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Bulletin No. 73 - Experiments in Butter-Making and Cheese-Making

F. B. Linfield

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Experiments in Butter-making and Cheese-making

F. B. LINFIELD.

Part I—Butter-making.
Part II—Methods of Making Cheddar Cheese.
Part III—Experiments in Cheese-making.

August, 1901.

LOGAN, UTAH.

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The Bulletins will be sent free to any address in the State, on written application to the Experiment Station, Logan, Utah.
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A Large Ranch Dairy. The making room in basement, the curing room above.

The Oldest Separator Factory in the State.
Part I.

BUTTER-MAKING.

INTRODUCTION.

No bulletins have heretofore been issued by the Dairy department of this Station on the special question of the manufacture of dairy products. The main work of the Dairy department has been with the farm end of the dairy problem; viz: the production of milk. This includes the breeding, feeding and management of cows, the raising and developing of the young stock, and the economic disposal of the by-products of the dairy. From information gathered during my first year at the College it was apparent that this foundation work should have first attention. At this time but six to eight factories were in operation in the State and most of these handled but a small amount of milk. Some farm dairying was carried on, but the butter that came to market was not such as to encourage a large trade, either from within or without the State; much of the best trade was supplied from outside the State. Again the natural conditions, first in regard to the production of a fine quality of milk, then economy of production, and finally the market, were all that could be asked for.

It would be interesting to record the growth and development of the dairy business in the State during the past eight or ten years, but this has been done by the writer in another place. (See Farmers' Institute Annuals Nos. 2, 3 and 4.) Suffice it to say that the cheese and butter factories in operation in the State in 1893 have increased from some six or eight in number to seventy-five or over, and the output of the factories from a few hundred thousand dollars' worth of product to close to $2,000,000 worth. The business is yet growing and spreading and is
fast becoming one of the most important lines of the farm work of the State. The past few years have been a period of foundation laying. The business is now firmly established in the confidence of the farmers and its further increase and development is assured.

Bulletins Nos. 57 and 68 recorded experiments in the animal husbandry of the work of the Dairy department. In this we present a report of the facts gleaned from the work of manufacturing butter and cheese.

Since the beginning of 1894, cheese and butter have been made at the College dairy and a little data have been accumulated on the work of both butter and cheese-making. Extensive experiments in these lines have not been undertaken, first because the other line, the development of the farm end of the business was of more immediate importance; and second, our equipment was not such that a scientific study could be made of the manufacturing process, and at best, therefore, we could but follow other Stations, who were specializing on this line and had provided men and equipment to make a thorough study of the question. In many ways, however, the agriculture of this State is peculiar and as we become acquainted with those peculiarities we aim to study them both in milk production and in the manufacturing process. As time has passed, we have also at various times made tests of the work of various factories throughout the State; testing the work of the churn, separator, etc.

I. TESTS OF SEPARATORS.

During the years 1897, 1898 and 1899, as opportunity offered, tests were made of the work of various separators in several of the factories of the State. The purpose was (1) to gather a little actual data on the work of the various machines under factory conditions. (2) To learn how the butter makers in the factories were operating the machinery and checking up on the results. (3) To get acquainted with the peculiarities of the various machines, and how the same were regulated. In gathering this data some twenty-two factories were visited and over seventy-seven tests were made of six makes of power machines. The hand machines were those run in the College dairy. Table I gives the average results from those tests.
TABLE I. TESTS OF SEPARATORS RUN IN VARIOUS CREAMERIES OF THE STATE.

<table>
<thead>
<tr>
<th>Name of Machine</th>
<th>No. of Tests</th>
<th>No. of Creameries</th>
<th>Claimed Rate of Sep.</th>
<th>Actual Rate of Milk</th>
<th>Per Cent Fat of Milk as Cream</th>
<th>Speed of Bowl</th>
<th>Speed Recommended</th>
<th>Tonnage of Milk</th>
<th>Per Cent Fat in Cream</th>
<th>Per Cent Fat in Skin Milk</th>
<th>Range of Test in Skin Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Laval No. 1</td>
<td>19</td>
<td>11</td>
<td>2500</td>
<td>2413</td>
<td>14.4</td>
<td>5771</td>
<td>2500</td>
<td>86</td>
<td>29.4</td>
<td>.055</td>
<td>.1-.02</td>
</tr>
<tr>
<td>Acme De Laval</td>
<td>5</td>
<td>5</td>
<td>1300</td>
<td>1131</td>
<td>16.3</td>
<td>5975</td>
<td>6000</td>
<td>81</td>
<td>25.1</td>
<td>.072</td>
<td>.12-.02</td>
</tr>
<tr>
<td>Standard Russian</td>
<td>40</td>
<td>3</td>
<td>1500</td>
<td>1397</td>
<td>14.8</td>
<td>7600</td>
<td>7000</td>
<td>85</td>
<td>24.7</td>
<td>.12</td>
<td>.16-.18</td>
</tr>
<tr>
<td>Danish Western</td>
<td>6</td>
<td>1</td>
<td>3500</td>
<td>3815</td>
<td>15.5</td>
<td>6000</td>
<td>6000</td>
<td>77</td>
<td>32.0</td>
<td>.44</td>
<td>.9-.02</td>
</tr>
<tr>
<td>Empire No. 25</td>
<td>6</td>
<td>1</td>
<td>3000</td>
<td>2423</td>
<td>19.4</td>
<td>6625</td>
<td>7500</td>
<td>88</td>
<td>47.0</td>
<td>.05</td>
<td>.06-.03</td>
</tr>
<tr>
<td>Tubular No. 46</td>
<td>5</td>
<td>1</td>
<td>4000</td>
<td>3860</td>
<td>21.4</td>
<td>22180</td>
<td>22000</td>
<td>86</td>
<td>20.3</td>
<td>.114</td>
<td>.16-.07</td>
</tr>
</tbody>
</table>

The De Laval Alpha No. 1 (belt) was found in eleven of the creameries visited. Except in one or two instances the machines were running very smoothly. In most of the tests the machines were run close to their estimated capacity 2400 to 2500 pounds. Tests were made, however, as low as 2000 pounds and as high as 2925 pounds per hour. No tests were made of the latest improved machines of 3000 pounds capacity.

The per cent of fat in the cream ranged from twenty to forty-one, the average being 29.4.

The range of temperature of the milk was from $78^\circ$ to $94^\circ$ F. and averaged $86^\circ$ F.

The test of the skim milk ranged from .02 to .1 as read in the double necked bottle. The average test was .055 per cent.

This type of machine appeared to do good work under a variety of conditions. A point in its construction which appeared to be of considerable value was that the regulation of the inflow of the milk was almost automatic, while it was impossible to crowd the machine beyond its capacity to skim thoroughly; a careless maker could not hurry the skimming at the expense of good work.

The Acme De Laval was found in five creameries and as many tests were made of the machine. The comments on the Alpha No. 1 would practically apply to this machine. The variations in the test of skim milk were from .02 to 12% fat and an average of .072%.

The Standard Russian machine (steam turbine) was tested in three factories. Thirty-six of the forty tests were made...
in the College dairy. This is a hollow bowl machine as contrasted to the discs in the De Laval type. This machine is rated at a capacity of 1500 pounds of milk per hour, and was run at from 900 to 1600 pounds per hour. The speed recommended is 7000 revolutions per minute and in the tests made the revolutions ranged from 7400 to 8200 per minute and averaged 7600. The temperature of the milk averaged 85.6°F. and ranged from 82°F. to 90°F.

The test of the cream ranged from 17 to 35% fat and the test of the skim milk from .06 to .16% fat and averaged .12% fat.

As these machines are made, considerable is left to the judgment of the butter maker in running them. This is noted in the speed at which they were run and also the amount of milk run through the machine. At one factory visited 1700 to 1800 pounds of milk was being run through in an hour, when the first test was made, with of course, considerable loss in the skim milk, but the maker was not aware of it.

But one Danish Weston machine (Reid's Improved) was tested, but six tests were made altogether on two different occasions. The maker rates this machine at 2000 to 3000 pounds per hour capacity. The operator at the factory said it was 3500 pounds and it was tested at about that capacity. From the test of the skim milk this was evidently too high, though for one test made not included in this average over 5000 pounds per hour was being run through the machine. This shows a wonderful capacity to take milk if the maker will put it through. The test of the skim milk under this forcing, however, showed about 1% fat, a very serious loss. A convenience on this machine not noted on any other was that the richness of the cream could be changed without stopping the machine, or changing the inflow. A cream of 15% fat and of 50% fat was thus obtained.

The test of the Empire No. 25 was not made by the writer but by a student of the College who made the test according to his directions. The rated capacity of this machine was 3000 pounds per hour but only 2423 pounds per hour was run through it on the average. The range was from 2160-2700 pounds and equally good work was done on each quantity of milk. The cream was quite rich, averaging 47%. The tests of the skim milk showed very good skimming, an average of .05% fat.
Of the Tubular No. 40 but one machine was tested, though five tests were made of it. This machine has a very long bowl but it is only four inches in inside diameter. It travels at a speed of 22,000 revolutions per minute and is driven by a steam jet. The machine was set some distance from the boiler and it was hard to maintain the proper steam pressure. From 3300 to 5000 pounds of milk per hour was run through the separator and strange to say better results were obtained at the higher capacity than at the lower. The results were .08% fat in skim milk with 5000 pounds per hour and .16% fat with 3300 pounds per hour. The cream in the former case, however, was 10.5% fat and in the latter 36% fat. The closest skimming with this machine was .07% fat and the average of the five tests .114% fat.

