By "diameter of wheel" is meant the distance between the inside bottoms of opposite cups measured thru the center of rotation of the centrifuge wheel while the cups are horizontally extended.

Diameter of wheel, in inches:	10	12	14	16	18	20	22	24
No. revolutions per minute:	1074	980	909	848	800	759	724	693

"The water bath for test bottles shall be provided with a thermometer and a device for maintaining a temperature of 55°-60°C.

"Determination. Transfer 18 gm. of the sample, prepared as directed, to the milk-test bottle by means of the pipet. Blow out the milk remaining in the pipet tip after free outflow has ceased. Add 17.5 c.c. of H_2SO_4, preferably not all at one time, pouring it down the side of the neck of the bottle in such a way as to wash any traces of the milk into the bulb. The temperature of the acid shall be about 15°-20°C. Shake until all traces of curd have disappeared; then transfer the bottle to the centrifuge; counterbalance it; and, after the proper speed has been attained, whirl 5 minutes. Add soft H_2O at 60°, or above, until the bulb of the bottle is filled. Whirl 2 minutes. Add hot H_2O until the liquid column approaches the top graduation of the scale. Whirl 1 minute longer at a temperature of 55°-60°C. Transfer the bottle to the warm water bath maintained at a temperature of 55°-60°C., immerse it to the level of the top of the fat column, and leave it there until the column is in equilibrium and the lower fat surface has assumed a final form. Remove the bottle from the bath; wipe it; and, with the aid of dividers or calipers, measure the fat column, in terms of percentage by weight, from its lower surface to the highest point of the upper meniscus.

"The fat column, at the time of measurement, should be translucent, of a golden yellow or amber color, and free from visible suspended

particles. Reject all tests in which the fat column is milky or shows the presence of curd or of charred matter, or in which the reading is indistinct or uncertain."

Method followed in this Study.

Reagent. Regular commercial, unstandardized sulfuric acid of specific gravity 1.84 was used. On account of its strength only about 15 c.c. were used.

Apparatus. The test bottles were standard Babcock milk test bottles meeting the specifications of the State of Michigan (70), the Association of Official Agricultural Chemists (67), and the United States Bureau of Standards (71). However, they were re-checked for accuracy by the mercury method and all bottles that did not exactly check were rejected.

The pipettes used were standard pipettes meeting the specifications of the state of Michigan(70).

The centrifuge used was an electric, twenty-four bottle tester having a diameter of 16 inches and running at a speed of 850 revolutions per minute. It was made portable by mounting on a concrete block of relatively light weight and was fastened to the concrete block by means of long, threaded bolts placed in the concrete, thereby simplifying leveling. The tester was equipped with an electric heater and a thermometer for registering its temperature.

The water bath for the test bottles was a thermostatically controlled water bath maintained at a temperature of 138°F.

Determination. Thirty samples of milk representing the patrons delivering milk to the college dairy were collected daily on various days until over five hundred samples were collected. Each sample was well

mixed by pouring back and forth from two containers six to eight times. Each sample was pipetted into six Babcock test bottles which previously had been re-checked for accuracy. The pipetted portions from the same sample were divided into three lots of two each to be whirled with the centrifuge operating at low, medium, and high temperatures, the tests for each temperature being run in duplicate.

The tests to be centrifuged at a low temperature were placed in a twenty-four bottle shaker and about 15 c.c. of acid added to each. After complete shaking, the tests were immediately placed in the centrifuge which was located in the refrigerator at 35°to 40°F. and whirled for five, two, and one minute intervals. Hot, soft water was added to the tests in accordance with the procedure of the Official Method (67). The tests were immediately placed in a constant temperature water bath and held at a temperature of 138°F. for readings at a later period. The same procedure was carried out with the remaining two lots of tests except for the location of the centrifuge and the temperature at which it was run. The second lot was whirled with the same centrifuge located in the laboratory with the temperature at the start at 70°F. but the temperature should rise due to the heat from the tests. The third lot was whirled with the temperature of the tester at 135° to 150°F. this temperature being maintained by the use of an electric heating element.

After completion of the centrifuging and after the tests had remained in the water bath for at least three minutes they were removed singly from the water bath and readings made by two persons. The results were determined individually and tabulated on separate records.

Procedure for the Chemical (Mojonnier) Test

The regular procedure for the Mojonnier fat determination in milk was used (72) except that the milk samples were accurately weighed instead of measured from a Mojonnier ten-gram pipette. This modification would render the procedure practically identical to that of the official Roese-Gottlieb Method.

Because of the time involved in making duplicate tests of the milk, in a majority of cases one determination was made on each sample. However, sixty samples were run in duplicate to check the accuracy of the operator. The average difference between the duplicate tests was $\pm$0.021 per cent with a variation of from 0.000 to 0.072 per cent. Therefore, the single tests were considered very reliable.

Procedure for Residual Fat Determination

Since there is no official procedure for the determination of that amount of fat which remains in the body of the Babcock test due to the minute size of fat globule, the following procedure was devised and checked for accuracy:

Preparation of Babcock Tests for the Determination of Residual Fat. The Babcock milk test bottle was first balanced on an analytical balance after which 17.5 c.c. of a well mixed sample of milk was pipetted into it and the exact weight of the sample was determined to the fourth decimal. Twelve samples of milk were weighed in this manner until seventy-two tests had been obtained. These seventy-two tests were divided into three lots of twenty-four each and the tests completed with the centrifuge operating at low, medium, and high temperatures as in the case of the regular experimental procedure. After centrifuging, the fat was floated from the neck of the test bottles by means of boiling water and the tests

whirled for another minute. Any traces of fat were again removed with boiling water. This method of eliminating the fat from the neck of the tests was thought to be just as efficient, and much more economical, as the method used by Bailey (66) where the necks of the bottles were broken off to eliminate the fat.

Extraction of the Residual Fat. Each test prepared in the above manner was emptied into 250 c.c. separatory funnels. The test bottle was refilled with water and rinsed into the separatory funnel thereby diluting the acid mixture. The test bottle was again rinsed with a small portion of ethyl ether to remove all traces of fat in the bottle and the contents emptied into the separatory funnel. Then 50 c.c. of ethyl ether was added to the acid mixture, the funnel stoppered tightly and the mixture shaken vigorously for 20 seconds. 50 c.c. of petroleum ether was then added and the mixture again shaken for 20 seconds after which 20 c.c. of ethyl alcohol was added and the mixture shaken for 30 seconds. The alcohol was necessary for the removal of the gelatinous mixture which collected at the interface between the acid mixture and the ether solution. The test was allowed to stand for five minutes or until complete separation of the ethereal layer after which the acid mixture was drawn into a beaker for re-extraction. Meanwhile the remaining ethereal layer was washed twice with 100 c.c. portions of water and then filtered thru a fine, fat free filter into weighed aluminum (Mojonnier) fat dishes. For the re-extraction the acid mixture was treated with 25 c.c. of ethyl ether, 25 c.c. of petroleum ether, and 10 c.c. of ethyl alcohol and the mixture was shaken for 20 second intervals after the addition of each reagent. The acid mixture was again drawn off and discarded while the remaining ethereal layer was washed twice with 100 c.c. portions of

water and the ether-fat solution filtered into the fat dish. Care was exercised to insure that all the wash water which clung to the sides of the separatory funnel above the ethereal layer was shaken down into the water layer before the final separation was made in both extractions. From this point on the fat dishes were treated in the regular Mojonnier technique (72).

The Check on the Procedure. This method was checked for accuracy by determining the amount of fat that could be recovered when a weighed amount of pure butter oil was passed thru the same procedure. Four tests were run with the fat being weighed into water while four other tests were run with the fat being weighed into sulfuric acid. Only 15 c.c. of acid were used for each test as in the regular Babcock tests.

The Method for Determining the Temperature of the Tests.

Since the amount of heat generated by the action of sulfuric acid on milk, and the drop in temperature due to centrifuging at various temperatures was thought to be of interest, this simple procedure was followed and the expensive method of the calorimeter was not used for obvious reasons. Twelve charges of 17.6 c.c. of milk were pipetted into each of twelve Babcock cream test bottles for the convenience of the larger neck. After the addition of the acid to the milk a thermometer was lowered into the bottom of the test bottle and the test shaken, the highest temperature reached being recorded. After these twelve temperatures were determined thirty-six more portions of milk were pipetted into cream test bottles to be divided into lots of twelve each for the determination of the drop in temperature when centrifuged at low, medium, and high temperatures. These three lots were centrifuged in exactly the same manner as in the experimental procedure for the Babcock test for milk.

Hot soft water at a temperature of about 160°F. was used in filling the tests. After completion of the whirling, the test bottles were removed from the tester one at a time and held over a container to catch the overflow while the thermometer was being lowered to the bottom of the test bottle. The highest temperature for the tests was again recorded.

EXPERIMENTAL RESULTS

Comparison of Babcock and Mojonnier Results.

It was the purpose of this experimental work to ascertain whether a significant difference in the efficiency of the fat separation existed when heated and unheated centrifuges were used in the operation of the Babcock test for the estimation of fat in milk. Further, a comparison between the Babcock test and a standard chemical test, such as the Mojonnier method, was thought necessary if positive conclusions were to be drawn. The comparison was made to determine at which temperature of centrifuging, the results of the Babcock test would more nearly equal those of the Mojonnier test. Consequently, samples of milk representing the patrons delivering milk daily to the college dairy were collected until 515 samples were obtained. The samples were treated and tested according to the procedure previously given. The results are reported in detail in Tables I to XVIII inclusive. Each sample of milk was tested in duplicate at each of the three temperatures of centrifuging, namely, 60° to 68°F., 85° to 100°F., 135° to 150°F. For each temperature of centrifuging four readings were made of these duplicate tests due to their having been read by two readers. In this manner it was hoped to eliminate differences due to personal factors as much as possible. The average of these four readings at each temperature of centrifuging appear in a fifth column under the three main headings of "Low, Medium and High Temperature". These averages are the figures that were considered in the interpretation of these data. No attempt was made to show differences due to individual readers as that was beyond the scope of this problem. However, others (41) have done this and found

that an average variation as high as 0.15 per cent might exist.

In order to facilitate the interpretation of these data a few mathematical calculations were necessary and the results are summarized in Table XIX. It will be noted that the average or mean readings for the 513 samples when centrifuged at the various temperatures were as follows: when centrifuged at low temperatures (60°to 68°F.) the mean reading was 3.72 per cent; at medium temperatures (85° to 100°F.) the mean reading was 3.75 per cent; and, at high temperatures (135° to 150°F.), the mean reading was 3.76 per cent. This would make a difference in the average readings of 0.04 per cent between the tests centrifuged at low and at high temperatures, the greatest difference in means that might be attributed to the differences in temperatures of centrifuging. However, the last column of the table shows a probable error of ±0.0177 which is nearly half the difference. Therefore, one could not conclude that this difference in average readings is due to the variation in temperatures of centrifuging.

These differences in average readings resulting in the three lots of tests can be explained only in part. It indeed seems odd that the average readings would progress upward as they were centrifuged at higher temperatures, yet these differences are of no significance mathematically. Perhaps this variable factor had its influences but not sufficiently great to attribute the differences to it. Since these differences can not be due to variations in speed of centrifuging, length of time of centrifuging, length of time of holding tests after mixing the acid and milk, inaccuracies in glassware, etc., all of which were held constant in this experiment, the differences might be due to variations in readings by the individual readers, slight errors in pipetting, and more

occlusion of water and sulfuric acid in the fat column in the case of some tests. It appeared in the case of the Babcock tests centrifuged at the low temperatures that the fat column receded in the neck due to the lower temperature while centrifuging and it is possible that some of the fat did not rise again when the tests were immersed in a water bath but clung to the glass near the bottom of the neck. Consequently it was not included in the reading and lower averages were obtained for the tests centrifuged at low temperatures. Even though water was added to the tests which was higher in temperature than is recommended in standard procedures yet the coldness of the room brought the temperature of the fat column down during centrifuging to about the solidifying temperature of milk fat (88° to 96°F.). The fat in the tests made in the cold room or low temperature centrifuge was usually near solidification when the test bottles were removed from the centrifuge even though water at a temperature of 158°F. was added to the tests. Table XXIII shows that the average temperature of the tests after centrifuging in a tester at 60° to 68°F. to be 94.5°F. or very near the solidification temperature of milk fat. In order to insure that the tests would come from the cold centrifuge in a good condition the water added should be much higher than 158°F.

Since the Babcock test results were not materially altered due to temperatures of centrifuging, a mean of all the test was secured for comparison with the chemical test. Since the means were obtained from the same number of tests in the case of each temperature of whirling, an average of these means was secured to represent the mean of all Babcock tests made. The mean of all the Babcock tests was found to be 3.74 per cent while inspection of Table XIX shows the mean of the Mojonnier tests

to be 3.67 per cent. Apparantly the Babcock method yields results 0.07 per cent higher than the Mojonnier method. The last column of the same table shows a probable error in the means of $\pm$0.0172 which would indicate that this difference is highly significant and under the same conditions of investigation similar differences should be obtained.

An explanation as to why the Babcock method should produce higher results than the Mojonnier method can be obtained from the work of Bailey (41). The losses to the fat column studied by Bailey are: (a) residual fat which averaged 0.132 per cent, and (b) the amount of milk delivered by the pipette which was found to be 0.076 grams less than should have been delivered; while the gains to the fat column appeared as: (a) impurities in the fat in the neck of the bottle which was mostly acid and water amounting to about 0.78% of the total fat, (b) reading of tests at 130° -145°F. instead of 113°F. at which temperature fat has a specific gravity of 0.9, and (c) the inclusion of the upper meniscus in reading the test.