This particular machine did not appear to be able to give a thick cream and at the same time a close skimming. There was no opportunity to test any other machine and thus I could not say whether this trouble was the fault of this machine or of the style of the machine. Reports from other sources would rather indicate the former.

Both the hand separators tested gave satisfactory results, all that could be desired. Recent tests of the 20th Century De Laval Baby No. 2 with the increased capacity of 450 pounds per hour show equally good work.

(1) HOW TO GET THE BEST WORK FROM A SEPARATOR.

To get the best results from a separator, the operator should understand how to operate it, and know some of the conditions which modify its work. Attention to the parts noted below will help to this end.

In the first place the operator should be thoroughly acquainted with the machine, by studying its make and the different parts. In setting up a separator it is necessary of course to have the machine in balance, to set it perfectly level, and set it on a fairly firm foundation, one that cannot be jarred by moving anything on the floor near the separator.

In separating milk, there are three things mainly to note, (1) the speed of the bowl, (2) the temperature of the milk and (3) the inflow of the milk. It was evident from observations made in several factories that enough attention was not paid to those points and apparently their interdependence was not
recognized in many instances. Under conditions of gravity setting the cream comes to the surface of the milk in 12 to 36 hours because the cream is lighter than the milk. In the separator the milk is subjected to centrifugal force which multiplies the difference between the relative weight of the milk and the cream by as many times as the force exerted is greater than the force of gravity. The amount of force exerted increases very rapidly with the speed, in fact increases as the square of the speed; that is if the speed is doubled, the force exerted is increased four times (or \(2^2 = 2 \times 2 = 4\)). It is, therefore, very important that proper speed be obtained before the milk is run into the machine and that this speed be maintained throughout the run. If the speed of the separator runs down the force is reduced and thus the separator cannot skim as much milk, or will not skim the usual amount as closely. An increase in speed gives a converse result. It is not safe, however, to run the machine at a greater speed than the maker recommends.

Milk when cold is somewhat sticky or viscid; when warm it becomes thinner somewhat in the same way as does syrup or honey. It is also known that when heated the fat expands more than the serum of the milk, and thus there is a greater difference between the relative weight of the skim milk and fat at a high than at a low temperature. For these reasons milk should be warmed for the separator to do its best work. The skimming capacity of most separators is rated on the amount of milk they will skim when the temperature of the milk is from 80° to 90° F. If the temperature is lower than this the separator will not skim as much milk or will not skim the same amount of milk as closely. On the other hand if the milk is heated to 140 or 150 F. the separator will skim more milk, or the same amount of milk more closely. It is well to note, however, that this statement applies only to milk heated in a vat or receptacle where steam does not come in direct contact with it. Milk heated by a jet of steam being turned into it is not as easily skimmed at the high temperature.*

Some separators are so made, as noted above, that not more than a certain amount of milk can be forced through them in a given time. With other machines the amount of milk run

*See Wisconsin Bulletin No. 69.
through is regulated largely by the operator, and may be increased much beyond the capacity of the machine. While it is true that the separation of the cream in the cream separator is practically instantaneous, yet a certain amount of time is necessary for complete separation. When the milk is run in too fast, it cannot remain in the bowl long enough, or in other words it is not subjected to the centrifugal force long enough and thus is not thoroughly skimmed.

The factory operator who will study carefully the above facts and test his skim milk frequently should have no difficulty in getting any separator to do close work. Close skimming cannot be done when the milk is cold, or when the speed of the machine runs down, or if the inflow of the milk is too great; those factors must be carefully watched and adjusted if good work is expected.

It was perhaps on this point of checking up results with the Babcock test that many factory operators were most neglectful, and, as a consequence, sometimes the loss of butter fat in the skim milk was serious. To illustrate, in one test made a separator was losing .5% in the skim milk and five to six thousand pounds of milk were handled daily. Had the skimming been as close as .1% the saving would have been twenty pounds of butter, worth at twenty cents per pound, $4.00. A loss like that kept up for a month meant $120.00. I could not learn when this operator had tested his skim milk. In other places losses of .3, .2, .1% greater than was necessary were noted, and to those the same remarks will apply though the losses are not as great. The maker who tests his skim milk frequently can modify his work so as to prevent these losses.

(2) COMPARATIVE TESTS OF SKIM MILK, BUTTERMILK AND WHEY.

In this connection it may be well to call attention to the tests of the skim milk. When the Babcock test was first introduced in 1890, the bottle used for testing skim milk, was graduated the same as the whole milk bottles but double the amount of milk and acid was taken. Later the double necked bottles, the Ohlsson and Wagner, were introduced and are now almost universally used in testing skim milk, buttermilk, and whey. These bottles were a great improvement, yet without especial
manipulation they almost invariably give low readings when but a small amount of fat was present in the milk. In testing skim milk it has been suggested to use an excess of acid, 20 c.c., and to whirl the bottles fully five minutes at full speed.* Our experience confirms the correctness of this method in getting a more correct reading for skim milk.

During the winter of 1897 and 1898 several comparative tests of buttermilk, skim milk, and whey were made. Not as many tests were made as I would have liked, as the Station Chemist was too busy to do more, and no opportunity has been afforded since to repeat the work. The table No. 2 shows the results of these tests. Each result is the average of two or more tests of the sample.

**TABLE 2.—COMPARATIVE TESTS OF SKIM MILK, BUTTERMILK AND WHEY.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Sample</th>
<th>Double Necked Bottles</th>
<th>Russian Skim Milk Bottles</th>
<th>Double Necked Bottle. Ohlsson</th>
<th>Chemical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 30</td>
<td>Skim Milk</td>
<td></td>
<td>.35</td>
<td>Trace</td>
<td>.6</td>
</tr>
<tr>
<td></td>
<td>Buttermilk</td>
<td></td>
<td>.1</td>
<td>.02</td>
<td>.11</td>
</tr>
<tr>
<td>Nov. 6</td>
<td>Separator Skim Milk</td>
<td></td>
<td>.1</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>Buttermilk</td>
<td></td>
<td>.05</td>
<td>.1</td>
<td>.1</td>
</tr>
<tr>
<td>Nov. 9</td>
<td>Whey</td>
<td></td>
<td>.4</td>
<td>.05</td>
<td>.3</td>
</tr>
<tr>
<td>Nov. 13</td>
<td>Separator Skim Milk</td>
<td></td>
<td>.1</td>
<td>.05</td>
<td>.22</td>
</tr>
<tr>
<td></td>
<td>Buttermilk</td>
<td></td>
<td>.3</td>
<td>.1</td>
<td>.25</td>
</tr>
<tr>
<td>Nov. 16</td>
<td>Whey</td>
<td></td>
<td>.4</td>
<td>.05</td>
<td>.3</td>
</tr>
<tr>
<td>Dec. 4</td>
<td>Separator Skim Milk</td>
<td></td>
<td>.1</td>
<td>.08</td>
<td>.08</td>
</tr>
<tr>
<td></td>
<td>Buttermilk</td>
<td></td>
<td>.05</td>
<td>.08</td>
<td>.08</td>
</tr>
<tr>
<td>Dec. 7</td>
<td>Whey</td>
<td></td>
<td>.25</td>
<td>...</td>
<td>.25</td>
</tr>
<tr>
<td>Dec. 9</td>
<td>Skim Milk</td>
<td></td>
<td>.1</td>
<td>.09</td>
<td>.12</td>
</tr>
<tr>
<td>Dec. 11</td>
<td>Skim Milk</td>
<td></td>
<td>.1</td>
<td>.05</td>
<td>.08</td>
</tr>
<tr>
<td></td>
<td>Buttermilk</td>
<td></td>
<td>.3</td>
<td>.04</td>
<td>.1</td>
</tr>
<tr>
<td>Jan. 20</td>
<td>Skim Milk</td>
<td></td>
<td>.05</td>
<td>.05</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>Skim Milk</td>
<td></td>
<td>.1</td>
<td>.04</td>
<td>.1</td>
</tr>
<tr>
<td>Jan. 25</td>
<td>Whey</td>
<td></td>
<td>...</td>
<td>.04</td>
<td>.15</td>
</tr>
<tr>
<td>Jan. 27</td>
<td>Skim Milk</td>
<td></td>
<td>.2</td>
<td>.28</td>
<td>.2</td>
</tr>
</tbody>
</table>

There are a few things very apparent in this table. The tests by chemical analysis show that the fat present is one to four-tenths more than the test by the double necked bottles, the

*See "Testing Milk and its Products," page 82.
average of all the tests shows two-tenths more fat by chemical analysis. The tests of the whey are more nearly uniform through all styles of bottles than those of the skim milk, or buttermilk. With the Russian skim milk bottle each test given is the average of four tests of the sample. There was always a wide variation in the tests of these samples and as is to be noted in the table the tests are uniformly low. In conclusion it is well to note that the closest results we were able to get in creaming milk with the separator were 2% fat lost, as shown by chemical analysis, when but .05% loss was shown by the Babcock test. It is well for factory operators to keep those facts in mind in testing their skim milk and buttermilk. The addition of more acid and longer and faster whirling, will, I believe, give closer results between the double necked bottle and chemical analysis, but careful work must be done and two or three tests made of each sample, and the highest selected as nearest correct.

It might be thought by some that if such wide variations are found in the skim milk tests that the Babcock test would not be any more reliable in testing whole milk. It must not be forgotten, however, that the fat left in the skim milk from a separator is in very minute globules, so small that the great force of the separator could not take them out. The difference in the average size of those globules as compared with those in whole milk is very apparent under the microscope. When large globules are present as noted in the whey tests, they readily separate, but for skim milk the small fat globules do not separate readily and thus the tests are from .1 to .2 higher than shown in the Babcock bottles. Again in reading the test of whole milk, these small fat globules which do not separate are allowed for by reading the column of fat from the extreme edges of the column, so that when properly read the Babcock tests of whole milk are closer to chemical analysis than the test of the skim milk.

2 CHURNING TESTS.

At various times, as opportunity offered, when making the test of separators, tests were also made of the work being done by the churn in the creamery visited, and some observations made on the churning conditions. One object was to learn what were the conditions prevailing and the results obtained.
We could thus suggest changes that might be deemed advisable. Some tests were also made at the College dairy on the various points of inquiry. The ultimate object sought was the conditions which give an exhaustive churning. Tests were made at ten different creameries and from thirty different churnings. The majority of the churns were some style of combined churn and worker. In the College dairy forty tests were made and they were about equally divided between the box style of churn and the combined churn and worker. Table 3 gives the average results obtained, arranged according to the per cent. fat in the cream.

**TABLE 3.—CHURNING TESTS ARRANGED ACCORDING TO PER CENT FAT IN THE CREAM.**

<table>
<thead>
<tr>
<th>No. Tests</th>
<th>Per Cent Fat in Cream</th>
<th>Per Cent Fat in Buttermilk</th>
<th>Time of Churning</th>
<th>Temp. of Cream as put in Churn</th>
<th>Acidity of Cream</th>
<th>Variation in Fat Lost in Buttermilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creameries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>18.5</td>
<td>.145</td>
<td>69 min.</td>
<td>56.5</td>
<td>.66</td>
<td>.07-.2</td>
</tr>
<tr>
<td>4</td>
<td>27.7</td>
<td>.11</td>
<td>42 min.</td>
<td>56.0</td>
<td>.56</td>
<td>.06-1.2</td>
</tr>
<tr>
<td>8</td>
<td>33.2</td>
<td>.07</td>
<td>93 min.</td>
<td>52.0</td>
<td>.60</td>
<td>.05-.12</td>
</tr>
<tr>
<td>14</td>
<td>39.5</td>
<td>.24</td>
<td>74 min.</td>
<td>51.0</td>
<td>.57</td>
<td>.03-.5</td>
</tr>
<tr>
<td>College Dairy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>27.0</td>
<td>.10</td>
<td>40 min.</td>
<td>55.0</td>
<td>.61</td>
<td>.06-.4</td>
</tr>
<tr>
<td>5</td>
<td>31.0</td>
<td>.06</td>
<td>34 min.</td>
<td>53.0</td>
<td>.59</td>
<td>.03-.1</td>
</tr>
<tr>
<td>6</td>
<td>35.0</td>
<td>.06</td>
<td>34 min.</td>
<td>53.0</td>
<td>.54</td>
<td>.02-.15</td>
</tr>
<tr>
<td>2</td>
<td>38.5</td>
<td>.04</td>
<td>42 min.</td>
<td>54.0</td>
<td>.6</td>
<td>.03-.05</td>
</tr>
</tbody>
</table>

The tests of the cream given are, as nearly as may be, the tests of the cream as it was put into the churn.

The tests of the buttermilk would seem to indicate that up to 33% fat in the cream there was the most thorough churning, but with 39.5% fat in the cream the buttermilk shows a higher test. This was probably due to the fact that the rich cream got very thick and some stuck around the inside of the churn. Later, when the rest of the cream churned, it was washed into the buttermilk. If the churn had been watched closely and the cream diluted so that the agitation of the cream could have been continued, this result would not have followed.

The tests made in the College dairy show a gradual reduc-
tion in the test of the buttermilk even to 38.5% fat in the cream and the tests are more uniformly low.

These tests would appear to show that under average conditions, cream testing 30% fat will churn more exhaustively than cream with a lower per cent of fat.

(a) EFFECT ON CHURNING OF THE THICKNESS OF THE CREAM.

To a certain extent, apart from the richness of the cream in fat, the cream may be of varying consistency when churned, though as a rule the richest cream is the thickest cream. This thickening is due to the kind of fermentation developed in ripening the cream and the stage of its development.

<table>
<thead>
<tr>
<th>No. of Tests</th>
<th>Consistency of Cream</th>
<th>Per Cent Fat in Cream</th>
<th>Acidity of Cream</th>
<th>Time of Churning</th>
<th>Tem of Cream</th>
<th>Per Cent Fat in Butter</th>
<th>Range of Fat in Butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>College Dairy</td>
<td>Thin Cr'm</td>
<td>22.0</td>
<td>6.25</td>
<td>40 min.</td>
<td>54</td>
<td>.15</td>
<td>.1—.4</td>
</tr>
<tr>
<td></td>
<td>Medium...</td>
<td>25.0</td>
<td>.59</td>
<td>41 min.</td>
<td>53</td>
<td>.155</td>
<td>.05—.6</td>
</tr>
<tr>
<td></td>
<td>Thiek.....</td>
<td>28.6</td>
<td>.60</td>
<td>39 min.</td>
<td>53</td>
<td>.10</td>
<td>.05—.3</td>
</tr>
<tr>
<td>Creameries...</td>
<td>Thin.......</td>
<td>20.0</td>
<td>.75</td>
<td>68 min.</td>
<td>54</td>
<td>.47</td>
<td>1—1.2</td>
</tr>
<tr>
<td></td>
<td>Medium...</td>
<td>32.0</td>
<td>.61</td>
<td>70 min.</td>
<td>55</td>
<td>.11</td>
<td>.05—.3</td>
</tr>
<tr>
<td></td>
<td>Thick ........</td>
<td>37.8</td>
<td>.57</td>
<td>67 min.</td>
<td>52</td>
<td>.17</td>
<td>.04—.5</td>
</tr>
</tbody>
</table>

The table shows that the thickest cream churned most exhaustively. In the creameries the medium thick cream churned the best, but most of the samples of thick cream were very thick and stuck around the churn, as explained above. Our experience has shown that usually the quality of the product as well as the ease of handling is at its best just after the cream thickens in the vat. If the cream does not thicken in ripening there is usually some undesirable fermentation present and the butter will not have the best flavor, though it does not necessarily follow that cream which thickens properly will always have a first-class flavor. The thickening of the cream is associated with the development of lactic acid and is thought to be due to a curdling of the cream.

(b) THE CHURNING TEMPERATURE.

A question that is asked probably more frequently than any other in regard to churning, is: What is the churning temperature? The only answer that can be given to this is a general
one. The best churning temperature is that temperature which will bring the butter into proper condition and in a reasonable time. Table 5 gives the average results at various creameries and at the College dairy.

**TABLE 5.—CHURNING EXPERIMENTS ARRANGED ACCORDING TO TEMP. OF CHURNING.**

<table>
<thead>
<tr>
<th>No. of Tests</th>
<th>Temp. of Churning</th>
<th>Time of Churning</th>
<th>Acidity of Cream</th>
<th>Per Cent Fat in Cream</th>
<th>Per Cent Fat in Butter-milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Begin. End</td>
<td>Min.</td>
<td>.54</td>
<td>.58</td>
<td>.55</td>
</tr>
<tr>
<td>Creameries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>46—52</td>
<td>113</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>48—54</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>52—56</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>54—55</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>57—61</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>58—61</td>
<td>51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College Dairy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>43—55</td>
<td>46</td>
<td></td>
<td>.54</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50—58</td>
<td>42</td>
<td></td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>52—59</td>
<td>45</td>
<td></td>
<td>.59</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>54—60</td>
<td>40</td>
<td></td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>56—62</td>
<td>50</td>
<td></td>
<td>.62</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>59—62</td>
<td>27</td>
<td></td>
<td>.62</td>
<td></td>
</tr>
</tbody>
</table>

Cream was put into the churn at from 43° to 59° F., but in no case was the temperature of the buttermilk at the end of churning below 52° F. The highest temperature of the buttermilk at the end of churning was 62° F. These churning temperatures apply to cream separated by the centrifugal separator. Cream from any of the setting methods will not churn as a rule at so low a temperature.

There is not enough difference in the tests of the buttermilk to enable us to say that there was any particular difference in the thoroughness of the churning at the different temperatures. Other conditions made necessary the variations in the temperature of churning—the seasons of the year or local conditions, etc. It will be noted, however, that in the main, when at the highest temperature the cream churned in a little shorter time, though the differences in the result at the College are slight.

The above observations simply record a fact. It is evident that the cream was churned in those instances at the tempera-
The acidity test is a means of determining approximately the stage of fermentation in the ripening cream. It is a valuable aid to the butter maker, as it enables him in a large measure to know the condition of his cream, and thus control the fermentation. It enables him also to get approximately the same degree of ripeness on the cream each day, which means a uniform flavor, a very important point in the sale of the product.