The explanation as to why the Babcock method yielded higher results than the Mojonnier method seems to be that the gains to the fat column greatly offset the losses.

Table I Patrons' Milk Samples Tested January 25, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
1	6	4.50-4.60	4.55-4.60	4.56	4.70-4.70	4.75-4.75	4.72	4.70-4.75	4.70-4.70	4.71	4.581
2	7	3.50-3.50	3.55-3.55	3.52	3.70-3.70	3.80-3.75	3.74	3.70-3.70	3.70-3.70	3.70	3.653
3	8	4.40-4.45	4.35-4.45	4.41	4.70-4.70	4.70-4.70	4.70	4.60-4.65	4.65-4.65	4.64	4.537
4	9	3.20-3.15	3.20-3.10	3.16	3.40-3.45	3.45-3.50	3.45	3.50-3.50	3.45-3.45	3.47	3.410
5	10	2.95-2.95	2.95-3.00	2.96	3.20-3.20	3.20-3.10	3.17	3.20-3.25	3.20-3.20	3.21	3.341
6	11	3.60-3.60	3.60-3.60	3.60	3.75-3.75	3.75-3.75	3.75	3.80-3.85	3.80-3.85	3.82	3.729
7	12	4.20-4.30	4.20-4.25	4.24	4.30-4.30	4.30-4.30	4.30	4.35-4.35	4.35-4.40	4.36	4.317
8	13	3.40-3.40	3.40-3.30	3.38	3.50-3.55	3.50-3.50	3.51	3.50-3.55	3.50-3.50	3.51	3.332
9	14	3.00-3.05	3.05-3.00	3.03	3.30-3.30	3.30-3.35	3.31	3.35-3.40	3.30-3.30	3.34	3.230
10	16	3.40-3.40	3.40-3.40	3.40	3.40-3.40	3.40-3.40	3.40	3.50-3.60	3.45-3.45	3.50	3.415
11	17	3.50-3.55	3.50-3.50	3.51	3.50-3.50	3.45-3.45	3.48	3.50-3.55	3.50-3.50	3.51	3.464
12	20	3.35-3.40	3.40-3.35	3.38	3.40-3.40	3.35-3.40	3.39	3.45-3.50	3.40-3.40	3.44	3.346
13	25	3.70-3.75	3.75-3.70	3.73	3.75-3.80	3.70-3.75	3.75	3.85-3.95	3.85-3.90	3.89	3.802
14	26	3.40-3.40	3.30-3.30	3.35	3.25-3.30	3.30-3.20	3.26	3.30-3.35	3.30-3.30	3.31	3.229
15	27	4.80-----	4.85-----	4.83	4.85-4.90	4.80-4.85	4.85	4.95-5.00	4.85-4.90	4.93	4.805
16	36	3.60-3.60	3.50-3.55	3.56	3.60-3.60	3.50-3.55	3.56	3.65-3.70	3.60-3.60	3.64	3.613
17	50	3.30-3.30	3.25-3.20	3.26	3.25-3.30	3.30-3.25	3.28	3.30-3.30	3.25-3.25	3.28	3.166
18	51	3.40-3.50	3.45-3.50	3.46	3.60-3.65	3.65-3.65	3.64	3.70-3.70	3.70-3.70	3.70	3.754
19	54	3.20-3.20	3.20-3.20	3.20	3.15-3.10	3.05-3.10	3.10	3.10-3.10	3.00-3.05	3.06	3.094
20	59	4.05-4.05	4.00-4.00	4.03	3.95-3.90	3.95-4.00	3.95	4.00-4.00	3.90-3.90	3.95	3.955
21	61	3.70-3.75	3.80-3.75	3.75	3.70-3.75	3.70-3.75	3.73	3.80-3.80	3.70-3.75	3.76	3.711
22	62	3.40-3.50	3.50-3.40	3.45	3.35-3.40	3.35-3.40	3.38	3.35-3.35	3.30-3.30	3.33	3.405
23	66	3.40-3.45	3.40-3.40	3.41	3.45-3.45	3.40-3.40	3.43	3.40-3.45	3.40-3.40	3.41	3.411

Table II Patrons' Milk Samples Tested January 28, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Average	Reader A	Reader B	Average	Reader A	Reader B	Average	
24	2	3.45-3.45	3.40-3.40	3.43	3.50-3.55	3.50-3.45	3.50	3.40-3.50	3.45-3.55	3.48	3.460
25	4	3.70-3.75	3.65-3.60	3.68	3.70-3.75	3.65-3.65	3.69	3.70-3.75	3.70-3.75	3.73	3.611
26	5	3.80-3.75	3.75-3.70	3.75	3.80-3.80	3.80-3.80	3.80	3.80-3.85	3.80-3.85	3.83	3.752
27	6	5.30-5.30	5.35-5.30	5.31	5.30-5.30	5.30-5.30	5.30	5.30-5.30	5.30-5.30	5.30	5.103
28	7	3.75-3.75	3.70-3.70	3.73	3.80-----	3.80-3.80	3.80	3.80-3.85	3.80-3.80	3.81	4.028
29	8	4.55-4.60	4.60-4.60	4.59	4.60-4.65	4.60-4.60	4.61	4.60-4.60	4.50-4.55	4.56	4.531
30	10	3.70-3.75	3.75-3.80	3.75	3.80-3.80	3.80-3.85	3.81	3.80-3.90	3.80-3.85	3.84	3.802
31	14	3.85-3.85	3.85-3.90	3.86	3.90-3.90	3.90-3.90	3.90	3.85-3.90	3.85-3.85	3.86	3.887
32	15	3.20-3.20	3.20-3.20	3.20	3.30-3.30	3.35-3.30	3.31	3.30-3.30	3.20-3.20	3.25	3.248
33	17	3.35-3.35	3.40-3.40	3.38	3.40-3.40	3.40-3.40	3.40	3.45-3.50	3.40-3.40	3.44	3.425
34	20	3.25-3.30	3.30-3.30	3.29	3.40-3.40	3.40-3.40	3.40	3.50-3.50	3.45-3.40	3.46	3.379
35	21	4.20-4.15	4.25-4.30	4.22	4.20-4.20	4.25-4.30	4.24	4.20-4.20	4.20-4.20	4.20	4.225
36	22	3.60-3.65	3.65-3.65	3.64	3.45-3.50	3.50-3.50	3.49	3.60-3.60	3.60-3.60	3.60	3.540
37	23	3.40-----	3.45-----	3.43	3.40-3.40	3.40-3.35	3.39	3.50-3.50	3.50-3.50	3.50	3.411
38	24	3.25-3.30	3.30-3.35	3.30	3.25-3.25	3.30-3.25	3.26	3.30-3.35	3.30-3.35	3.33	3.161
39	25	3.70-3.70	3.70-3.75	3.71	3.70-3.70	3.70-3.70	3.70	3.80-3.80	3.80-3.80	3.80	3.627
40	26	3.50-3.50	3.60-3.55	3.54	3.45-3.50	3.50-3.50	3.49	3.45-3.50	3.50-3.50	3.49	3.455
41	36	3.80-3.85	3.80-3.85	3.83	3.80-3.80	3.85-3.80	3.81	3.90-----	3.90-----	3.90	3.744
42	50	3.20-3.20	3.30-3.30	3.25	3.20-3.25	3.25-3.30	3.25	3.40-----	3.40-----	3.40	3.264
43	51	3.60-3.65	3.70-3.65	3.65	3.55-3.60	3.60-3.60	3.59	3.70-----	3.70-----	3.70	3.551
44	59	4.10-4.10	4.10-4.15	4.11	4.05-4.10	4.10-4.10	4.09	4.20-4.20	4.20-4.20	4.20	4.029
45	61	4.35-4.35	4.35-4.40	4.36	4.30-4.30	4.30-4.30	4.30	4.40-4.45	4.45-4.40	4.43	4.328
46	62	3.65-3.65	3.60-3.65	3.64	3.55-3.60	3.65-3.69	3.60	3.65-3.70	3.65-3.60	3.65	4.208

Table III Patrons' Milk Samples Tested February 4, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
47	2	3.35-3.30	3.35-3.35	3.34	3.30-3.35	3.30-3.35	3.33	3.35-----	3.35-----	3.35	3.280
48	4	3.30-3.40	3.40-3.45	3.39	3.45-3.50	3.45-3.45	3.46	3.45-3.40	3.45-3.45	3.44	3.424
49	5	3.50-3.55	3.60-3.60	3.56	3.65-3.65	3.60-3.65	3.64	3.50-3.55	3.65-3.65	3.59	3.574
50	6	4.30-4.35	4.30-4.25	4.30	4.40-4.40	4.40-4.45	4.41	4.40-4.45	4.45-4.50	4.45	4.302
51	7	3.60-3.60	3.65-3.70	3.64	3.70-3.75	3.75-3.70	3.73	3.70-----	3.70-----	3.70	3.774
52	8	4.50-4.50	4.50-4.55	4.51	4.60-4.70	4.70-4.70	4.68	4.50-----	4.50-----	4.50	4.494
53	9	3.35-3.35	3.35-3.35	3.35	3.35-3.40	3.40-3.40	3.39	3.40-----	3.40-----	3.40	3.308
54	10	3.70-3.70	3.70-3.70	3.70	3.70-3.75	3.80-3.75	3.75	3.65-----	3.70-----	3.68	3.718
55	11	4.00-4.00	4.10-4.00	4.03	4.00-4.00	4.00-4.10	4.03	4.00-4.00	3.95-4.00	3.99	3.929
56	12	4.60-4.65	4.65-4.65	4.64	4.65-4.70	4.70-4.70	4.69	4.65-----	4.70-----	4.68	4.664
57	13	3.15-3.20	3.20-3.20	3.19	3.20-3.20	3.20-3.20	3.20	3.20-3.20	3.20-3.20	3.20	3.213
58	14	3.40-3.40	3.50-3.50	3.45	3.50-3.50	3.50-3.50	3.50	3.40-3.40	3.45-3.50	3.44	3.442
59	15	3.20-3.20	3.30-3.30	3.25	3.30-3.35	3.30-3.35	3.33	3.30-3.30	3.25-3.35	3.30	3.699
60	16	3.30-3.35	3.35-3.40	3.35	3.35-3.40	3.40-3.40	3.39	3.45-3.50	3.40-3.40	3.44	3.038
61	17	3.55-3.60	3.60-3.55	3.58	3.60-3.60	3.50-3.55	3.56	3.55-3.60	3.50-3.55	3.55	3.491
62	20	3.40-3.45	3.50-3.45	3.45	3.40-3.40	3.50-3.45	3.44	3.50-3.50	3.55-3.50	3.51	3.387
63	21	4.00-4.05	4.00-4.00	4.01	4.00-4.05	4.05-4.10	4.05	4.00-4.00	4.00-4.05	4.01	3.936
64	22	3.35-3.40	3.35-3.35	3.36	3.35-3.35	3.25-3.30	3.31	3.40-3.40	3.25-3.35	3.35	3.372
65	23	2.95-3.00	3.05-3.00	3.00	2.95-2.95	3.00-3.00	2.98	3.00-3.05	3.05-3.00	3.03	2.990
66	24	3.30-3.35	3.40-3.35	3.35	3.40-3.40	3.40-3.40	3.40	3.40-3.45	3.45-3.45	3.44	3.386
67	25	3.65-3.65	3.65-3.65	3.65	3.65-3.70	3.70-3.75	3.70	3.70-3.70	3.70-3.65	3.69	3.672
68	26	3.50-3.55	3.65-3.55	3.56	3.50-3.50	3.60-3.60	3.55	3.60-3.60	3.60-3.60	3.60	3.566
69	27	4.50-4.45	4.50-4.50	4.49	4.50-4.50	4.50-4.50	4.50	4.50-4.50	4.50-4.50	4.50	4.468
70	56	3.60-3.70	3.60-3.70	3.65	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.699
71	50	3.30-3.30	3.35-3.35	3.33	3.30-3.30	3.35-3.30	3.31	3.30-3.30	3.40-3.40	3.35	3.321
72	51	3.70-3.70	3.65-3.70	3.69	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.75-3.70	3.71	3.662
73	54	2.95-3.00	3.10-3.00	3.01	3.00-3.00	3.00-3.00	3.00	3.00-3.00	3.00-3.05	3.01	2.996
74	59	4.50-4.50	4.55-4.55	4.53	4.50-4.50	4.50-4.50	4.50	4.50-4.50	4.50-4.50	4.50	4.415
75	61	3.75-3.80	3.80-3.80	3.79	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.85	3.81	3.886
76	62	3.40-3.40	3.40-3.50	3.43	3.45-3.50	3.40-3.40	3.44	3.40-3.45	3.45-3.45	3.44	3.506
77	66	3.80-3.80	3.85-3.80	3.81	3.80-3.80	3.75-3.80	3.79	3.85-3.90	3.80-3.80	3.84	3.715

Table IV Patrons' Milk Samples Tested February 8, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
78	2	3.30-3.35	3.30-3.35	3.33	3.30-3.35	3.35-3.30	3.33	3.30-3.35	3.40-3.35	3.35	3.286
79	4	3.70-3.75	3.60-3.65	3.68	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.623
80	5	3.80-3.80	3.80-3.85	3.81	3.85-3.90	3.85-3.85	3.86	3.80-3.80	3.85-3.85	3.83	4.015
81	6	4.65-4.70	4.65-4.70	4.68	4.70-----	4.70-----	4.70	4.70-4.70	4.80-4.75	4.74	4.604
82	7	4.30-4.30	4.25-4.25	4.28	4.25-4.30	4.20-4.20	4.24	4.25-4.30	4.25-4.30	4.28	4.249
83	8	4.50-4.50	4.40-4.40	4.45	4.50-----	4.45-----	4.48	4.45-4.50	4.50-4.50	4.49	4.318
84	9	3.30-3.35	3.35-3.35	3.34	3.35-3.40	3.35-3.40	3.38	3.40-3.40	3.50-3.50	3.45	3.294
85	10	3.30-3.30	3.30-3.30	3.30	3.30-3.35	3.30-3.35	3.33	3.35-3.35	3.35-3.40	3.36	3.325
86	11	3.80-3.80	3.75-3.80	3.79	3.80-3.85	3.75-3.80	3.80	3.85-3.80	3.85-3.90	3.85	3.702
87	12	4.55-4.55	4.55-4.50	4.54	4.50-4.50	4.50-4.50	4.50	4.60-4.60	4.60-4.65	4.61	4.390
88	14	3.75-3.75	3.75-3.80	3.76	3.80-3.80	3.80-3.80	3.80	3.75-3.80	3.80-3.85	3.80	3.732
89	15	3.60-3.60	3.60-3.60	3.60	3.60-3.70	3.60-3.70	3.65	3.70-3.65	3.70-3.65	3.68	3.589
90	16	3.40-3.40	3.40-3.40	3.40	3.35-3.40	3.35-3.40	3.38	3.45-3.50	3.40-3.40	3.44	3.385
91	17	3.45-3.50	3.40-3.45	3.45	3.45-3.50	3.45-3.50	3.48	3.50-3.50	3.50-3.50	3.50	3.433
92	20	3.60-3.65	3.65-3.65	3.64	3.70-3.65	3.70-3.65	3.68	3.75-3.80	3.85-3.90	3.83	3.572
93	21	3.95-4.00	4.00-4.00	3.99	4.00-4.05	3.95-4.00	4.00	4.00-4.00	4.00-4.00	4.00	3.948
94	22	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.60-3.60	3.61	3.65-3.70	3.70-3.70	3.69	3.544
95	23	3.20-3.20	3.20-3.20	3.20	3.15-3.20	3.20-3.20	3.19	3.20-3.20	3.20-3.25	3.21	3.174
96	24	3.25-3.25	3.30-3.30	3.28	3.30-3.30	3.30-3.30	3.30	3.25-3.30	3.30-3.35	3.30	3.329
97	25	3.90-3.90	3.85-3.85	3.88	3.90-3.90	3.90-3.90	3.90	3.95-3.95	3.95-4.00	3.96	3.364
98	26	3.70-3.70	3.70-3.75	3.71	3.70-3.75	3.70-3.75	3.73	3.80-3.80	3.80-3.80	3.80	3.760
99	27	4.50-4.50	4.55-4.55	4.53	4.50-4.50	4.50-4.50	4.50	4.60-4.60	4.55-4.55	4.58	4.397
100	36	3.65-3.70	3.70-3.70	3.69	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.75-3.75	3.73	3.661
101	50	3.60-3.60	3.55-3.50	3.56	3.60-3.60	3.55-3.60	3.59	3.60-3.65	3.65-3.65	3.64	3.600
102	51	3.90-3.90	3.90-3.90	3.90	3.85-3.90	3.85-3.90	3.88	3.85-3.90	3.85-3.85	3.86	3.702
103	54	3.30-3.35	3.40-3.40	3.36	3.35-3.40	3.35-3.40	3.38	3.40-3.40	3.35-3.35	3.38	3.315
104	59	4.35-4.35	4.40-4.40	4.38	4.35-4.40	4.35-4.40	4.38	4.30-4.35	4.30-4.40	4.34	4.087
105	61	3.60-3.60	3.60-3.60	3.60	3.55-3.60	3.55-3.50	3.55	3.60-3.60	3.60-3.60	3.60	3.474
106	62	3.20-3.20	3.10-3.05	3.14	3.20-3.20	3.10-3.10	3.15	3.10-3.10	3.10-3.15	3.11	3.246
107	66	3.25-3.30	3.20-3.25	3.25	3.20-3.20	3.20-3.20	3.20	3.20-3.20	3.20-3.25	3.21	3.206

Table V Patrons' Milk Samples Tested February 15, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Average	Reader A	Reader B	Average	Reader A	Reader B	Average	
108	2	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.70-3.75	3.75-3.75	3.74	3.569
109	4	3.65-3.65	3.65-3.65	3.65	3.70-3.70	3.70-3.70	3.70	3.65-3.70	3.60-3.65	3.65	3.556
110	5	3.90-3.95	3.95-4.00	3.95	4.00-4.00	4.00-4.00	4.00	4.00-4.05	4.05-4.05	4.04	4.009
111	7	3.90-3.90	3.90-3.85	3.89	3.95-3.90	3.90-3.90	3.91	3.95-4.00	3.95-3.95	3.96	3.840
112	8	4.20-4.20	4.20-4.20	4.20	4.20-4.25	4.20-4.25	4.23	4.25-4.25	4.20-4.25	4.24	4.160
113	9	3.50-3.55	3.50-3.50	3.51	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.55-3.60	3.60	3.521
114	10	3.90-3.95	3.95-4.00	3.95	4.00-4.00	4.05-4.00	4.01	4.00-4.05	4.00-4.00	4.01	4.007
115	11	3.90-3.90	3.95-3.90	3.91	4.00-4.00	4.00-4.00	4.00	4.00-4.00	4.05-4.00	4.01	3.956
116	12	3.90-----	3.90-----	3.90	3.90-3.90	3.85-3.90	3.89	3.90-3.90	3.90-3.90	3.90	3.807
117	13	3.30-3.25	3.30-3.20	3.26	3.30-3.35	3.30-3.30	3.31	3.30-3.35	3.35-3.35	3.34	3.261
118	14	3.70-3.70	3.70-3.70	3.70	3.75-3.80	3.70-3.75	3.75	3.80-3.80	3.70-3.75	3.76	3.627
119	15	3.55-3.55	3.55-3.50	3.54	3.50-3.65	3.45-3.70	3.58	3.60-3.60	3.65-3.65	3.63	3.555
120	16	3.15-3.20	3.10-3.15	3.15	3.20-3.20	3.20-3.20	3.20	3.20-3.20	3.20-3.20	3.20	3.148
121	17	3.75-3.70	3.70-3.70	3.71	3.75-3.80	3.80-3.80	3.79	3.70-3.70	3.80-3.75	3.74	3.722
122	20	3.40-3.45	3.40-3.40	3.41	3.45-3.50	3.40-3.45	3.45	3.50-3.50	3.50-3.50	3.50	3.474
123	21	4.15-4.10	4.10-4.05	4.10	4.20-4.20	4.15-4.20	4.19	4.20-4.20	4.20-4.20	4.20	3.852
124	22	3.40-3.45	3.40-3.45	3.43	3.50-3.50	3.50-3.50	3.50	3.55-3.60	3.50-3.50	3.54	3.315
125	25	3.70-3.65	3.70-3.65	3.68	3.80-3.75	3.75-3.70	3.75	3.75-3.80	3.70-3.75	3.75	3.580
126	26	3.75-3.75	3.70-3.75	3.74	3.70-3.75	3.70-3.75	3.73	3.80-3.75	3.75-3.70	3.75	3.749
127	36	3.75-3.75	3.75-3.75	3.75	3.75-3.80	3.80-3.80	3.79	3.80-3.85	3.80-3.80	3.81	3.768
128	50	3.60-3.60	3.60-3.60	3.60	3.70-3.70	3.70-3.70	3.70	3.60-3.60	3.60-3.65	3.61	3.454
129	51	3.80-3.85	3.80-3.80	3.81	3.85-3.85	3.85-3.85	3.85	3.85-3.90	3.85-3.90	3.88	3.687
130	54	3.35-3.35	3.30-3.30	3.33	3.35-3.40	3.30-3.30	3.34	3.35-3.30	3.30-3.30	3.31	3.234
131	59	4.30-4.35	4.30-4.30	4.31	4.40-4.40	4.35-4.40	4.39	4.40-4.40	4.35-4.35	4.38	4.260
132	61	4.00-4.00	4.00-4.00	4.00	4.05-4.10	4.05-4.05	4.06	4.05-4.10	4.00-4.00	4.04	4.207
133	62	3.30-3.30	3.30-3.25	3.29	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.35-3.30	3.31	3.241
134	66	3.40-3.35	3.40-3.35	3.38	3.40-3.40	3.40-3.40	3.40	3.40-3.45	3.40-3.40	3.41	3.307

Table VI Patrons' Milk Samples Tested February 15, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Average	Reader A	Reader B	Average	Reader A	Reader B	Average	
135	2	3.45-3.45	3.40-3.45	3.44	3.45-3.50	3.50-3.50	3.49	3.55-3.60	3.55-3.60	3.58	3.428
136	4	3.60-3.60	3.60-3.65	3.61	3.60-3.65	3.70-3.75	3.68	3.70-----	3.70-----	3.70	3.596
137	5	3.85-3.95	3.90-3.95	3.91	3.90-3.95	3.95-4.00	3.95	4.00-----	4.00-----	4.00	3.856
138	6	4.40-4.45	4.40-4.45	4.43	4.40-4.40	4.45-4.45	4.43	4.40-----	4.45-----	4.43	4.325
139	7	3.80-3.85	3.80-3.90	3.84	3.85-3.90	3.85-3.85	3.86	3.95-4.00	3.95-4.00	3.98	3.794
140	8	4.10-4.10	4.10-4.15	4.11	4.00-4.00	4.10-4.10	4.05	4.05-4.15	4.05-4.15	4.10	4.064
141	9	3.55-3.60	3.60-3.65	3.60	3.60-3.60	3.60-3.60	3.60	3.70-3.70	3.70-3.70	3.70	3.536
142	10	3.55-3.60	3.60-3.60	3.59	3.60-3.60	3.60-3.60	3.60	3.65-3.70	3.65-3.70	3.68	3.544
143	11	3.95-4.00	3.95-4.00	3.98	3.95-4.00	3.95-4.00	3.98	4.00-4.00	4.10-4.10	4.05	3.913
144	12	4.60-4.60	4.65-4.65	4.63	4.60-----	4.65-----	4.63	4.60-----	4.60-----	4.60	4.579
145	13	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.50-3.50	3.50	3.60-3.60	3.60-3.60	3.60	3.491
146	14	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.75-3.80	3.74	3.75-3.80	3.75-3.80	3.78	3.646
147	15	3.65-3.70	3.70-3.70	3.69	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.80	3.80	3.745
148	16	3.25-3.20	3.25-3.25	3.24	3.25-3.25	3.30-3.30	3.28	3.30-3.30	3.30-3.35	3.31	3.233
149	17	3.40-3.40	3.50-3.40	3.43	3.40-3.45	3.45-3.50	3.45	3.45-3.50	3.40-3.45	3.45	3.393
150	20	3.40-3.40	3.40-3.45	3.41	3.45-3.45	3.50-3.50	3.48	3.50-3.50	3.50-3.50	3.50	3.449
151	21	4.00-4.05	4.00-4.00	4.01	4.10-4.10	4.10-4.10	4.10	4.05-4.05	4.10-4.05	4.06	3.957
152	22	3.65-3.70	3.70-3.70	3.69	3.70-3.75	3.75-3.75	3.74	3.75-3.75	3.70-3.75	3.74	3.695
153	23	3.05-3.10	3.10-3.05	3.08	3.05-3.10	3.10-3.10	3.09	3.05-3.10	3.10-3.10	3.09	2.993
154	24	3.25-3.30	3.30-3.30	3.29	3.30-3.30	3.35-3.35	3.33	3.40-3.40	3.30-3.35	3.36	3.213
155	25	3.70-3.75	3.70-3.75	3.73	3.75-3.75	3.80-3.85	3.79	3.75-3.80	3.80-3.80	3.79	3.619
156	26	3.60-3.60	3.60-3.65	3.61	3.65-3.60	3.70-3.65	3.65	3.65-3.70	3.70-3.70	3.69	3.522
157	27	3.70-3.75	3.70-3.70	3.71	3.70-3.75	3.75-3.80	3.75	3.70-3.70	3.70-3.75	3.71	3.642
158	36	3.70-3.75	3.65-3.70	3.70	3.70-3.70	3.80-3.75	3.74	3.70-3.70	3.75-3.70	3.71	3.625
159	50	3.50-3.60	3.55-3.55	3.55	3.60-3.60	3.60-3.60	3.60	3.60-3.70	3.60-3.70	3.65	3.465
160	51	3.50-3.50	3.50-3.55	3.51	3.65-3.60	3.65-3.65	3.64	3.60-3.70	3.70-3.70	3.68	3.525
161	54	3.60-3.50	3.60-3.55	3.56	3.60-3.65	3.60-3.60	3.61	3.60-3.60	3.60-3.60	3.60	3.554
162	59	4.10-4.15	4.15-4.20	4.15	4.25-4.20	4.30-4.25	4.25	4.20-4.25	4.20-4.25	4.23	4.128
163	61	3.70-3.75	3.70-3.75	3.73	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.75-3.70	3.76	3.714
164	62	3.30-3.20	3.30-3.20	3.25	3.35-3.35	3.40-3.35	3.36	3.30-3.40	3.30-3.40	3.35	3.265
165	66	3.40-3.40	3.40-3.40	3.40	3.40-3.45	3.50-3.55	3.48	3.50-3.50	3.50-3.55	3.51	3.371