**TABLE 6.—CHURNING EXPERIMENTS ARRANGED ACCORDING TO ACIDITY OF CREAM.**

<table>
<thead>
<tr>
<th>No. of Tests</th>
<th>Percent of Acidity in Cream</th>
<th>Temperature of Cream</th>
<th>Time of Churning</th>
<th>Per cent. Fat in Cream</th>
<th>Per cent. Fat in Butter-milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent of Acidity in Cream</td>
<td>Min.</td>
<td>55</td>
<td>50</td>
<td>28</td>
</tr>
<tr>
<td>14</td>
<td>.65-.69</td>
<td>55</td>
<td>50</td>
<td>28</td>
<td>.09</td>
</tr>
<tr>
<td>13</td>
<td>.55-.59</td>
<td>52</td>
<td>47</td>
<td>27</td>
<td>.08</td>
</tr>
<tr>
<td>4</td>
<td>.50-.54</td>
<td>51</td>
<td>32</td>
<td>33</td>
<td>.10</td>
</tr>
<tr>
<td>3</td>
<td>.45--</td>
<td>57</td>
<td>23</td>
<td>32</td>
<td>.12</td>
</tr>
</tbody>
</table>

College Dairy

<table>
<thead>
<tr>
<th>No. of Tests</th>
<th>Percent of Acidity in Cream</th>
<th>Temperature of Cream</th>
<th>Time of Churning</th>
<th>Per cent. Fat in Cream</th>
<th>Per cent. Fat in Butter-milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent of Acidity in Cream</td>
<td>Min.</td>
<td>55</td>
<td>50</td>
<td>28</td>
</tr>
<tr>
<td>14</td>
<td>.66-.68</td>
<td>53</td>
<td>48</td>
<td>33</td>
<td>.11</td>
</tr>
<tr>
<td>13</td>
<td>.60-.65</td>
<td>53</td>
<td>43</td>
<td>33</td>
<td>.25</td>
</tr>
<tr>
<td>5</td>
<td>.57-.58</td>
<td>52</td>
<td>62</td>
<td>35</td>
<td>.21</td>
</tr>
<tr>
<td>4</td>
<td>.50-.54</td>
<td>51</td>
<td>55</td>
<td>34</td>
<td>.17</td>
</tr>
<tr>
<td>5</td>
<td>.40-.45</td>
<td>54</td>
<td>66</td>
<td>32</td>
<td>.09</td>
</tr>
</tbody>
</table>

Creameries

In regard to the effect of acidity upon the thoroughness of churning, the table does not show that it has any material effect within the range noted, a difference of nearly .3%. It is evident that within those limits other factors have more to do in giving an exhaustive churning than does the acidity.

But few of the factories of the State use the acidity test, and its use could be extended with advantage. It is a test almost as valuable to the butter-maker in getting a uniform product as the Rennet test is to the cheese-maker.
**(d) COMPARATIVE QUALITY OF BUTTER MADE FROM COWS FED ON LUCERN AND ON CORN FODDER.**

During the winter of 1900 a cow feeding experiment, comparing the relative value of dry corn fodder and lucern, was in progress and advantage was taken of this to make a study of the quality of the butter made from the two fodders. The milk from each lot of cows was handled separately and made into butter. Three tests were made while the cows were fed differently, and one test after a change of feed, to learn whether the differences noted would in anywise be charged to the cows. It was the intention to repeat this test, but we could not during the past winter. It is here reported as a preliminary test, and the matter will be taken up again as opportunity offers.

**TABLE 7.—DATA OBTAINED IN COMPARING THE QUALITY OF BUTTER MADE FROM COWS FED ON LUCERN AND FROM THOSE FED CORN FODDER.**

<table>
<thead>
<tr>
<th></th>
<th>First Test Feb. 17th.</th>
<th>Second Test Feb. 24th</th>
<th>Third Test March 17th</th>
<th>Fourth Test May 12th</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn Fodder</td>
<td>Lucern</td>
<td>Corn Fodder</td>
<td>Lucern</td>
</tr>
<tr>
<td>Weight of Milk, lbs</td>
<td>167</td>
<td>169</td>
<td>149</td>
<td>151</td>
</tr>
<tr>
<td>Weight of Cream, lbs</td>
<td>27½</td>
<td>27</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Fat in Cream, Per Cent</td>
<td>24</td>
<td>27</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Churning Temperature, deg</td>
<td>56</td>
<td>56</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td>Time of Churning</td>
<td>20</td>
<td>25</td>
<td>45</td>
<td>25</td>
</tr>
<tr>
<td>Per Cent Fat in Buttermilk</td>
<td>2.5</td>
<td>.12</td>
<td>.06</td>
<td>.06</td>
</tr>
<tr>
<td>Pounds of Finished Butter</td>
<td>6¾</td>
<td>9</td>
<td>7</td>
<td>6¼*</td>
</tr>
</tbody>
</table>

*About three pounds of cream spilled.

Table 7 gives the data for the test. The first test was on February 17th; but four days' milk was used in each lot. The cream was allowed to ripen naturally, but it ripened slowly, and the cream from the cornfodder lot was a little fresh when churned.

There was quite a distinct difference in the cream from the two lots. That from the lucern fed cows was a nice shade of yellow though a little light, that from the cows fed corn fodder was almost white and this difference was much more noticeable in the butter. The cream from the lucern fed cows was considerably thicker and had more body. It foamed more in separating.
In flavor there was a pronounced difference. The cream from the corn fodder had a clean sour milk flavor while that from the lucern had a pronounced flavor that might have been called weedy. When churned, the difference was quite noticeable in the butter, and most of those who examined it preferred the flavor of the corn fodder butter.

On February 20th the butter after being held in the refrigerator was again examined. The flavor of the corn fodder butter was clean and sweet but not high. The grain was good but the butter was softer than that from the lucern. The color was almost white.

The lucern butter had a pronounced but peculiar flavor, the grain was all right and the butter was firm. The color was a light yellow a little below market standard.

The same difference was noted in the two following tests, one on February 24th and the other on March 17th. The butter from the lucern fodder was a light yellow color and of firm body, while there was a distinct difference in flavor, though it could not be said that the lucern was inferior in flavor. Its peculiar flavor was not so pronounced as in the first test.

On May 12th, after the cows were put on a mixed ration of corn fodder and lucern, another test was made of the milk. There was practically no difference noted in the flavor, the lot fed on lucern yet produced the highest colored and firmest butter, but there was not as much difference as when the cows were fed on lucern alone. It would thus appear that when fed alone to cows, lucern gives to milk and butter a peculiar flavor, though not an objectionable flavor to those used to eating it.

In this connection it might be noted that Mr. F. A. Leigh-ton of New Hampton, Iowa, who scored the butter at the Utah State Dairymen’s Association, in April of 1900, noticed a flavor as characteristic of the butter, which to an eastern man would be classed as decidedly weedy, though with a few days use he failed to particularly notice it, and it in no wise detracted from the eating quality of the butter.
A Modern Factory. Since this picture was taken this factory has been enlarged and now handles 25,000 to 30,000 pounds of milk a day.

A modern factory that handles 10,000 to 15,000 pounds of milk a day.
A Gassy Cheese. This cheese was made from fresh milk and no attempt was made to overcome the gas. The cheese is 16 inches across; this will give some idea of the size of the holes.

A Firm Close-Bodied Cheese. Gassy milk handled as described in this Bulletin may be made into as close and solid a cheese as this.
Part II.

METHOD OF MAKING CHEDDAR CHEESE.

(1) INTRODUCTION.

Cheese-making is by no means a new industry in this State. It is probable that many of the early settlers made cheese on the farm for home use and to supply local custom. Later when the country became more settled and danger from the Indian disappeared, the settlers combined and the cattle were herded on the range during the summer. To pay for herding the cow and calf, and to increase the returns, in many instances, cheese was made. The calves were kept in small pastures in some small fertile, watered valley. The cows were driven in twice a day and about one half the milk taken for cheese-making—the calves helped themselves to the remainder. A large quantity of cheese was made at one time in these mountain dairies, and is even yet made in some places. Sometimes those dairies attained large proportions and five to six hundred cows were kept. More frequently, however, the cows numbered from fifty to seventy-five.

The first cheese factory built and managed on modern lines, where the milk was purchased and drawn to the factory to be manufactured, was built in Wellsville, Cache county, about 1888, by Mr. Lorenzo Hansen, who is yet in the business and one of the largest manufacturers of cheese in the State.

As noted above, in the past six to eight years, factories have increased rapidly in this State. At present most of the cheese is made during the summer months while the flush of the milk lasts. Cheese as first made in the State was quite soft and open, and for immediate consumption it gave good satisfaction, but now much of the cheese has to be held for the fall and winter trade. In view of this fact the character of the cheese made has materially changed during the past few years, and now it is practically all firm cheddar put up in flats of about thirty pounds each.

At present the trade in cheese with other States is increasing, particularly with the States north and west. For this rea-
son more attention will have to be paid to the manufacturing and curing of the cheese, so as always to provide an article that will meet with ready sale at top prices. With the hope of aiding in bringing about this condition, a brief discussion on cheese-making is given in this bulletin.

(2) THE MANUFACTURE OF CHEESE.*

Cheese-making is an art that requires considerable skill and experience. Milk at its best carries in it the agencies that quickly change its character and if uncontrolled destroys its value. The work of the cheese-maker is in a large measure to guide and control the agencies present in the milk, using means and forces to shape his product. The best cheese-maker is he who is acquainted with all those aids, has them at his call, and knows how to use them. It is our purpose to call attention to those aids and illustrate how they may be used by the cheese-maker.

(3) GOOD MILK.

The first essential in cheese-making is good milk; milk free from odors due to feed, and free from dirt of any kind. This does not necessarily mean rich milk, provided it is the whole milk from the cow. This condition is easy of attainment in this State if a little intelligent care is exercised. The following points should be noted:

The cow should be clean. The teats of the cow should be wiped off with a damp cloth or washed; the thighs of the cow should be kept clean by clipping and brushing; and the body of the cow should be brushed occasionally. Some advocate dampening the udder, belly, and flank of the cow to prevent dust falling into the milk during the time of milking.

The utensils used in milking and holding the milk should be clean. Only vessels made of good tin should be used, and every joint should be thoroughly soldered both inside and out. The tin should be thoroughly cleaned by washing and scalding and then airing.

* The milkers should also keep themselves clean, their hands washed and clothes free from dust.

The stable should be clean and as free as possible from dust and odors.