Table VII Patrons' Milk Samples Tested February 17, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
166	2	3.50-3.50	3.50-3.55	3.51	3.55-3.60	3.55-3.55	3.56	3.55-3.60	3.60-3.60	3.59	3.489
167	4	3.65-3.65	3.70-3.70	3.68	3.70-3.75	3.70-3.80	3.74	3.70-3.70	3.70-3.75	3.71	3.643
168	5	3.75-3.80	3.70-3.80	3.76	3.90-3.90	3.90-3.90	3.90	3.80-3.85	3.90-3.90	3.86	3.752
169	7	3.90-3.90	3.90-3.90	3.90	3.90-3.90	3.90-3.95	3.91	3.95-3.95	4.00-4.00	3.98	3.865
170	8	4.20-4.20	4.20-4.20	4.20	4.20-4.10	4.20-4.15	4.16	4.20-4.20	4.20-4.25	4.21	4.166
171	9	3.45-3.45	3.50-3.50	3.48	3.55-3.60	3.50-3.55	3.55	3.55-3.55	3.55-3.60	3.56	3.468
172	10	3.35-3.40	3.40-3.40	3.39	3.40-3.45	3.45-3.50	3.45	3.40-3.40	3.40-3.40	3.40	3.349
173	11	3.90-3.90	3.85-3.95	3.90	3.90-3.90	3.90-3.90	3.90	3.90-3.90	3.90-3.95	3.91	3.861
174	13	3.50-3.50	3.50-3.50	3.50	3.60-3.60	3.60-3.55	3.59	3.60-3.65	3.65-3.65	3.64	3.588
175	14	3.40-3.45	3.50-3.50	3.46	3.45-3.45	3.50-3.50	3.48	3.50-3.50	3.50-3.50	3.50	3.415
176	15	3.50-----	3.50-3.50	3.50	3.50-3.55	3.55-3.55	3.54	3.55-3.55	3.60-3.60	3.58	3.495
177	16	3.30-3.30	3.30-3.30	3.30	3.40-3.35	3.35-3.35	3.36	3.40-3.40	3.35-3.40	3.39	3.315
178	17	3.35-3.40	3.35-3.40	3.38	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.50-3.50	3.50	3.440
179	20	3.25-3.25	3.30-3.30	3.28	3.35-3.35	3.35-3.40	3.36	3.40-3.40	3.35-3.40	3.39	3.314
180	21	4.05-4.05	4.10-4.15	4.09	4.10-4.10	4.15-4.10	4.11	4.10-4.15	4.05-4.10	4.10	4.053
181	22	3.45-3.40	3.40-3.40	3.41	3.50-3.50	3.50-3.55	3.51	3.55-3.50	3.55-3.55	3.54	3.429
182	23	3.05-3.00	3.10-3.05	3.05	3.10-3.10	3.10-3.10	3.10	3.15-3.10	3.10-3.10	3.11	3.034
183	24	3.10-3.15	3.15-3.20	3.15	3.20-3.20	3.20-3.20	3.20	3.25-3.25	3.25-3.20	3.24	3.139
184	25	3.45-3.45	3.45-3.45	3.45	3.55-3.50	3.55-3.50	3.53	3.60-3.60	3.60-3.55	3.59	3.450
185	26	3.70-3.75	3.70-3.75	3.73	3.80-3.85	3.75-3.80	3.80	3.85-3.85	3.85-3.90	3.86	3.788
186	27	4.25-4.20	4.20-4.20	4.21	4.30-4.30	4.25-4.20	4.26	4.20-4.20	4.15-4.20	4.19	4.121
187	36	3.70-3.70	3.70-3.65	3.69	3.75-3.70	3.75-3.70	3.73	3.70-3.70	3.70-3.70	3.70	3.667
188	50	3.55-3.60	3.60-3.60	3.59	3.65-3.70	3.65-3.65	3.66	3.65-3.70	3.70-3.70	3.69	3.521
189	51	3.75-3.75	3.75-3.75	3.75	3.80-3.80	3.85-3.85	3.83	3.80-3.80	3.80-3.80	3.80	3.803
190	54	3.55-3.50	3.55-3.50	3.53	3.55-3.55	3.60-3.60	3.58	3.55-3.60	3.55-3.55	3.56	3.491
191	59	4.30-4.30	4.35-4.35	4.33	4.40-4.40	4.40-4.40	4.40	4.40-4.40	4.40-4.40	4.40	4.289
192	61	3.80-3.90	3.85-3.85	3.85	3.90-3.90	4.00-4.00	3.95	3.90-3.90	3.95-3.95	3.93	3.810
193	62	3.45-3.45	3.45-3.45	3.45	3.50-3.50	3.55-3.55	3.53	3.45-3.55	3.45-3.50	3.49	3.448
194	66	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.35-3.35	3.33	3.40-3.40	3.40-3.40	3.40	3.282

Table VIII Patrons' Milk Samples Tested February 20, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
195	2	3.20-3.20	3.25-3.30	3.24	3.20-3.20	3.25-3.25	3.23	3.20-3.25	3.25-3.25	3.24	3.183
196	4	3.70-3.75	3.80-3.80	3.76	3.70-3.75	3.75-3.80	3.75	3.70-3.70	3.80-3.75	3.74	3.661
197	5	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.75-3.75	3.73	3.70-3.70	3.70-3.70	3.70	3.602
198	7	4.00-4.00	4.05-4.00	4.01	4.00-4.00	4.00-4.00	4.00	4.00-4.00	4.00-4.05	4.01	3.904
199	9	3.40-3.40	3.40-3.40	3.40	3.40-3.40	3.45-3.40	3.41	3.35-3.40	3.35-3.40	3.38	3.303
200	10	3.35-3.30	3.30-3.30	3.31	3.40-3.45	3.35-3.40	3.40	3.45-3.40	3.40-3.40	3.41	3.396
201	11	4.90-4.95	4.90-4.95	4.93	4.90-----	4.85-----	4.88	4.80-----	4.85-----	4.83	3.756
202	12	3.85-3.90	3.80-3.80	3.84	3.80-3.85	3.80-3.85	3.83	3.85-3.85	3.85-3.85	3.85	4.777
203	13	3.45-3.45	3.40-3.40	3.43	3.30-3.35	3.30-3.35	3.33	3.35-3.40	3.30-3.30	3.34	3.264
204	14	3.35-3.35	3.35-3.30	3.34	3.40-3.40	3.40-3.45	3.41	3.40-3.45	3.40-3.45	3.43	3.302
205	15	3.50-3.50	3.50-3.55	3.51	3.50-3.60	3.50-3.55	3.54	3.50-3.50	3.50-3.50	3.50	3.482
206	16	3.30-3.30	3.30-3.35	3.31	3.35-3.30	3.35-3.30	3.33	3.40-3.40	3.30-3.30	3.35	3.255
207	17	3.60-3.60	3.55-3.55	3.58	3.55-3.55	3.55-3.60	3.56	3.60-3.60	3.60-3.60	3.60	3.483
208	20	3.30-3.30	3.35-3.30	3.31	3.25-3.30	3.35-3.30	3.30	3.35-3.35	3.30-3.30	3.33	3.236
209	21	4.50-4.55	4.50-4.55	4.53	4.60-4.60	4.60-4.60	4.60	4.50-----	4.60-----	4.55	4.496
210	22	3.40-3.45	3.40-3.40	3.41	3.35-3.40	3.40-3.40	3.39	3.45-3.50	3.40-3.45	3.45	3.339
211	23	2.95-3.00	2.95-3.00	2.98	3.00-3.00	3.00-3.00	3.00	3.00-3.00	3.00-3.00	3.00	2.932
212	24	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.30-3.30	3.30	3.231
213	25	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.667
214	26	3.45-3.50	3.45-3.45	3.46	3.50-3.50	3.50-3.55	3.51	3.50-3.55	3.50-3.50	3.51	3.475
215	27	4.25-4.30	4.30-4.30	4.29	4.30-----	4.25-----	4.28	4.20-4.25	4.30-4.30	4.26	4.209
216	56	3.80-3.75	3.80-3.80	3.79	3.75-3.80	3.80-3.80	3.79	3.80-3.80	3.80-3.80	3.80	3.721
217	66	3.60-3.65	3.65-3.70	3.65	3.65-3.65	3.70-3.70	3.68	3.65-----	3.65-----	3.65	3.638

Table IX Patrons' Milk Samples Tested February 22, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
218	2	3.45-3.45	3.50-3.50	3.48	3.45-3.50	3.45-3.50	3.48	3.50-3.50	3.50-3.45	3.49	3.409
219	4	3.65-3.70	3.65-3.70	3.68	3.60-3.65	3.70-3.70	3.66	3.65-3.65	3.60-3.65	3.64	3.556
220	5	3.95-4.00	4.00-4.00	3.99	3.90-3.95	3.95-3.95	3.94	3.95-4.00	3.95-4.00	3.98	3.871
221	6	4.65-4.70	4.65-4.65	4.66	4.60-4.60	4.60-4.60	4.60	4.60-----	4.70-4.65	4.65	4.557
222	7	3.85-3.85	3.90-3.90	3.88	3.80-3.80	3.85-3.90	3.84	3.95-4.00	3.90-3.95	3.95	3.787
223	8	4.45-4.50	4.50-4.50	4.49	4.40-4.50	4.50-4.50	4.48	4.45-4.40	4.45-4.45	4.44	4.385
224	9	3.60-3.60	3.65-3.65	3.63	3.60-3.60	3.55-3.60	3.59	3.60-3.60	3.60-3.60	3.60	3.579
225	10	3.70-3.70	3.75-3.70	3.71	3.70-3.70	3.70-3.70	3.70	3.70-3.75	3.70-3.70	3.71	3.687
226	11	3.90-3.95	3.90-3.95	3.93	3.90-3.90	3.90-3.90	3.90	3.90-3.90	3.90-3.95	3.91	3.855
227	13	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.60-3.60	3.60	3.65-3.60	3.65-3.60	3.63	3.554
228	14	3.55-3.60	3.60-3.60	3.59	3.60-3.60	3.50-3.55	3.56	3.50-3.50	3.55-3.50	3.51	3.456
229	15	3.35-3.40	3.40-3.45	3.40	3.40-3.40	3.40-3.45	3.41	3.40-3.40	3.40-3.40	3.40	3.339
230	16	3.30-3.30	3.35-3.30	3.31	3.30-3.30	3.30-3.30	3.30	3.40-3.40	3.30-3.30	3.35	3.232
231	17	3.45-3.45	3.45-3.50	3.46	3.40-3.45	3.45-3.45	3.44	3.50-3.50	3.40-3.40	3.45	3.405
232	20	3.40-3.40	3.40-3.40	3.40	3.40-3.45	3.40-3.40	3.41	3.50-3.45	3.40-3.40	3.44	3.372
233	21	4.10-4.15	4.10-4.15	4.13	4.15-4.10	4.15-4.15	4.14	4.15-4.10	4.15-4.10	4.13	4.105
234	22	3.35-3.40	3.30-3.30	3.34	3.45-3.35	3.40-3.30	3.38	3.40-3.40	3.35-3.35	3.38	3.339
235	23	3.05-3.10	3.10-3.10	3.09	3.05-3.10	3.05-3.05	3.06	3.10-3.10	3.10-3.10	3.10	3.048
236	24	3.20-3.20	3.20-3.20	3.20	3.20-3.20	3.20-3.20	3.20	3.30-3.25	3.25-3.25	3.26	3.159
237	25	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.60-3.60	3.61	3.60-3.60	3.70-3.60	3.63	3.589
238	26	3.35-3.35	3.40-3.40	3.38	3.35-3.35	3.30-3.30	3.33	3.35-3.40	3.30-3.40	3.36	3.309
239	27	4.35-4.40	4.30-4.35	4.35	4.40-4.35	4.40-4.35	4.38	4.40-4.35	4.35-4.35	4.36	4.288
240	36	3.70-3.70	3.70-3.70	3.70	3.80-3.75	3.70-3.70	3.74	3.75-3.75	3.70-3.70	3.73	3.732
241	50	3.60-3.65	3.65-3.70	3.65	3.70-3.70	3.65-3.65	3.68	3.70-3.70	3.70-3.70	3.70	3.529
242	51	3.80-3.75	3.80-3.70	3.76	3.80-3.80	3.75-3.80	3.79	3.75-3.80	3.75-3.80	3.78	3.692
243	54	3.20-3.25	3.25-3.25	3.24	3.30-3.30	3.20-3.20	3.25	3.25-3.30	3.25-3.30	3.28	3.205
244	59	4.30-4.25	4.30-4.30	4.29	4.40-4.35	4.30-4.30	4.34	4.30-4.35	4.30-4.35	4.33	4.007
245	61	3.60-3.60	3.65-3.60	3.61	3.65-3.60	3.70-3.65	3.65	3.60-3.60	3.60-3.60	3.60	3.576
246	66	3.55-3.50	3.50-3.50	3.51	3.55-3.55	3.50-3.50	3.53	3.60-3.60	3.60-3.55	3.59	3.511