* In this article nothing more is attempted than to call attention to a few points that are frequently overlooked by our cheese-makers. Those who desire to investigate further, and this should include all who are making cheese, should get Professor Decker's book on "Cheese-making," which treats this subject thoroughly.
The milk should be removed from the stable as soon as possible to avoid contamination. It should be strained, aerated and cooled as soon as possible after milking. The aeration helps to remove any objectionable odors and the cooling quickly checks fermentation.

With healthy, thrifty cows, attention to the above points will give milk that is clean and comparatively free from ferments. Such milk is of much importance in cheese-making, as good milk is the first essential for good cheese, and it also gives the maker better control over the process of making.

(4) THE FERMENTATION TEST.

However, under conditions as they are in the factories, every patron will not send good milk. It is then of considerable importance to be able to locate the person who is sending the contaminated milk. The best device for this is known as the "Wisconsin Curd Test." A small quantity of milk, about one-half to three-fourths of a pint, is taken from the milk of each suspected patron. This is warmed in a water bath and ten to fifteen drops of rennet extract added to each bottle. After thickening it is cut and kept stirred, the same as in regular cheese-making, and the whey poured off as fast as it separates. The curd is allowed to mat together and after a few hours, is examined and the flavor and condition of the curd noted. If the flavor is not pronounced the sample may be kept for four to six hours longer and again examined. The temperature should be maintained at about 85° to 90° so as not to check the fermentation. A special apparatus can be had for this test but we have found the ordinary pint Mason jar to answer the purpose.

Having by this means located the source of the trouble, the attention of the patrons interested may be called to the fact, and they can be instructed how to improve the quality of the milk.

When only a few cans of milk are off flavor, but not sour, and the trouble is noted when the milk comes in and it is not thought advisable to return it, if the milk is heated to 160° or 170° F., the objectionable ferment may be destroyed. If much of the milk is affected however, it would not be advisable to heat it, as heated milk is not curdled properly by rennet.
(5) HEATING THE MILK.

For cheddar cheese-making, milk is heated to 86° F. before the rennet is added. The most convenient way to do this is by introducing steam into water around the vat. This temperature is used because experience has shown that at a lower temperature, the rennet acts slowly and gives a soft curd, while at a higher temperature it is difficult to keep the particles of curd apart after cutting.

(6) RENNENT.

Rennet plays quite an important part in the making of cheese. As used in cheese-making it is an extract from the dried fourth stomach of the calf. This extract when added to milk in very small quantity (one part to five thousand usually) causes a separation of the casein and most of the fat, which is enclosed by the casein, from the liquid portion of the milk. The exact nature of this change is not yet fully understood.

(7) THE RENNENT TEST.

As soon as the milk is heated a rennet test is taken of it to determine the condition of the milk or to learn the stage of progress of the fermentation changes going on. This test as first introduced some fifteen years ago, by a New York cheesemaker, J. B. Harris, was made with a teacup and spoon as the only apparatus. Later a half pint beaker and a dram measure were used to give more exact measurement. A half pint, (eight ounces) of milk, at a temperature of 86° F, was taken from the vat and to this one dram of rennet extract was added and mixed thoroughly with the milk. The length of time from adding the rennet till the milk thickened indicated the condition of the milk. This test requires some experience in handling, but when carefully made, I have found it fairly reliable and a very rapid test.

With the idea of getting greater accuracy the above test was modified by J. H. Monrad, who used dilute rennet and a pipette measure. The writer, however, has not found it to be any improvement over the Harris test.

A decided improvement on both the above tests for factory work is what is known as the Marshall test. This test is
automatic and thus needs no further attention after the rennet and milk is mixed. The apparatus consists of a quart cup with a small hole in the bottom, a 1 c.c. pipette, a small bottle and a spatule. The quart cup is filled with milk. As soon as the milk has run down to the zero mark on the inside, 1 c.c. of rennet extract diluted with water is added. As soon as the milk thickens it ceases running out the hole in the bottom of the cup. The graduations on the inside of the cup show the amount of milk which has run out and is a measure of the condition of the milk.

The result obtained by the rennet test will be modified by the following conditions:

1. The temperature of the milk. Rennet acts most quickly at a temperature of about 102° F. to 105° F.; below 70° F. it acts very slowly and at 140° F. rapidly loses its properties. It is very important, therefore, that the temperature at which the test is taken be always the same; 86° F. is the standard used.

2. The age of the milk and the fermentation changes that have taken place also affect the action of the rennet. The rennet acts more rapidly when acid has developed in the milk.

3. Rennet extracts vary in strength, some acting on milk much more quickly than others, and this fact must be considered in making the rennet test, especially in changing to a new extract.

4. The kind of cheese desired to be made has also to be considered in acting on the information given by the rennet test, as a different condition is required in the milk, if a slow or quick curing cheese is wanted.

Many make a mistake in using the rennet test, because they fail to comprehend exactly what it teaches. The rennet test is not an absolute guide, but only a means to get information about the condition of the milk. It is first necessary to test the rennet test. The maker must determine what length of time he desires to hold his curd in the whey to get a proper ‘‘cook’’ for the season of the year and the kind of cheese made. Having determined this fact, then find by the rennet test the condition of the milk that will allow the curd this time in the whey. By using the rennet test every day the cheese-maker
may have his milk in about the same condition at the time of setting and thus make his work uniform from day to day.

The length of time the curd is in the whey before it is ready for dripping is a measure of the fermentation in the milk at the time the milk is set. Having established a relation between this and the rennet test, the maker knows what to do if the milk is too fresh; he may use a starter to hasten fermentation, or if it is over-ripe he will have to modify his ordinary practice to make a good cheese. The rennet test is one of the most important tests in the hands of the cheese-maker, as when intelligently used it tells him at the beginning of his work what the condition of the milk is, and in the hands of such a man this knowledge is power and control.

(8) RIPENESS IN MILK.

In making cheddar cheese a certain degree of "ripeness" is needed in the milk. By ripeness is meant a certain stage of fermentation. Whether these fermentative changes are due wholly to organized ferments, as bacteria, or to both organized and unorganized, it is impossible at present to say. This stage of fermentation or degree of ripeness is determined by the rennet test as described above.

A ripe condition of the milk is desired as an aid in making cheddar cheese; and particularly in developing its peculiar characteristics both in making and curing. The amount desired is a point that can only be determined by experience. It will vary to a certain extent with the season of the year but more particularly with the kind of cheese to be made. If the milk is not ripe enough when it comes to the factory the natural fermentation may be hastened by warming the milk and allowing it to stand, or a clean flavored starter may be used.

A starter may be prepared by selecting some clean flavored milk from some careful patron, warming it, and allowing it to sour naturally. Just before it thickens it should be diluted with cold water and stirred thoroughly to prevent the curd from forming in hard lumps. Usually the milk prepared one day may be used as a starter the next. The starter should be kept in a good tin can and kept so that the temperature may be maintained. If the milk selected is very fresh a small starter will have to be added to it. In some
places more exact methods are followed and a commercial starter is obtained. This starter contains a small quantity of the proper kind of ferments and these are developed, or grown in milk that has been pasteurized to kill all undesirable germs. These starters may be propagated from day to day by adding a little of the sour milk to the new lot of milk for a starter and continuing as long as the milk is of good flavor when a new culture should be obtained. These starters if properly prepared contain those germs necessary to produce the proper fermentative changes in milk for the making of good cheese. An amount of starter should be used sufficient to ripen the milk in a reasonable time to the proper condition for setting as determined by the rennet test. The amount will vary from one per cent to five per cent depending upon the condition of the milk and the amount of fermentation desired. This can only be determined by experience.

The starter should be added to the milk as soon as it is known that the milk is too fresh. The starter is of great value to a cheese-maker, as it gives him control in a measure of the kinds of fermentation in the milk, and the rapidity of their action. Because of this latter point the starter is sometimes abused in the hands of a careless or ignorant maker, who will sometimes sacrifice the quality of his product for the sake of hurrying the process of making.

Sometimes the milk is over-ripe, or in other words, the fermentative changes have proceeded too far. The rennet test will tell the maker of this fact and he should govern his work accordingly. Again there may be developed in the milk an undesirable fermentation which gives to it a bad flavor and frequently makes a gassy curd. A starter intelligently used will sometimes minimize the danger from this kind of milk, but in any case it means a smaller and poorer product.

(9) COLORING THE CHEESE.

In this State, in fact nearly all over the United States, the trade demands a colored cheese. Uncolored cheese is not absolutely white, though the color varies with the season of the year. There are several brands of cheese coloring on the market, any of which, considering the small amount used in the cheese, is entirely harmless. The coloring demanded varies
for different markets, but here a light straw color is preferred. This is obtained by adding three-fourths to one ounce of coloring to one thousand pounds of milk or about one part to 15,000 parts milk. The coloring should be added to the milk as soon as the milk is ready for setting (not before) but before the rennet is added. It should be thoroughly stirred into the milk.

(10) ADDING THE RENNET TO MILK.

Rennet as noted above is added to milk to aid in separating the casein and fat from the liquid portions of the milk. It throws the casein out of solution or coagulates it.

The amount to use varies with the strength of the rennet and the kind of cheese to be made. The rule usually given is as follows: For a quick curing cheese to use enough rennet to coagulate the milk in twenty to twenty-five minutes, and for a slow curing cheese enough rennet to coagulate the milk in thirty-five to forty-five minutes. This will mean about four to five ounces of standard rennet extract to one thousand pounds of milk in the first case and two and a half to three ounces per one thousand pounds of milk for the second.

Recent experiments at the Wisconsin Station show that the amount of rennet modifies the rapidity of the curing process, due to the pepsin in the rennet. That rennet had an effect upon the rapidity of cheese ripening was known and acted upon by makers for many years though the point had been disputed by some. The Wisconsin Station demonstrated this fact and showed the cause.

Immediately upon adding the rennet to the milk in the vat it should be diluted with cold water (never use hot water) to about four or five times its volume. Then pour into the milk by distributing it over the vat. It should be mixed thoroughly with the milk by stirring for two or three minutes. All currents in the milk should be stopped after stirring to permit the milk to thicken properly.

(11) CUTTING THE CURD.

After the milk has thickened the curd is cut into small particles to facilitate the separation of the whey. The test used to determine when the curd is ready to cut is to put the finger under the surface of the curd. If when lifting it out the
EXPERIMENTS IN BUTTER-MAKING AND CHEESE-MAKING.

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curd breaks clean over the finger it is ready to be cut. The
cutting is done with the perpendicular and horizontal curd
knives which need no description here. They cut the curd in-
to small particles about three-eighth inch cubes. An even cut is
important as it is thus easier to cook the curd evenly. The cut-
ting should also be carefully done to avoid unnecessary loss of
fat and particles of curd. For an over-ripe or fast-working
curd, the particles should be cut quite fine to permit of giving a
more rapid ‘‘cook.’’

(12) “COOKING” THE CURD.

By “cooking” is meant the drying out of the curd or its sep-
eration from the whey while yet in the vat. The curd when
thickened with rennet tends to contract upon itself, thus for-
cing the water out of the particles. This action is hastened by
stirring the curd to keep the particles apart, by heating the
curd, and by a slight development of acid, the whole applied
for a certain length of time.

After cutting the curd it should be gently stirred for
five to ten minutes, keeping the particles of curd apart and
cleaning the curd off the bottom and sides of the vat. Heat
should then be applied and the curd warmed till it reaches a
temperature of 98 ° F. At the start the heat should be rising
gradually, about one degree in three minutes, and thirty to
forty minutes should be taken to heat the curd to the
98 ° F. Careful stirring at the beginning of the heating is im-
portant to avoid loss of particles of curd and fat, which by
careless handling while the curd is soft would be broken off and
lost in the whey. Usually the first stirring can be done with
the hands, but when the curd has been heated to 90 ° F.
a rake may be used, either a special rake for the purpose or an
ordinary hand hay rake.

It is evident that there is an interdependence between the
above factors in the proper cooking of the curd. The normal
method as described, gives the maker better control over his
product and a larger amount of product. Sometimes, how-
ever, the milk is over-ripe, then by cutting the curd finer;
stirring more vigorously and heating faster, and even at times
four to six degrees higher, the curd can be properly dried be-
fore enough acid has been developed to spoil the cheese. By
these means the curd is cooked in a shorter time, though always at the expense of the quantity of the product and there is some risk as to its quality. It is not to be followed except when, because the milk is over-ripe, the practice is demanded to avoid making sour cheese. Rightly understood, those factors are of great value to the cheese-maker in controlling his product. If a soft or moist cheese is wanted then the stirring and heating should not be applied long, and slightly less acid developed; thus the particles of curd are not dried as much. The application of those forces for a longer time gives a dryer curd and a longer keeping cheese, other things being equal. As a rule a soft cheese needs to be about two hours to two and a half hours in the whey and for a firmer cheese two and a half to three hours under normal conditions. A cheese-maker shows his skill when he so shapes conditions that the curd is properly dried in the whey by the time the acid has developed far enough, thus having the curd in just the desired condition when dipped.

(13) DRAWING THE WHEY.

When is the curd ready to dip? or when should the whey be drawn off? Two things are desirable, (1) a cooked condition of the curd, (2) a sufficient development of acid, or of the fermentative changes. In cheddar cheese-making the latter has to be the deciding factor. Thus the maker should always endeavor to bring the former in harmony with the latter. The first is determined by the dryness of the curd particles. After being pressed in the hand lightly and released they fall apart. The second is determined by the hot iron test. At the time of dipping this test is of very great importance. Take a piece of curd from the vat and hold it firmly and steadily in the hand until the particles are firmly joined together. To a hot iron (a piece of iron pipe will do) heating to the toasting stage, apply this piece of curd for a few moments and then draw it steadily yet firmly away from the iron and fine strings will spin out, usually from one-eighth to one-fourth of an inch varying with the season of the year and the kind of cheese made. In the spring usually one-eighth inch is sufficient. Later in the season and for a cheese that has to be held one-fourth inch is desirable. To get a proper test the following
points are important: first, the iron should be of the proper temperature; second, the curd should be pressed firm and dry; third, the curd and iron must be firmly held; fourth, the curd must be drawn from the iron as slowly as possible; fifth, the test should be taken in a warm place, free from drafts. Lack of attention to these points I have known on more occasions than one to result in a sour lot of cheese.

The hot iron test is supposed to tell the stage of development of the acid in the curd. It is probable, however, that it indicates the degree of fermentative changes going on in the curd of which the acid development is one. To check the fermentations, or rather, perhaps, to give a new direction to them, the whey is drawn from the curd. When it is determined that the curd is ready, the whey should be drawn as quickly as possible, especially if the fermentative changes are proceeding rapidly.

When the whey has been removed the curd should be placed upon racks in the vat or dipped into a curd sink and stirred to permit the whey, which is around and between the particles, to escape. The amount of stirring will depend somewhat upon the condition of the curd. The aim should be to have it in about the same condition in each vat and from day to day.

If too much acid has developed at the time of dipping, the curd should be stirred quite dry. In bad cases our practice is to wash the whey out of the curd by means of water heated to 98° F. Draw the whey down to the curd and then pour in the water and wash the curd. Our experience has shown that very good cheese can be made in this way from milk very much over-ripe. It is the sugar in the whey that is changed into an acid; thus, if all the whey is washed out, acid formation ceases.

CHEDDARING AND MATTING.

After being stirred dry enough the curd is allowed to mat. In twenty minutes it may be cut into pieces and turned over to permit the whey to run off. In another ten to fifteen minutes it may be turned again and piled two deep, and so continue until it is time to grind the curd. The curd is turned and piled to facilitate the escape of the whey and also
to maintain an even temperature in all parts of the curd, thus aiding the fermentative changes. At this stage the temperature of the curd should be kept at about 94°-96° F. For a gassy curd we usually pile the pieces of curd five to ten deep, or until they have flattened out quite thin; this maintains the heat, thus aiding fermentation, it also flattens the gas holes by the pressure and exposes a larger surface to the air in handling.

(14) GRINDING THE CURD.

The next stage in the work is the grinding of the curd. Here again the hot iron test is called into use. In our practice, for the Utah market, when the curd will spin from three-fourths inch to one inch on the hot iron, the curd is ground. This is frequently spoken of as showing the degree of acidity, but it is more likely a test of the stage of the fermentative changes going on in the curd of which acidity is but one. When the curd has been piled during matting we usually find that at this stage the curd is in a measure, fibrous and will tear apart in flakes.

The curd is ground to hasten the ripening of the curd by exposing the particles to the air. It may also improve the flavor. Mainly, however, the curd is ground to facilitate the handling, particularly in the salting and putting in the hoops to press.

The grinding is done by some kind of a mill operated by either hand or power. There are several kinds of mills but they are of two general classes, the peg and the knife mills. The latter is preferred by most makers, as with the knife the curd is cut without being crushed and thus less fat is lost. The curd has to be pressed a little harder, however, to make a close cheese. For a gassy curd our practice is to grind the curd very fine, putting it through the mill at least twice. This facilitates the escape of the gas.

(15) SALTING THE CURD.

After grinding, the curd is stirred every ten to fifteen minutes to keep the particles apart and expose them to the air. This stirring should continue till the curd becomes smooth, and has a glossy appearance, and from the particles when squeezed
in the hand the fat runs. The curd is then ready for the salt. 

Cheese is salted, first to preserve the cheese. In other words, it checks fermentation; while not stopping the fermentation changes it retards their action. Associated with this is its action in aiding to give a close bodied cheese, due probably to the fact that the fermentative actions are checked. The salt also improves the flavor of the cheese. Salt when applied to the curd tends also to draw out the moisture, thus drying the cheese to a certain extent.

The above facts should be kept in mind in considering the amount of salt to use. Cheese that is to be sold as soon as possible should be salted light, to permit it to cure quickly; about two pounds of salt per one thousand pounds of milk. A cheese that is to be kept, must be salted heavier, from two and a half to three pounds of salt per one thousand pounds of milk. However, the amount of salt may vary slightly from day to day, a dry curd requiring a little less than normal and a moist curd a little more. The richness of the milk will also modify somewhat the amount of salt to use. Cheese from rich milk requires more salt than cheese from poor milk.

The salt used should always be good. For cheese salt a little coarser than that used for butter is preferred; the larger crystals will dissolve more slowly, thus giving time for the salt to penetrate the curd. The salt should be thoroughly mixed through all parts of the curd, giving as even a salting as possible.

(16) PRESSING THE CHEESE.

Cheese are pressed to remove excess of moisture, to close up the curd, thus excluding the air, and finally to make it possible to handle the cheese. The pressing out of moisture and the exclusion of air tends to retard fermentative action.

The curd is ready for the press as soon as the salt is dissolved. It should be at a temperature of about 80° to 85°F. at this time. The curd should be divided as even as possible into the hoops, preferably by weighing.

When put in the press pressure should be applied gradually at first, so not to start the white whey. Gradually increase the pressure till sufficient is applied. After an hour
or two the cheese are taken out and bandaged and then put back to press for fifteen to twenty hours.