Table X Patrons' Milk Samples Tested February 24, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Average	Reader A	Reader B	Average	Reader A	Reader B	Average	
247	2	3.15-3.20	3.10-3.15	3.15	3.15-3.15	3.10-3.15	3.14	3.20-3.20	3.20-3.15	3.19	3.100
248	4	3.40-3.40	3.35-3.35	3.38	3.35-3.40	3.40-3.45	3.40	3.40-3.40	3.40-3.35	3.39	3.402
249	5	3.65-3.70	3.70-3.70	3.69	3.60-3.60	3.65-3.60	3.61	3.60-3.65	3.65-3.70	3.65	3.574
250	6	4.90-4.90	4.85-4.90	4.89	4.90-4.90	4.90-4.90	4.90	4.90-4.90	4.90-4.90	4.90	4.858
251	7	3.85-3.90	3.80-3.85	3.85	3.90-3.90	3.80-3.80	3.85	3.90-3.90	3.95-3.90	3.91	3.778
252	8	4.40-4.40	4.35-4.40	4.39	4.35-4.40	4.30-4.35	4.35	4.30-4.30	4.30-4.30	4.30	4.295
253	9	3.60-3.65	3.55-3.50	3.58	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.55-3.55	3.59	3.566
254	10	3.65-3.65	3.70-3.70	3.68	3.65-3.70	3.65-3.65	3.66	3.60-3.60	3.65-3.65	3.63	3.601
255	11	3.80-3.85	3.80-3.80	3.81	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.80	3.80	3.779
256	12	4.70-4.70	4.75-4.70	4.71	4.65-4.70	4.65-4.65	4.66	4.70-4.70	4.70-4.70	4.70	4.712
257	13	3.20-3.20	3.25-3.25	3.23	3.25-3.30	3.20-3.20	3.24	3.20-3.25	3.20-3.25	3.23	3.218
258	14	3.70-3.70	3.60-3.60	3.65	3.65-3.70	3.65-3.65	3.66	3.65-3.70	3.60-3.65	3.65	3.606
259	15	3.65-3.70	3.60-3.65	3.65	3.60-3.70	3.65-3.70	3.66	3.70-3.70	3.65-3.70	3.69	3.656
260	16	3.10-3.15	3.10-3.10	3.11	3.10-3.20	3.10-3.15	3.14	3.15-3.20	3.10-3.10	3.14	3.085
261	17	3.70-3.70	3.65-3.70	3.69	3.65-3.70	3.65-3.65	3.66	3.70-3.75	3.65-3.70	3.70	3.651
262	20	3.60-3.60	3.60-3.60	3.60	3.65-3.65	3.65-3.65	3.65	3.75-3.75	3.65-3.60	3.69	3.605
263	21	4.00-4.05	4.00-4.00	4.01	4.00-4.00	4.00-4.05	4.01	4.00-4.05	4.05-4.05	4.04	4.014
264	22	3.40-3.40	3.30-3.35	3.36	3.40-3.35	3.35-3.35	3.36	3.45-3.50	3.40-3.45	3.45	3.358
265	23	3.05-3.10	3.05-3.10	3.08	3.05-3.10	3.05-3.10	3.08	3.10-3.10	3.05-3.05	3.08	2.996
266	24	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.30-3.30	3.30	3.35-3.35	3.30-3.30	3.33	3.189
267	25	3.65-3.70	3.60-3.65	3.65	3.70-3.70	3.65-3.70	3.69	3.70-3.70	3.60-3.65	3.66	3.619
268	26	3.45-3.50	3.40-3.40	3.44	3.45-3.50	3.50-3.50	3.49	3.50-3.50	3.45-3.45	3.48	3.429
269	27	4.40-4.40	4.35-4.40	4.39	4.40-4.40	4.50-4.50	4.45	4.30-4.30	4.40-4.40	4.35	4.321
270	36	3.55-3.55	3.50-3.55	3.54	3.50-3.55	3.60-3.60	3.56	3.50-3.55	3.55-3.55	3.54	3.499
271	50	3.60-3.60	3.55-3.55	3.58	3.55-3.55	3.55-3.55	3.55	3.60-3.60	3.55-3.55	3.58	3.426
272	51	3.70-3.75	3.65-3.60	3.68	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.621
273	54	3.45-3.50	3.50-3.55	3.50	3.45-3.50	3.50-3.50	3.49	3.50-3.50	3.50-3.50	3.50	3.406
274	59	4.30-4.30	4.35-4.30	4.31	4.30-4.30	4.30-4.30	4.30	4.30-4.30	4.30-4.35	4.31	3.880
275	61	4.00-4.00	4.00-4.00	4.00	4.00-4.05	4.00-4.05	4.03	3.95-4.00	3.90-3.95	3.95	3.802
276	66	3.40-3.45	3.40-3.45	3.43	3.45-3.45	3.45-3.40	3.44	3.50-3.50	3.45-3.45	3.48	3.375

Table XI Patrons' Milk Samples Tested February 27, 1933.

Sample No.	Patron No.	Low Temperature Reader A	Low Temperature Reader B	Low Temperature Average	Medium Temperature Reader A	Medium Temperature Reader B	Medium Temperature Average	High Temperature Reader A	High Temperature Reader B	High Temperature Average	Chemical Test
277	2	3.20-3.20	3.20-3.15	3.19	3.20-3.20	3.20-3.20	3.20	3.30-3.30	3.30-3.30	3.30	3.203
278	4	3.60-3.60	3.60-3.60	3.60	3.65-3.65	3.60-3.60	3.63	3.65-3.65	3.60-3.65	3.64	3.566
279	5	3.75-3.80	3.85-3.85	3.81	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.80	3.80	3.745
280	6	4.90-4.90	4.90-4.90	4.90	4.90-4.90	4.95-4.90	4.91	4.90-4.90	4.90-4.90	4.90	4.761
281	7	3.90-3.90	3.90-3.90	3.90	3.90-3.90	3.90-3.90	3.90	3.90-3.95	4.00-3.99	3.94	3.855
282	8	4.30-4.30	4.30-4.30	4.30	4.30-4.30	4.30-4.30	4.30	4.25-4.30	4.30-4.30	4.29	4.205
283	9	3.50-3.50	3.50-3.50	3.50	3.55-3.60	3.50-3.50	3.54	3.60-3.60	3.50-3.50	3.55	3.483
284	10	3.55-3.55	3.55-3.55	3.55	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.60-3.55	3.59	3.540
285	11	3.90-3.95	3.95-3.95	3.94	3.95-----	3.95-----	3.95	4.00-4.00	3.90-3.90	3.95	3.737
286	12	4.40-4.45	4.40-4.45	4.43	4.40-4.45	4.40-4.40	4.41	4.45-4.45	4.40-4.40	4.43	4.313
287	13	3.50-3.50	3.55-3.55	3.53	3.60-3.60	3.60-3.60	3.60	3.70-3.70	3.60-3.60	3.65	3.567
288	14	3.70-3.70	3.70-3.70	3.70	3.80-3.80	3.75-3.80	3.79	3.85-3.85	3.75-3.70	3.79	3.779
289	15	3.55-3.60	3.55-3.60	3.58	3.55-3.55	3.60-3.60	3.58	3.55-3.60	3.60-3.60	3.59	4.236
290	17	3.60-3.60	3.60-3.60	3.60	3.55-3.60	3.55-3.60	3.58	3.60-3.60	3.50-3.50	3.55	3.540
291	20	3.40-3.40	3.40-3.40	3.40	3.40-3.45	3.40-3.40	3.41	3.40-3.40	3.40-3.40	3.40	3.396
292	21	4.00-4.05	4.00-4.00	4.01	4.00-4.00	4.00-4.00	4.00	4.00-4.00	4.00-4.00	4.00	3.939
293	22	3.50-3.50	3.50-3.50	3.50	3.50-3.55	3.50-3.50	3.51	3.55-3.60	3.55-3.60	3.58	3.468
294	23	3.30-3.30	3.30-3.30	3.30	3.25-3.30	3.25-3.25	3.26	3.30-3.35	3.30-3.30	3.31	3.310
295	24	3.05-3.10	3.10-3.10	3.09	3.05-3.10	3.10-3.10	3.09	3.15-3.10	3.10-3.10	3.11	3.053
296	25	3.35-3.40	3.35-3.40	3.38	3.35-3.40	3.35-3.35	3.36	3.35-3.40	3.40-3.40	3.39	3.364
297	26	3.50-3.50	3.55-3.55	3.53	3.50-3.55	3.50-3.50	3.51	3.50-3.50	3.50-3.50	3.50	3.544
298	27	4.40-4.45	4.40-4.40	4.41	4.45-4.50	4.40-4.40	4.44	4.40-4.45	4.40-4.40	4.41	4.348
299	36	3.70-3.75	3.75-3.80	3.75	3.80-3.80	3.75-3.80	3.79	3.80-3.80	3.75-3.80	3.79	3.809
300	50	3.60-3.60	3.60-3.60	3.60	3.65-3.70	3.65-3.60	3.65	3.60-3.60	3.60-3.60	3.60	3.547
301	51	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.80	3.80	3.75-3.80	3.75-3.80	3.78	3.763
302	54	3.40-3.50	3.45-3.50	3.46	3.50-3.40	3.50-3.40	3.45	3.45-3.50	3.40-3.50	3.46	3.405
303	59	4.55-4.60	4.60-4.60	4.59	4.65-4.65	4.60-4.60	4.63	4.60-4.60	4.60-4.60	4.60	4.120
304	61	4.10-4.10	4.10-4.10	4.10	4.10-4.10	4.15-4.15	4.13	4.10-4.10	4.10-4.10	4.10	4.076
305	66	3.40-3.45	3.40-3.40	3.41	3.40-3.40	3.40-3.40	3.40	3.30-3.25	3.30-3.25	3.28	3.365

Table XII Patrons' Milk Samples Tested March 3, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
306	2	3.25-3.30		3.28	3.30-3.35	3.30-3.35	3.33	3.40-----	3.40-----	3.40	3.360
307	5	3.70-3.75		3.73	3.80-3.80	3.80-3.80	3.80	3.75-3.80	3.75-3.80	3.78	3.696
308	6	4.20-4.20		4.20	4.30-4.30	4.25-4.30	4.29	4.20-4.25	4.30-4.30	4.26	4.121
309	7	3.70-3.70		3.70	3.85-3.90	3.85-3.90	3.88	3.80-3.85	3.80-3.80	3.81	3.719
310	8	4.00-4.10		4.05	4.10-4.10	4.20-4.20	4.15	4.10-4.10	4.10-4.10	4.10	4.046
311	9	3.40-3.40		3.40	3.45-3.45	3.45-3.40	3.44	3.50-3.50	3.45-3.40	3.46	3.363
312	10	3.30-3.35		3.33	3.35-3.35	3.30-3.30	3.33	3.30-3.30	3.35-3.35	3.33	3.264
313	11	3.90-3.90		3.90	4.00-4.00	3.95-3.95	3.98	4.00-4.00	3.95-3.95	3.98	3.853
314	12	4.65-4.70		4.68	4.80-4.85	4.80-4.80	4.81	4.80-4.80	4.80-4.80	4.80	4.664
315	13	3.25-3.30		3.28	3.35-3.40	3.30-3.30	3.34	3.40-3.40	3.35-3.35	3.38	3.320
316	14	3.50-3.50		3.50	3.65-3.65	3.60-3.60	3.63	3.65-3.65	3.65-3.60	3.64	3.566
317	15	3.50-3.45		3.48	3.60-3.60	3.60-3.60	3.60	3.55-3.60	3.60-3.60	3.59	3.630
318	16	3.05-3.10		3.08	3.15-3.20	3.15-3.15	3.16	3.20-3.20	3.10-3.15	3.16	3.107
319	17	3.70-3.70		3.70	3.75-3.75	3.70-3.70	3.73	3.80-3.85	3.75-3.75	3.79	3.719
320	20	3.30-3.35		3.33	3.45-3.50	3.40-3.40	3.44	3.40-3.40	3.40-3.35	3.39	3.514
321	21	4.05-4.05		4.05	4.10-4.10	4.00-4.00	4.05	4.00-4.10	4.00-4.05	4.04	4.084
322	22	3.20-3.20		3.20	3.40-3.40	3.30-3.30	3.35	3.50-3.50	3.50-3.50	3.50	3.355
323	23	3.50-3.45		3.48	3.40-3.45	3.45-3.45	3.44	3.40-3.45	3.40-3.45	3.43	3.385
324	24	3.05-3.05		3.05	3.10-3.15	3.10-3.10	3.11	3.10-3.10	3.05-3.05	3.08	3.073
325	25	3.20-3.20		3.20	3.30-3.30	3.30-3.25	3.29	3.25-3.30	3.25-3.25	3.26	3.242
326	26	3.40-3.40		3.40	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.50-3.45	3.49	3.451
327	27	4.00-4.00		4.00	4.05-4.10	4.10-4.10	4.09	4.05-4.10	4.00-4.00	4.04	4.018
328	36	3.45-3.40		3.43	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.45-3.45	3.48	3.476
329	50	3.35-3.40		3.38	3.45-3.50	3.40-3.40	3.44	3.45-3.45	3.40-3.45	3.44	3.374
330	51	3.60-3.65		3.63	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.65-3.70	3.69	3.629
331	54	3.35-3.35		3.35	3.50-3.55	3.50-3.50	3.51	3.45-3.50	3.50-3.50	3.49	3.450
332	59	4.50-4.60		4.55	4.65-4.70	4.70-4.70	4.69	4.65-4.70	4.65-4.70	4.68	4.587
333	61	3.70-3.75		3.73	3.90-3.90	3.90-3.90	3.90	3.90-----	3.90-----	3.90	3.798
334	66	3.35-3.40		3.38	3.40-3.45	3.40-3.45	3.43	3.45-3.50	3.40-3.45	3.45	3.453