There is practically but one style of press used in this State, the gang. Of this, however, there are two kinds, the ordinary and those with an automatic pressure block. The latter are much to be preferred as they maintain a steady pressure on the cheese as long as it is in the press, and thus closes up the cheese better than in the ordinary press.

A standard cheddar cheese weighs about sixty pounds. There are few if any of this size made in this State. The size usually made weighs about thirty pounds and is known as a flat, being five to six inches thick and fourteen to fifteen in diameter. When shipped two in a box there are sometimes called twins. Yet another form, used for local trade to some extent, is a small cheese six to seven inches thick and seven inches in diameter known as Young American. These names are applied to distinguish the size of the cheese; they are all made in practically the same way.

(17) CURING THE CHEESE.

One of the most important points in making good cheese is to get it cured properly. By curing is meant the rendering soluble of the curd of the cheese and the development of a proper and desirable flavor. Green cheese is only slightly soluble in water, whereas 25% to 50% of the curd of cured cheese is soluble, varying with its age and the condition under which it has been kept. The changes in the cheese known as curing are produced by at least three agencies, bacteria, rennet and enzymes, peculiar to milk.

The bacteria are known to play an important part in the making of cheese, but to just what extent they are concerned in the curing of the cheese is not yet known. Experiments have shown that the lactic acid class of organisms increase very rapidly in the cheese for the first week or two after it is made, and then decrease in number till in old cheese there are comparatively few. The other classes of organisms seem to decrease almost from the time the cheese is made.

The effect of varying amounts of rennet on the curing of cheese has been a disputed question for a number of years. Recent experiments by Babcock and Russell of the Wisconsin
EXPERIMENTS IN BUTTER-MAKING AND CHEESE-MAKING. 35

Experiment Station seem to show that the pepsin in rennet which is associated with the curdling ferment (or rennin) does aid in the curing of cheese, and that the action varies with the amount of rennet used.

Perhaps one of the most interesting and valuable discoveries in regard to cheese curing was that of Babcock and Russell in finding an enzyme, an unorganized ferment, which is a normal constituent of milk and has the power to liquify or cure the curd of cheese.†

It is evident from these experiments that this enzyme is the most potent factor in cheese-curing. The activity of this enzyme is modified by external conditions, in a measure the same as bacteria, but it has the power to continue its work even at a very low temperature. It is probable when the work of this enzyme has been more carefully and more thoroughly studied that our present method of cheese curing may be materially modified. Our present methods are empirical, the result of experience and as yet only a beginning has been made in the scientific study of cheese-making or curing; a large and interesting field which several Stations are now exploring.

In curing, the character of the cheese is modified by several conditions which may be expressed graphically as follows:

\[
\begin{align*}
\text{Conditions which modify the curing of cheese.} & \quad \text{Manner in which cheese is made.} & \quad \text{Kind and amount of fermentation in milk. Moisture in cheese. Salt in Cheese. Closeness of cheese.} \\
& \quad \text{Heating of the curing room.} & \quad \{ \text{High, Medium, Low} \} \quad \text{Uniform} \\
& \quad \text{Ventilation of the curing room.} & \quad \{ \text{Pure air, Cool or warm air, Dry or moist air} \} \\
& \quad \text{Cleanliness of the curing room.} & \quad \end{align*}
\]

It is perhaps scarcely necessary to comment on those points. That the kind and amount of fermentation in the milk

†See 14th Annual Report of Wisconsin Experiment Station.
will modify the character of the cured cheese is well known. I believe this is true not alone when cured at the ordinary temperature but even when cured at a low temperature as will be noted later. A moist cheese will cure differently and quicker than a dry cheese. The effect of salt and of the closeness of the cheese has been commented on before.

The temperature at which the cheese is held will modify both the rapidity and the kind of the changes going on in the cheese. At a high temperature the cheese will cure and go off flavor very rapidly. Experience seems to show that a fairly uniform temperature is desirable and $60^\circ$ to $65^\circ$ F. has given the best results. Recent experiments seem to show that cheese may be cured at as low a temperature as $5^\circ$ to $10^\circ$ below freezing or at $22^\circ$ to $27^\circ$ F. though they cure very slowly. Past experience has seemed to teach that the curing room should be well ventilated and advantage may be taken of this to warm or cool the curing room and also to regulate the moisture.

The control of the temperature and moisture of the curing room is a very important point. From observations made over the State this has seemed to me to be a point worthy of much more attention than it at present receives from the factory operators. Its neglect often results in an inferior product. Instances have come to my notice where the loss in one season's make of cheese would more than pay for the improvements necessary to regulate very thoroughly the temperature and moisture of the curing room.

To control those points the location and manner of constructing the building are important. It should as far as possible be protected from the strong rays of the sun and the walls built so as to keep out the heat of summer and the cold of winter. A well ventilated cellar makes a good curing room. To keep down the temperature in the summer, while at the same time supplying moisture, ice is sometimes used. A method that has met with much favor in eastern cheese districts for cooling the curing room, and increasing the moisture of the air, is the sub-earth air duct. I do not know of any of them used in this State.

During the winter the curing room should be heated and for this purpose a stove or a steam coil may be used. Both should be located and protected in such a way as to distribute the heat as evenly as possible over the room.
It is a good practice to put the newer cheese on the top shelves of the curing room, which is the warmest place, and to keep turning them down to the lower shelves as they grow older. For the first three or four weeks the cheese in the curing room should be turned on the shelves every day, after that at every second day, and as they get older less turning will suffice.

(18) MARKETING CHEESE.

No systematic method of marketing cheese has yet been adopted in this State, due mainly to the market being a local one. With the growth of the business, however, there are indications of changes which promise much for the future development of the business. With the continued exercise of reasonable intelligence and care on the part of the cheesemakers and managers of the factories, the indications are that Utah cheese will occupy a prominent place in the markets of this western country. Our experiments have shown that in Utah as fine cheese can be made as in any State in the Union. This fact is already being recognized in the markets around us, and it should be the ambition of every maker to not alone maintain that reputation but to continue to improve it.

Next to making a good article, the most important point to be considered in the development of the cheese industry of the State, is the making of a uniform article. We want uniformity of quality and uniformity of appearance. The cheese made each day in the factory should be the same and this should be extended to include all the factories of the State. This point has always appealed to me as something of very great importance but the point was brought pertinently to mind this summer in talking to a prominent operator. A buyer from outside the State in bargaining with him for cheese said: "We want your cheese and are willing to pay a premium to get it because we know (from experience) that we can depend upon every cheese in the carload being the same." This uniformity of quality may be controlled to a large extent by the method of making. The quality of the cheese will vary some with the season of the year and moreover cheese changes with age, but if the cheese of each month is sold together or better of each two weeks, they should if properly made be practically the same in quality. The growth
of the market in surrounding States will demand in time greater uniformity in the product over the State. This has been accomplished in other States by a system of State instruction, experts being employed to visit the various factories and to give practical demonstrations in cheese-making. As the need for it arises, such a plan may be put in operation in this State. While a good and uniform article is of first importance, the smaller things must not be neglected. A neatly dressed cheese that arrives at the market in strong, sound and neat boxes, always commands attention, even on a dull market.

The two worst difficulties with which the cheese-maker has to deal are over ripe milk and gassy milk. These have been touched upon before, but because of their importance, the method of treating such milk, will be briefly summarized.

(19) OVER-RIFE MILK.

Over-ripe milk is milk in which the fermentative changes have proceeded too far, and too much acid has developed for the proper setting stage. In a factory phrase, it works fast. The fermentation having a good start works rapidly, and it should be the cheese-maker’s object to catch up to and control it.

Over-ripe milk will generally make known its presence by its odor, which is that of old or slightly sour milk, though sometimes it is not noticed till the rennet test is taken. Attention to the following points will control the difficulty, even when well advanced, though as much, or as good cheese cannot be guaranteed. The method of handling described, the writer has tried on several occasions, with very gratifying success.

(1) Heat the milk as rapidly as possible to 86°C F., but avoid scalding.

(2) Always test with the rennet test, so as to know exactly the condition of the milk, when we may proceed with more confidence.

(3) Color as usual.

(4) Add one-third to one-half more rennet to give a quick coagulation.

(5) Cut finer than usual, very fine if the milk is very much over-ripe; from the size of peas to wheat.
Heat the curd as quickly as possible to 98° F., keeping it well stirred the while. If very much over-ripe heat it to 104° F.

(7) As soon as heated test the curd with the hot iron. Possibly the rapid work so far has allowed the maker to catch up to the fermentation, or acid development, or even to get ahead of it. If so proceed as in the regular method.

(8) If the curd spins beyond normal, dip immediately and stir very dry, to expell all the whey possible.

(9) If the acid development is considerably ahead of the work, keep stirring the curd and do not allow it to mat in large pieces. Grind early, half to three-quarters of an hour after dipping, and then keep stirring to dry the curd as much as possible.

(10) In very bad cases the curd may be washed with water at time of dipping. Draw the whey down to the curd, then pour in warm water (98° F.) and wash all the whey out of the curd.

(11) Curd handled as described above will be quite dry and require a little less salt than usual.

(20) **GASSY MILK.**

Gassy milk is caused by some varieties of gas-producing bacteria which get into the milk. Usually they get into the milk at the time of milking, but some experimental evidence seems to show that at times the udder of the cow may be affected, particularly where the cows are not kept clean when in the stable. Gassy milk is usually much more common in the summer than in the winter.