Table XIII Patrons' Milk Samples Tested March 14, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
335	2	3.45-3.50	3.55-3.55	3.51	3.50-3.55	3.50-3.50	3.51	3.50-3.55	3.50-3.50	3.51	3.420
336	4	3.65-3.70	3.60-3.70	3.66	3.70-3.75	3.70-3.70	3.71	3.70-3.75	3.70-3.70	3.71	3.585
337	5	3.85-3.90	3.80-3.85	3.85	3.90-3.90	3.85-3.80	3.86	3.90-3.90	3.90-3.90	3.90	3.689
338	6	5.10-5.10	5.10-5.10	5.10	5.10-5.10	5.10-5.10	5.10	5.10-5.10	5.05-5.05	5.08	4.860
339	7	3.85-3.85	3.85-3.80	3.84	3.95-3.95	3.90-3.90	3.93	3.95-4.00	4.00-4.00	3.99	3.816
340	8	4.30-4.35	4.30-4.35	4.33	4.35-4.40	4.35-4.40	4.38	4.35-4.35	4.35-4.40	4.36	4.224
341	9	3.50-3.55	3.55-3.60	3.55	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.60-3.60	3.60	3.522
342	10	3.85-3.90	3.85-3.85	3.86	3.90-3.90	3.90-3.85	3.89	3.90-3.90	3.90-3.90	3.90	3.761
343	11	4.20-4.25	4.20-4.20	4.21	4.20-4.25	4.20-4.20	4.21	4.20-4.30	4.20-4.25	4.24	4.122
344	12	5.00-5.05	5.10-5.10	5.06	5.00-5.05	5.05-5.10	5.05	5.00-5.00	5.00-5.05	5.01	4.821
345	13	4.05-4.10	4.10-4.10	4.09	4.10-4.10	4.10-4.10	4.10	4.20-4.20	4.15-4.15	4.18	4.022
346	14	3.75-3.80	3.75-3.80	3.78	3.80-3.80	3.85-3.85	3.83	3.70-3.70	3.75-3.75	3.73	3.675
347	15	3.45-3.45	3.45-3.45	3.45	3.45-3.50	3.45-3.50	3.48	3.50-3.50	3.55-----	3.52	3.469
348	16	3.30-3.30	3.35-3.35	3.33	3.35-3.40	3.35-3.40	3.38	3.40-3.40	3.40-3.35	3.39	3.258
349	17	3.60-3.65	3.65-3.65	3.64	3.75-3.70	3.70-3.70	3.71	3.65-3.70	3.70-3.70	3.69	3.587
350	20	3.65-3.70	3.65-3.70	3.68	3.70-3.70	3.70-3.70	3.70	3.60-3.70	3.70-3.70	3.68	3.661
351	21	4.30-4.35	4.30-4.30	4.31	4.30-4.35	4.30-4.40	4.34	4.35-4.40	4.30-4.30	4.34	4.243
352	22	3.60-3.65	3.60-3.60	3.61	3.65-3.70	3.70-3.70	3.69	3.65-3.70	3.70-3.70	3.69	3.581
353	23	3.40-3.45	3.40-3.45	3.43	3.45-3.45	3.50-3.45	3.46	3.50-3.50	3.45-3.45	3.48	3.364
354	24	3.20-3.20	3.15-3.15	3.18	3.20-3.20	3.20-3.20	3.20	3.20-3.25	3.20-3.20	3.21	3.127
355	25	3.55-3.60	3.65-3.65	3.61	3.65-3.65	3.70-3.70	3.68	3.70-3.70	3.70-3.70	3.70	3.525
356	26	3.65-3.70	3.65-3.65	3.66	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.650
357	27	5.10-5.15	5.15-5.20	5.15	5.20-5.20	5.20-5.20	5.20	5.15-5.15	5.15-5.20	5.16	5.052
358	36	3.45-3.50	3.45-3.45	3.46	3.50-3.50	3.55-3.55	3.53	3.50-3.50	3.50-3.55	3.51	3.439
359	50	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.70-3.70	3.66	3.60-3.70	3.70-3.65	3.66	3.569
360	51	3.90-3.90	3.90-3.90	3.90	3.95-3.95	4.00-3.95	3.96	3.95-3.95	3.95-3.90	3.94	3.777
361	54	3.55-3.60	3.55-3.55	3.56	3.65-3.70	3.70-3.70	3.69	3.60-3.70	3.65-3.70	3.66	3.575
362	59	4.50-4.50	4.50-4.50	4.50	4.50-4.50	4.55-4.55	4.53	4.50-4.50	4.50-4.50	4.50	4.002
363	61	3.70-3.70	3.75-3.80	3.74	3.80-3.80	3.85-3.85	3.83	3.80-3.80	3.80-3.80	3.80	3.591
364	66	3.20-3.20	3.20-3.20	3.20	3.25-3.30	3.30-3.30	3.29	3.25-3.25	3.30-3.30	3.28	3.209

Table XIV Patrons' Milk Samples Tested March 16, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
365	2	3.40-3.50	3.40-3.40	3.45	3.45-3.50	3.50-3.50	3.49	3.55-3.55	3.50-3.50	3.53	3.408
366	4	3.75-3.80	3.70-3.75	3.75	3.75-3.80	3.80-3.80	3.79	3.80-3.85	3.80-3.80	3.81	3.579
367	5	3.80-3.80	3.80-3.80	3.80	3.85-3.90	3.80-3.80	3.84	3.80-3.85	3.80-3.80	3.81	3.509
368	6	4.10-4.15	4.10-4.15	4.13	4.20-4.20	4.20-4.20	4.20	4.20-4.20	4.20-4.20	4.20	3.927
369	7	3.75-3.80	3.75-3.75	3.76	3.80-3.80	3.70-3.80	3.78	3.80-3.85	3.75-3.80	3.80	3.659
370	8	4.20-4.20	4.15-4.15	4.18	4.20-4.20	4.20-4.20	4.20	4.20-4.20	4.20-4.20	4.20	4.064
371	9	3.50-3.55	3.45-3.45	3.49	3.45-3.50	3.50-3.55	3.50	3.50-3.50	3.50-3.50	3.50	3.321
372	10	3.70-3.70	3.65-3.65	3.68	3.70-3.70	3.65-3.70	3.69	3.70-3.75	3.70-3.70	3.71	3.450
373	11	3.90-3.95	3.90-3.90	3.91	3.90-3.95	3.90-3.90	3.91	3.90-3.95	3.90-3.90	3.91	3.719
374	12	4.35-4.35	4.40-4.40	4.38	4.40-4.40	4.40-4.40	4.40	4.40-4.40	4.40-4.40	4.40	4.188
375	13	3.30-3.30	3.30-3.25	3.29	3.40-3.40	3.30-3.35	3.36	3.35-3.40	3.35-3.40	3.38	3.291
376	14	3.50-3.50	3.40-3.45	3.46	3.55-3.60	3.50-3.55	3.55	3.55-3.60	3.50-3.50	3.54	3.447
377	15	3.90-3.90	3.85-3.85	3.88	3.90-3.90	3.95-3.95	3.93	3.90-3.90	3.90-3.90	3.90	3.865
378	16	3.30-3.30	3.30-3.30	3.30	3.30-3.35	3.30-3.30	3.31	3.40-3.40	3.30-3.30	3.35	3.198
379	17	3.50-3.55	3.50-3.50	3.51	3.50-3.50	3.50-3.50	3.50	3.60-3.60	3.50-3.50	3.55	3.393
380	20	3.50-3.50	3.55-3.50	3.51	3.50-3.50	3.50-3.55	3.51	3.60-3.60	3.55-3.50	3.56	3.469
381	21	4.00-4.05	3.95-4.00	4.00	3.95-4.00	3.95-4.00	3.98	3.95-4.00	3.95-4.00	3.98	4.164
382	22	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.30-3.30	3.30	3.35-3.40	3.30-3.30	3.34	3.398
383	23	3.30-3.35	3.30-3.30	3.31	3.25-3.25	3.25-3.30	3.26	3.30-3.35	3.30-3.30	3.31	3.346
384	24	3.30-3.30	3.30-3.30	3.30	3.30-3.35	3.30-3.30	3.31	3.35-3.35	3.30-3.30	3.33	3.229
385	25	3.40-3.45	3.40-3.40	3.41	3.40-3.45	3.40-3.40	3.41	3.45-3.45	3.40-3.40	3.43	3.285
386	26	3.20-3.20	3.15-3.15	3.18	3.15-3.15	3.15-3.20	3.16	3.20-3.20	3.20-3.20	3.20	3.160
387	27	4.40-4.40	4.45-4.40	4.41	4.40-4.40	4.40-4.45	4.41	4.40-4.45	4.45-4.45	4.44	4.376
388	36	3.55-3.60	3.50-3.55	3.55	3.55-3.55	3.55-3.55	3.55	3.60-3.60	3.55-3.50	3.56	3.470
389	50	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.60-3.60	3.60	3.70-3.70	3.60-3.60	3.65	3.635
390	51	3.75-3.80	3.75-3.80	3.78	3.80-3.80	3.80-3.80	3.80	3.85-3.85	3.80-3.80	3.83	3.789
391	54	3.35-3.40	3.40-3.40	3.39	3.40-3.40	3.40-3.40	3.40	3.50-3.50	3.45-3.45	3.48	3.417
392	59	4.30-4.30	4.30-4.30	4.30	4.35-4.35	4.25-4.25	4.30	4.35-4.40	4.30-4.30	4.34	4.042
393	61	4.20-4.20	4.10-4.15	4.16	4.15-4.20	4.15-4.20	4.18	4.25-----	4.15-4.15	4.18	4.131
394	66	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.55-3.50	3.56	3.65-3.70	3.60-3.60	3.64	3.583

Table XV Patrons' Milk Samples Tested March 19, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
395	2	3.50-3.50	3.45-3.45	3.48	3.45-3.50	3.50-3.50	3.49	3.50-3.50	3.50-3.50	3.50	3.542
396	4	4.00-4.00	4.00-4.00	4.00	3.95-3.95	3.95-3.95	3.95	3.90-3.95	3.90-3.90	3.91	3.820
397	5	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.85-3.85	3.83	3.80-3.80	3.80-3.80	3.80	3.663
398	6	4.85-4.90	4.85-4.90	4.88	4.80-----	4.90-----	4.85	4.90-----	4.85-----	4.88	4.748
399	7	3.70-3.75	3.70-3.70	3.71	3.65-3.70	3.70-3.70	3.69	3.80-3.80	3.70-3.70	3.75	3.580
400	8	4.30-4.30	4.30-4.30	4.30	4.30-4.30	4.30-4.30	4.30	4.30-4.30	4.30-4.30	4.30	4.204
401	9	3.50-3.50	3.40-3.40	3.45	3.50-3.55	3.50-3.50	3.51	3.50-3.50	3.50-3.50	3.50	3.452
402	10	3.70-3.75	3.65-3.70	3.70	3.70-3.70	3.75-3.70	3.71	3.70-3.75	3.65-3.70	3.70	3.646
403	11	4.15-4.15	4.15-4.10	4.14	4.10-4.10	4.20-4.20	4.15	4.10-4.10	4.15-4.20	4.14	4.096
404	12	4.35-4.35	4.30-4.30	4.33	4.35-4.40	4.35-4.35	4.36	4.30-4.30	4.40-4.30	4.33	4.298
405	13	3.65-3.70	3.65-3.70	3.68	3.70-3.70	3.70-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.680
406	14	3.30-3.30	3.30-3.30	3.30	3.30-3.30	3.35-3.30	3.31	3.30-3.30	3.30-3.30	3.30	2.896
407	15	3.75-3.80	3.75-3.75	3.76	3.75-3.80	3.75-3.80	3.78	3.70-3.70	3.75-3.70	3.71	3.715
408	16	3.20-3.20	3.15-3.10	3.16	3.20-3.20	3.20-3.20	3.20	3.10-3.15	3.20-3.15	3.15	3.115
409	17	3.80-3.80	3.75-3.80	3.79	3.75-3.80	3.75-3.80	3.78	3.80-3.85	3.75-3.75	3.79	3.717
410	20	3.80-3.80	3.80-3.80	3.80	3.75-3.75	3.75-3.80	3.76	3.80-3.75	3.80-3.75	3.78	3.722
411	21	4.10-4.15	4.10-4.10	4.11	4.10-4.10	4.15-4.15	4.13	4.10-4.10	4.10-4.10	4.10	4.094
412	22	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.60-3.60	3.60	3.65-3.70	3.60-3.60	3.64	3.630
413	23	3.30-3.40	3.30-3.40	3.35	3.35-3.35	3.35-3.30	3.34	3.35-3.35	3.35-3.30	3.34	3.141
414	24	3.30-3.30	3.30-3.30	3.30	3.25-3.30	3.25-3.30	3.28	3.30-3.30	3.30-3.30	3.30	3.285
415	25	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.55-3.55	3.53	3.495
416	26	3.25-3.30	3.30-3.30	3.29	3.25-3.25	3.25-3.25	3.25	3.30-3.30	3.30-3.30	3.30	3.256
417	27	4.25-4.20	4.20-4.20	4.21	4.20-4.20	4.20-4.20	4.20	4.10-4.10	4.15-4.20	4.14	4.141
418	36	3.80-3.80	3.85-3.80	3.81	3.70-3.70	3.80-3.75	3.74	3.75-3.80	3.70-3.80	3.76	3.731
419	50	3.45-3.50	3.50-3.50	3.49	3.50-3.50	3.50-3.50	3.50	3.50-3.50	3.50-3.50	3.50	3.421
420	51	3.95-4.00	3.95-4.00	3.98	4.00-3.95	4.00-3.95	3.98	4.00-4.00	4.00-4.00	4.00	3.880
421	54	3.50-3.50	3.50-3.50	3.50	3.50-3.45	3.50-3.50	3.49	3.50-3.50	3.50-3.50	3.50	3.451
422	59	4.45-4.45	4.45-4.45	4.45	4.45-4.45	4.45-4.50	4.46	4.45-4.45	4.45-4.50	4.46	4.147
423	61	4.00-3.95	4.05-4.00	4.00	4.00-4.00	4.00-4.00	4.00	4.00-4.00	4.00-4.00	4.00	3.916
424	66	3.20-3.20	3.20-3.20	3.20	3.25-3.20	3.25-3.20	3.23	3.25-3.30	3.20-3.25	3.25	3.141

Table XVI Patrons' Milk Samples Tested March 22, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
425	2	3.30-3.30	3.30-3.25	3.29	3.35-3.40	3.35-3.40	3.38	3.35-3.40	3.40-3.40	3.39	3.253
426	4	3.60-3.60	3.60-3.60	3.60	3.65-3.65	3.65-3.70	3.66	3.65-3.65	3.70-3.70	3.68	3.508
427	5	3.80-3.80	3.75-3.80	3.79	3.85-3.85	3.80-3.80	3.83	3.80-3.90	3.85-3.85	3.85	3.661
428	6	5.00-5.05	5.00-5.05	5.03	5.05-5.05	5.10-5.05	5.06	5.10-----	5.05-----	5.08	4.850
429	7	3.85-3.90	3.80-3.85	3.85	3.90-3.90	3.85-3.90	3.89	3.90-3.90	3.90-3.90	3.90	3.744
430	8	4.35-4.40	4.40-4.40	4.39	4.40-4.45	4.40-4.50	4.44	4.40-4.40	4.45-4.40	4.41	4.284
431	9	3.40-3.45	3.40-3.40	3.41	3.50-3.50	3.45-3.50	3.49	3.50-3.50	3.50-3.50	3.50	3.373
432	10	3.70-3.70	3.70-3.65	3.69	3.70-3.70	3.70-3.70	3.70	3.75-3.80	3.75-3.75	3.76	3.608
433	11	4.35-4.40	4.35-4.35	4.36	4.35-4.40	4.40-4.40	4.39	4.40-4.40	4.40-4.40	4.40	4.288
434	12	4.50-4.50	4.50-4.50	4.50	4.55-4.55	4.55-4.55	4.55	4.55-4.60	4.50-4.55	4.55	4.432
435	13	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.80	3.80	3.80-3.90	3.85-3.85	3.85	3.732
436	14	3.70-3.70	3.75-3.70	3.71	3.70-3.75	3.70-3.70	3.71	3.75-3.75	3.75-3.70	3.74	3.591
437	15	3.70-3.65	3.70-3.65	3.68	3.70-3.75	3.70-3.75	3.73	3.75-3.80	3.75-3.80	3.78	3.689
438	16	3.30-3.30	3.30-3.25	3.29	3.40-3.40	3.40-3.40	3.40	3.40-3.40	3.40-3.35	3.39	3.255
439	17	3.80-3.80	3.85-3.80	3.81	3.85-3.85	3.85-3.85	3.85	3.90-3.90	3.85-3.80	3.86	3.751
440	20	3.70-3.75	3.65-3.70	3.70	3.75-3.80	3.75-3.75	3.76	3.85-3.85	3.80-3.80	3.83	3.723
441	21	4.15-4.10	4.20-4.10	4.14	4.20-4.20	4.20-4.20	4.20	4.20-4.25	4.20-4.25	4.23	4.137
442	23	3.10-3.10	3.10-3.10	3.10	3.10-3.15	3.20-3.20	3.16	3.15-3.20	3.15-3.20	3.18	3.042
443	24	3.40-3.40	3.40-3.40	3.40	3.40-3.40	3.40-3.45	3.41	3.50-3.50	3.45-3.40	3.46	3.332
444	25	3.30-3.30	3.35-3.30	3.31	3.40-3.45	3.40-3.45	3.43	3.40-3.40	3.40-3.40	3.40	3.337
445	26	3.60-3.60	3.60-3.60	3.60	3.75-3.70	3.70-3.70	3.71	3.75-3.75	3.70-3.70	3.73	3.612
446	27	4.65-4.70	4.65-4.70	4.68	4.70-4.75	4.70-4.70	4.71	4.70-----	4.70-----	4.70	4.598
447	36	3.10-3.10	3.05-3.05	3.08	3.10-3.10	3.10-3.10	3.10	3.15-3.15	3.10-3.10	3.13	3.075
448	50	3.55-3.55	3.50-3.50	3.53	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.60-3.65	3.63	3.497
449	51	4.00-4.00	4.00-4.00	4.00	4.05-4.05	4.10-4.10	4.08	4.10-4.15	4.10-4.10	4.11	4.023
450	54	3.50-3.50	3.50-3.55	3.51	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.55-3.60	3.59	3.512
451	59	4.45-----	4.45-----	4.45	4.55-4.55	4.50-4.50	4.53	4.55-4.60	4.60-4.60	4.59	4.381
452	61	3.70-3.75	3.70-3.70	3.71	3.80-3.80	3.80-3.80	3.80	3.80-3.80	3.80-3.80	3.80	3.717
453	66	3.30-3.30	3.35-3.30	3.31	3.35-3.35	3.35-3.35	3.35	3.40-3.40	3.40-3.35	3.39	3.348

Table XVII Patrons' Milk Samples Tested March 23, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	Reader A	Reader B	Aver-age	
454	2	3.40-3.40	3.40-3.45	3.41	3.40-3.40	3.45-3.45	3.43	3.50-3.50	3.45-3.40	3.46	3.324
455	4	3.70-3.70	3.70-3.70	3.70	3.65-3.70	3.65-3.65	3.66	3.75-3.70	3.70-3.70	3.71	3.547
456	5	3.95-3.90	3.95-3.90	3.93	3.95-4.00	3.95-4.00	3.98	4.00-4.00	4.00-4.00	4.00	3.808
457	6	4.55-4.60	4.50-4.60	4.56	4.60-4.60	4.60-4.60	4.60	4.70-4.70	4.60-4.60	4.65	4.412
458	7	4.00-4.00	4.00-4.00	4.00	4.05-4.10	4.00-4.00	4.04	4.05-4.10	4.00-4.05	4.05	3.902
459	8	4.45-4.45	4.45-4.45	4.45	4.40-4.45	4.40-4.45	4.43	4.50-4.45	4.40-4.40	4.44	4.321
460	9	3.50-3.50	3.45-3.45	3.48	3.45-3.50	3.45-3.50	3.48	3.50-3.55	3.45-3.50	3.50	3.380
461	10	3.65-3.65	3.65-3.65	3.65	3.65-3.65	3.65-3.65	3.65	3.70-3.70	3.60-3.70	3.68	3.564
462	11	4.20-4.25	4.20-4.20	4.21	4.20-4.15	4.20-4.20	4.19	4.20-4.25	4.20-4.25	4.23	4.109
463	12	4.65-4.70	4.70-4.70	4.69	4.65-4.70	4.65-4.70	4.68	4.70-4.75	4.70-4.75	4.73	4.513
464	13	3.70-3.75	3.70-3.75	3.73	3.70-3.75	3.70-3.75	3.73	3.80-3.80	3.80-3.80	3.80	3.689
465	14	3.50-3.55	3.45-3.50	3.50	3.55-3.55	3.55-3.55	3.55	3.50-3.55	3.50-3.50	3.51	3.402
466	15	3.65-3.70	3.60-3.65	3.65	3.75-3.70	3.65-3.70	3.70	3.70-3.70	3.70-3.70	3.70	3.621
467	16	3.60-3.60	3.50-3.50	3.55	3.55-3.60	3.50-3.55	3.55	3.60-3.60	3.55-3.55	3.58	3.484
468	17	3.70-3.70	3.70-3.75	3.71	3.75-3.80	3.75-3.75	3.76	3.75-3.80	3.75-3.80	3.78	3.655
469	20	3.90-3.90	3.85-3.85	3.88	3.90-3.90	3.85-3.90	3.89	3.95-4.00	3.90-3.90	3.94	3.850
470	21	4.15-4.15	4.10-4.15	4.14	4.15-4.20	4.10-4.10	4.14	4.10-4.15	4.10-4.15	4.13	4.066
471	22	3.30-3.40	3.30-3.40	3.35	3.45-3.45	3.45-3.40	3.44	3.50-3.55	3.40-3.50	3.49	3.413
472	23	3.40-3.40	3.45-3.40	3.41	3.40-3.45	3.35-3.40	3.40	3.50-3.50	3.40-3.40	3.45	3.369
473	24	3.50-3.55	3.50-3.50	3.51	3.60-3.50	3.55-3.50	3.54	3.60-3.60	3.55-3.60	3.59	3.463
474	25	3.60-3.60	3.65-3.65	3.63	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.60-3.60	3.61	3.565
475	26	3.75-3.75	3.75-3.75	3.75	3.80-3.80	3.80-3.80	3.80	3.80-3.85	3.80-3.80	3.81	3.759
476	27	4.70-4.75	4.75-4.75	4.74	4.80-4.75	4.80-4.80	4.79	4.80-4.80	4.80-4.80	4.80	4.674
477	36	3.65-3.65	3.60-3.65	3.64	3.70-3.70	3.70-3.65	3.69	3.70-3.70	3.70-3.65	3.69	3.666
478	50	3.60-3.60	3.65-3.65	3.63	3.70-3.70	3.65-3.60	3.66	3.60-3.65	3.60-3.60	3.61	3.593
479	51	4.00-4.00	4.05-4.00	4.01	4.00-4.00	4.00-4.00	4.00	4.05-4.00	4.00-4.00	4.01	3.958
480	54	3.50-3.55	3.50-3.50	3.51	3.60-3.60	3.55-3.55	3.58	3.50-3.50	3.50-3.60	3.53	3.494
481	59	4.60-4.60	4.65-4.65	4.63	4.60-4.60	4.60-4.60	4.60	4.55-4.60	4.55-4.55	4.56	4.413
482	61	3.90-3.85	3.90-3.85	3.88	3.90-3.95	3.85-3.90	3.90	3.80-3.90	3.85-3.90	3.86	4.274
483	66	3.40-3.40	3.40-3.40	3.40	3.40-3.40	3.40-3.40	3.40	3.40-3.40	3.40-3.35	3.39	3.371

Table XVIII Patrons' Milk Samples Tested March 25, 1933.

		Low Temperature			Medium Temperature			High Temperature			Chemical Test
Sample No.	Patron No.	Reader A	Reader B	Average	Reader A	Reader B	Average	Reader A	Reader B	Average	
484	2	3.60-3.60	3.60-3.60	3.60	3.65-3.65	3.65-3.70	3.66	3.60-3.70	3.70-3.70	3.68	3.616
485	4	3.60-3.60	3.60-3.60	3.60	3.65-3.70	3.70-3.70	3.69	3.65-3.65	3.65-3.60	3.64	3.630
486	5	3.80-3.90	3.85-3.85	3.85	3.90-3.95	3.90-3.90	3.91	3.90-3.90	3.90-3.90	3.90	3.825
487	6	4.60-4.60	4.55-4.50	4.56	4.60-4.60	4.55-4.60	4.59	4.60-4.65	4.60-4.65	4.63	4.527
488	7	3.70-3.70	3.80-3.80	3.75	3.75-3.75	3.75-3.75	3.75	3.80-3.80	3.80-3.80	3.80	3.729
489	8	4.30-4.30	4.30-4.30	4.30	4.30-4.30	4.30-4.30	4.30	4.30-4.30	4.30-4.30	4.30	4.217
490	9	3.25-3.25	3.25-3.30	3.26	3.30-3.30	3.25-3.30	3.29	3.30-3.30	3.25-3.25	3.28	3.207
491	10	3.40-3.40	3.35-3.40	3.39	3.40-3.40	3.35-3.40	3.39	3.40-3.40	3.35-3.35	3.38	3.312
492	11	4.20-4.25	4.20-4.20	4.21	4.20-4.25	4.20-4.20	4.21	4.25-4.25	4.25-4.20	4.24	4.210
493	12	4.50-4.50	4.35-4.40	4.44	4.40-4.45	4.40-4.45	4.43	4.40-4.45	4.35-4.40	4.40	4.432
494	13	3.30-3.40	3.30-3.35	3.34	3.35-3.40	3.35-3.35	3.36	3.40-3.40	3.40-3.40	3.40	3.390
495	14	3.50-3.50	3.45-3.45	3.48	3.50-3.50	3.50-3.55	3.51	3.50-3.55	3.50-3.50	3.51	3.452
496	15	3.70-3.70	3.75-3.75	3.73	3.70-3.75	3.70-3.75	3.73	3.75-3.75	3.70-3.70	3.73	3.688
497	16	3.40-3.40	3.45-3.45	3.43	3.50-3.45	3.50-3.45	3.48	3.50-3.45	3.50-3.50	3.49	3.408
498	17	3.75-3.75	3.80-3.75	3.76	3.75-3.75	3.75-3.75	3.75	3.75-3.75	3.75-3.75	3.75	3.697
499	20	3.65-3.65	3.65-3.65	3.65	3.65-3.70	3.60-3.60	3.64	3.70-3.65	3.65-3.70	3.68	3.640
500	21	3.90-4.00	3.95-3.90	3.94	3.95-4.00	3.90-3.90	3.94	3.95-4.00	3.95-3.95	3.96	3.899
501	22	3.60-3.65	3.60-3.60	3.61	3.55-3.60	3.60-3.60	3.59	3.55-3.60	3.60-3.60	3.59	3.550
502	23	3.40-3.40	3.35-3.30	3.36	3.30-3.30	3.35-3.30	3.31	3.30-3.30	3.30-3.30	3.30	3.282
503	24	3.50-3.50	3.50-3.50	3.50	3.45-3.45	3.45-3.50	3.46	3.45-3.45	3.45-3.50	3.46	3.379
504	25	3.35-3.40	3.35-3.40	3.38	3.30-3.30	3.30-3.30	3.30	3.40-3.35	3.35-3.30	3.35	3.301
505	26	3.35-3.35	3.40-3.40	3.38	3.35-3.40	3.35-3.40	3.38	3.40-3.40	3.35-3.40	3.39	3.306
506	27	4.55-4.60	4.55-4.60	4.58	4.60-4.60	4.60-4.60	4.60	4.60-----	4.55-4.60	4.58	4.444
507	56	3.70-3.65	3.65-3.60	3.65	3.65-3.65	3.60-3.65	3.64	3.65-3.60	3.65-3.65	3.64	3.608
508	50	3.50-3.45	3.55-3.50	3.50	3.45-3.50	3.50-3.55	3.50	3.50-3.50	3.45-3.50	3.49	3.420
509	51	4.00-4.00	4.00-4.00	4.00	4.00-4.05	4.00-4.05	4.03	4.10-4.10	4.10-4.10	4.10	3.988
510	54	3.60-3.60	3.60-3.60	3.60	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.60-3.65	3.63	3.549
511	59	4.00-4.05	4.00-4.05	4.03	4.15-4.20	4.20-4.20	4.19	4.20-4.20	4.20-4.20	4.20	4.087
512	61	3.80-3.75	3.80-3.70	3.76	3.80-3.80	3.80-3.80	3.80	3.75-3.80	3.75-3.80	3.78	3.720
513	66	3.55-3.55	3.55-3.55	3.55	3.60-3.60	3.60-3.60	3.60	3.60-3.65	3.60-3.60	3.61	3.539

Table XIX Statistical Summary of Babcock and Mojonnier Test Results.

Method of Testing	Number of Tests	Mean in Per Cent	Average Variation from Mojonnier in Per Cent	Standard Deviation in Per Cent	Probable Error of Single Determination	Probable Error of Means
Mojonnier	513	$M_1 = 3.67 \pm 0.017$	0.00	.40	0.2698	(a) $M_4-M_1 = 0.09 \pm 0.0172$
						(b) $M_3-M_1 = 0.08 \pm 0.0172$
						(c) $M_2-M_1 = 0.05 \pm 0.0172$
Babcock at:						
Low Temperature	513	$M_2 = 3.72 \pm 0.018$	0.05	.42	0.2833	(d) $M_4-M_3 = 0.01 \pm 0.0177$
Medium Temperature	513	$M_3 = 3.75 \pm 0.018$	0.08	.42	0.2833	(e) $M_4-M_2 = 0.04 \pm 0.0177$
High Temperature	513	$M_4 = 3.76 \pm 0.018$	0.09	.42	0.2833	(f) $M_3-M_2 = 0.03 \pm 0.0177$

Results of Residual Fat Determinations.

Preliminary Trials. Since there is no standard procedure for the determination of the fat that remains in the liquid portion below the fat column of the Babcock test a procedure was devised which was described in the "Procedure" of this manuscript. In order to check this method, preliminary tests were run. About 0.1000 gram portions of butter oil were weighed into separatory funnels and extracted according to this procedure. The percentage recovery of the 8 tests run was about 98.5 per cent. The details of these preliminary trials are shown in Table XX.

Table XX Results of Residual Fat Trials.

Mixture	Weight of fat taken	Weight of fat recovered	Weight difference	Per Cent difference	Loss or Gain
oil in water	.1054 gms.	.1032 gms.	.0022 gms.	2.087	Loss
oil in water	.1016 gms.	.1002 gms.	.0014 gms.	1.378	Loss
oil in water	.1032 gms.	.1006 gms.	.0026 gms.	2.519	Loss
oil in water	.0979 gms.	.0972 gms.	.0007 gms.	0.715	Loss
Average Per Cent Difference				-1.675	
oil in acid	.0969 gms.	.0956 gms.	.0013 gms.	1.341	Loss
oil in acid	.0984 gms.	.1008 gms.	.0024 gms.	2.439	Gain
oil in acid	.1062 gms.	.1046 gms.	.0016 gms.	1.506	Loss
oil in acid	.0933 gms.	.0934 gms.	.0001 gms.	1.071	Gain
Average Per Cent Difference				±1.348	
Average Per Cent Difference for all Tests				±1.511	

Results of Residual Fat Determinations. The details of the tests made to determine the amount of residual fat contained in the Babcock tests when centrifuged at low, medium, and high temperatures are shown in Table XXI. The tests represent 12 samples of milk prepared according to the procedure outlined and tested in duplicate for each temperature of centrifuging. Table XXII gives the summary of the tests and it will be noticed that the average amount of residual fat contained in the test at the low temperatures of whirling was 0.1801 per cent; at the medium temperature it was 0.1194 per cent; while at the high temperatures it was 0.0881 per cent. These averages would tend to indicate that the greatest amount of residual fat is present in the tests centrifuged at low temperatures while the least amount of fat is present in the tests centrifuged at higher temperatures. However, the tests vary considerably from their averages at the same temperature of centrifuging, hence, these averages are less significant. In the last column of the table appears the probable error of these averages. From these it is noticed that there is a great variation in the tests in the same class and consequently there is not enough difference in these averages to conclude that there is any appreciable difference in residual fat content of the Babcock milk tests when centrifuged at various temperatures.

Table XXI Per Cent Residual Fat in Babcock Milk Tests.

Sample Number	Per Cent Fat at Low Temperature	Per Cent Fat at Medium Temperature	Per Cent Fat at High Temperature
1	0.2082	0.1549	0.1210
1a	0.1759	0.1176	0.1061
2	0.1523	0.1120	0.0537
2a	0.1585	0.1191	0.0710
3	0.1633	0.1162	0.0794
3a	0.1957	0.1102	0.0878
4	0.1661	0.1416	0.1092
4a	0.1602	0.1354	0.0790
5	0.1658	0.1657	0.0868
5a	0.1645	0.1534	0.0770
6	0.1423	0.1002	0.0916
6a	0.1219	0.1380	0.0787
7	0.1727	0.1251	0.0751
7a	0.1791	0.1001	0.0911
8	0.1692	0.1184	0.0828
8a	0.2466	0.1096	0.1151
9	0.1128	0.1348	0.0643
9a	0.1134	0.1202	0.0671
10	0.2820	0.1376	0.0921
10a	0.2268	0.1216	0.0805
11	0.2275	0.0692	0.1287
11a	0.2590	0.1083	0.1218
12		0.0766	0.0867
12a		0.0996	0.0726

Table XXII Statistical Summary of Residual Fat Determinations.

Temperature of Centrifuge for Babcock Test	Number of Tests	Mean in Per Cent	Standard Deviation	Probable Error of Single Determinations	Probable Error of Means
Low Temperature	22	$M_1 = 0.1801 \pm 0.0266$	0.186	0.125	(a) $M_1 - M_2 = 0.0607 \pm 0.0287$
Medium Temperature	24	$M_2 = 0.1194 \pm 0.0161$	0.079	0.053	(b) $M_1 - M_3 = 0.0920 \pm 0.0425$
High Temperature	24	$M_3 = 0.0881 \pm 0.0151$	0.074	0.050	(c) $M_2 - M_3 = 0.0313 \pm 0.0221$

Effect of Centrifuge Temperatures on the Test Temperatures.

The temperatures of the centrifuge at low, medium, and high temperature were observed at various and irregular intervals to ascertain the range in temperature at which it operated. The common range appeared to be for the low temperature, 60° to 68°F., for the medium temperature, 85° to 100°F., and for the high temperature, 135° to 150°F. As stated in the "Procedure" the centrifuge was placed in a refrigerator at 35°-40°F. for the low temperature centrifuging, while the other tests were run in the laboratory which had a temperature of about 70°F. The temperatures of the centrifuge is markedly increased by the heat of the tests.

The temperatures of 12 samples of milk were obtained after mixing with acid and after centrifuging at the various temperatures. The results are reported in Table XXIII. On mixing the acid and milk in the test bottle the average temperature was about 219°F. After centrifuging in the heated tester at 135° to 150°F., with the water added in all cases at 158°F., the temperature of the tests dropped to an average of 168°F. After centrifuging at medium temperature (85° -100°F.) the average temperature of the tests dropped to about 131°F., while at low temperature (60° -68°F.) the average temperature of the tests dropped to 94.5°F. This study is important in explaining many features of the Babcock test. The heat from the tests raises the temperature of the centrifuge from 25 to 35 degrees, the final temperature of the centrifuge, of course, depending on the temperature of the room in which it is located. At ordinary room temperatures the heat from the tests maintains the temperature of the tester at about 100°F. which is a satisfactory temperature

and which indicates that no heater is required. Also, the conditions that exist at extreme low temperatures of centrifuging are better explained from this data. When the centrifuge is running at a temperature of about 65°F. we would expect to remove the tests after centrifuging at about 94°F. which is near the solidifying point of milk fat. Solidification of the fat is undesirable. To improve this condition water should be added to the tests at almost boiling temperature.

Table XXIII Temperature of the Acid-Milk Mixtures in the Babcock Test Bottle.

Sample Number	Degrees F. at start	Degrees F. after centrifuging at Low Temperature	Medium Temperature	High Temperature
1	214	106	133	165
2	221	109	132	162
3	221	106	129	167
4	217	104	135	172
5	215	88	132	169
6	219	90	132	169
7	217	88	132	167
8	217	90	132	167
9	221	90	129	172
10	223	93	127	171
11	221	82	129	167
12	225	88	129	169
Mean	219.2	94.5	130.9	168.0

* Temperature of the milk and acid on mixing 70°F.

* Temperature of Water added to the tests 158°F.

SUMMARY

Inaccurate technique in testing milk and milk products may cause material loss both to the producer and to the manufacturer. The use of centrifuges operating at varying temperatures is thought by some to be such a practise.

Consequently, in this experiment samples of milk representing the patrons delivering milk daily to the college dairy were collected until 513 samples were obtained. Each sample was tested for fat by the Mojonnier and Babcock methods. Single determinations were made by the Mojonnier method according to standard procedure except that the samples were weighed instead of measured. Sixty samples were run in duplicate to prove the reliability of the single tests. The average difference between the duplicates was ±.02 per cent.

For the Babcock determinations each sample was pipetted into re-checked and absolutely accurate Babcock test bottles. Six tests were made on each sample, duplicates being made according to standard procedure with the same centrifuge operating at low temperatures (60° to 68°F.), at medium temperatures (85° to 100°F.), and at high temperatures (135° to 150°F.). After centrifuging, the tests were immediately placed in a constant temperature water bath at 138°F., held at least five minutes, and read by two readers. The average of the four readings was considered the reading of the test for that particular centrifuging temperature.

The results of the Mojonnier determinations showed an average of 3.67 ± 0.017 per cent for the 513 determinations. The means of the 513 samples tested by the Babcock method were as follows: at low temperatures

of centrifuging the mean was 3.72 ± 0.018 per cent, at medium temperatures of centrifuging the mean was 3.75 ± 0.018 per cent, and at high temperatures of centrifuging the mean was 3.76 ± 0.018 per cent. This makes a difference in the means of 0.01 ± 0.0177 per cent for the medium and high temperatures of centrifuging, 0.04 ± 0.0177 per cent for the low and high temperatures, and 0.03 ± 0.0177 per cent for the low and medium temperatures of centrifuging. These results indicate that there are no differences in readings due to the temperatures of centrifuging.

On comparison of the Mojonnier and Babcock results, a marked difference was noted. The mean of all Babcock tests (1539 in all) was 3.74 ± 0.018 per cent and the mean of the Mojonnier tests was 3.67 ± 0.017 per cent. The difference in means was 0.07 ± 0.0172 per cent. This figure is very significant and the conclusion could be drawn that the Babcock method yields higher results, by 0.07 ± 0.0172 per cent, than the Mojonnier method.

Residual fat determinations were made on 12 samples of milk run in duplicate at the above mentioned temperatures of centrifuging. At low temperatures of centrifuging an average of 0.1801 ± 0.0266 per cent of residual fat remained in the Babcock test, at medium temperatures 0.1194 ± 0.0161 per cent remained, while at high temperatures 0.0881 ± 0.0151 per cent was present. The tests in each class varied widely from their means and consequently these differences in residual fat cannot be definitely attributed to the various temperatures of centrifuging.

The temperature of the milk and acid mixture after mixing was ascertained as well as the drop in temperature after centrifuging at

the various temperatures. It was found that the heat of the tests raised the temperature of the centrifuge from 25 to 35 degrees. However, in the cold centrifuge the tests when removed after whirling were nearly at the solidifying temperature of milk fat. To overcome this condition , water should be added to the tests at near its boiling point.

CONCLUSIONS

The results from this experimental work indicate the following conclusions:

1. Although there appears to be slight differences in the average tests by the Babcock method due to centrifuging at various temperatures, yet this difference is not significant. No appreciable variation in readings can be attributed to centrifuging at low or moderately high temperatures.

2. There is a significant difference between the results secured by the Mojonnier and Babcock methods. The Babcock method yields results averaging 0.07 $\pm$ 0.0172 per cent higher than the Mojonnier method.

3. The Babcock tests contain on an average of 0.129 per cent fat remaining in the liquid portion below the fat column. No differences in the amounts can be attributed to temperatures of centrifuging as the tests varied widely from their means.

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