Gassy milk usually has a peculiar, strong flavor or smell, which is sometimes not noticed till the milk is heated in the vat. The herd, or herds, from which the contaminated milk comes may be readily located by the fermentation test. The curd will be full of round holes from the size of a pin up, according to the kind and number of germs in the milk. When the milk is very gassy the curd will sometimes float on the top of the whey, due to a little gas forming in each particle of curd. A bad case is shown in the cheese illustrated. (See plate opposite page 21.)

The treatment of gassy milk will depend upon when the trouble is first noticed.
(1) If the flavor is detected when the milk comes to the factory, heating the milk to 170° or 180° F. will correct it.

(2) If detected when the milk is heated in the vat, ripen the milk more for setting; if necessary use a starter.

(3) If detected after the curd is heated, stir and air the curd well, and if the acid is developing slowly, a starter may be added at this time.

Practical experience seems to teach that the gassy fermentation has to be controlled by the proper development of acid. To aid the development more moisture must be retained in the curd by the following methods: Use a little extra rennet; cut as coarse as possible; cook at a lower temperature (96° F.); stir less at dipping, and allow a full amount of acid in the whey.

If the gas holes show in the curd after matting do not grind so early, pile the curd six to ten pieces deep, till they have flattened quite thin. This maintains heat, aerates the curd and tends to flatten the holes.

In grinding cut the curd fine by putting it through the curd mill twice.

After grinding stir over a few times, then pile the curd quite high in the vat or sink to press out the gas. If very bad the curd may have to be stirred and again piled. Let the curd stand till it has lost its springy or spongy feeling. Then air well by stirring. This exposing of the curd to the air, will improve its flavor. A gassy curd should be well mellowed down before being put to press, and should be salted a little more than usual.
Part III.

EXPERIMENTS IN CHEESE-MAKING.

RELATION OF WEIGHT OF MILK AND PER CENT FAT TO AMOUNT OF CHEESE.

Beginning with the spring of 1897 observations have been made on the making and curing of cheese, the object being to make a study of the effect of local conditions on the amount and quality of the product. Our facilities for this work were limited and for this reason we have not been able to do the amount or kind of work we would like to have done. Most of the tests were made during the summer and fall though some were made in every month of the year. No effort was made to select milk so as to get a certain richness in fat in the vat or other conditions. The variations are such as might be expected during a series of years in handling the milk from different lots of cows.

Table 8 gives some of the results obtained in the work. It is arranged to show the product obtained from milk according to the per cent of fat. It will be noted that 146,873 pounds of milk were used during the test, and 16,053 pounds of cheese were made. On the average 2.77 pounds of cheese were made from each pound of butter fat in the milk. However, from the milk poor in fat proportionately more cheese was made than from that richer in fat. While not absolutely uniform there is a gradual decrease in cheese yield for each pound of fat in the milk from the poorer to the richer milk. For instance, milk testing 3.4% fat made 2.94 pounds of green cheese, for each pound of fat, while milk testing 4.8% fat made only 2.52 pounds cheese to each pound of fat. This result coincides with experiments reported from eastern stations, notably in Wisconsin and Ontario, Canada.

While the above is true, however, it must not be forgotten that the milk richest in fat produced more cheese per 100 pounds of milk than the milk poorest in fat. The milk testing
<table>
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<th>Per Cent. Fat</th>
<th>Lbs. Milk Used</th>
<th>Lbs. Cheese Made</th>
<th>Lbs. Fat in Milk</th>
<th>Lbs. Cheese to 1 lb. Fat in Milk</th>
<th>Lbs. Cheese to 100 lbs Milk</th>
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<td>2.99</td>
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<td>355.43</td>
<td>3.04</td>
<td>9.17</td>
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<td>45882</td>
<td>4871.5</td>
<td>1687.47</td>
<td>2.89</td>
<td>9.11</td>
<td>10.97</td>
</tr>
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<td>24556</td>
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<td>914.00</td>
<td>2.88</td>
<td>8.90</td>
<td>11.12</td>
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<td>11.47</td>
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<td>2446</td>
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<td>2.57</td>
<td>8.80</td>
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<td>2.60</td>
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<td>1827</td>
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<td>87.70</td>
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<td>8.27</td>
<td>12.09</td>
</tr>
<tr>
<td>Total &amp; Av.</td>
<td>148,873</td>
<td>16,063.5</td>
<td>5610.28</td>
<td>2.775</td>
<td>8.87</td>
<td>11,315</td>
</tr>
</tbody>
</table>

**GREEN CHEESE.**

**CURED CHEESE.**

<table>
<thead>
<tr>
<th>Per Cent. Fat</th>
<th>Lbs. Milk Used</th>
<th>Lbs. Cheese Made</th>
<th>Lbs. Fat in Milk</th>
<th>Lbs. Cheese to 1 lb. Fat in Milk</th>
<th>Lbs. Cheese to 100 lbs Milk</th>
<th>No. of Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4</td>
<td>707</td>
<td>69.0</td>
<td>24.04</td>
<td>2.76</td>
<td>10.25</td>
<td>9.75</td>
</tr>
<tr>
<td>3.5</td>
<td>1837</td>
<td>171.0</td>
<td>64.29</td>
<td>2.65</td>
<td>10.77</td>
<td>9.38</td>
</tr>
<tr>
<td>3.6</td>
<td>6960</td>
<td>689.0</td>
<td>250.56</td>
<td>2.77</td>
<td>10.00</td>
<td>10.00</td>
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<td>11225</td>
<td>1076.0</td>
<td>415.32</td>
<td>2.50</td>
<td>10.43</td>
<td>9.59</td>
</tr>
<tr>
<td>3.8</td>
<td>39273</td>
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<td>1402.37</td>
<td>2.58</td>
<td>10.12</td>
<td>9.88</td>
</tr>
<tr>
<td>3.9</td>
<td>17365</td>
<td>1727.5</td>
<td>677.23</td>
<td>2.55</td>
<td>10.05</td>
<td>9.95</td>
</tr>
<tr>
<td>4.0</td>
<td>14303</td>
<td>1511.5</td>
<td>568.12</td>
<td>2.66</td>
<td>9.39</td>
<td>10.75</td>
</tr>
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<td>4.1</td>
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<td>254.28</td>
<td>2.43</td>
<td>9.88</td>
<td>10.18</td>
</tr>
<tr>
<td>4.2</td>
<td>1196</td>
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<td>50.23</td>
<td>2.76</td>
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<td>11.36</td>
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<td>329.0</td>
<td>125.30</td>
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<td>8.86</td>
<td>11.28</td>
</tr>
<tr>
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<td>1116</td>
<td>124.5</td>
<td>49.10</td>
<td>2.53</td>
<td>8.97</td>
<td>11.13</td>
</tr>
<tr>
<td>4.5</td>
<td>1318</td>
<td>123.0</td>
<td>59.31</td>
<td>2.07</td>
<td>10.71</td>
<td>9.34</td>
</tr>
<tr>
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<td>59.0</td>
<td>24.84</td>
<td>2.37</td>
<td>9.15</td>
<td>10.93</td>
</tr>
<tr>
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<td>200</td>
<td>22.5</td>
<td>9.40</td>
<td>2.39</td>
<td>9.02</td>
<td>11.08</td>
</tr>
<tr>
<td>4.8</td>
<td>1827</td>
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<td>87.70</td>
<td>2.32</td>
<td>8.95</td>
<td>11.17</td>
</tr>
<tr>
<td>Total &amp; Av.</td>
<td>106,882</td>
<td>10728.5</td>
<td>4153.09</td>
<td>2.54</td>
<td>9.67</td>
<td>10.38</td>
</tr>
</tbody>
</table>

* Not enough tests to get a reliable result.
4.8% fat produced two pounds more cheese from 100 pounds of milk than milk testing 3.4% fat though the increase is not in proportion to the increase in fat. An excess of 1.4 pounds of fat in the 100 pounds of milk gave only two pounds greater yield of cheese, whereas, had the increase in cheese yield been in proportion to the increase in the amount of fat, the increase in cheese should have been about 3.5 to 3.8 pounds.

The results for cured cheese are given to allow of comparison with the green cheese. Not as many tests are available, as for green cheese especially in the lower and higher per cents of fat, 2.54 pounds of cheese were made for each pound of fat in the milk. This represents an average loss in curing of 8.83% due mainly to a loss of water. The same variations from low to high fat test as were noted in regard to the green cheese, are to be seen in the results for cured cheese, though the results are not quite as uniform, as in several tests there were not enough cheese made to give the correct average.

(2) LOSS OF WEIGHT IN CURING CHEESE.

The curing of cheese, as noted in another place, is one of the most important parts of the factory work. There are some good curing rooms in the State but as a rule not enough attention is paid to this part of the business. Utah has a very dry climate and cheese are inclined to dry out considerable unless especial care is taken to keep the curing room moist. The College curing room is in the basement of the main College building and in the center of the building. It is ventilated by a short sub-earth air duct and heated by hot water. The conditions are perhaps as favorable for the proper regulation of temperature and moisture as in any curing room in the State. During the summer season the temperature has ranged from 65° to 70° F. and during the winter from 58° to 65° F. though occasionally higher and lower temperatures were recorded. The relative humidity ranged from 60% to 70% of saturation during the summer and fall and 65% to 75% during the winter and spring. During the summer ice was used sometimes in the curing room and during the colder weather a little steam was allowed to escape into the air. The cheese were all flats, weighing from twenty-five to thirty-five pounds each.
TABLE 9—LOSS OF WEIGHT IN CURING CHEESE.

<table>
<thead>
<tr>
<th>Average Time in Curing Room</th>
<th>Weight of Green Cheese</th>
<th>Cured Weight</th>
<th>Lbs. Loss</th>
<th>Per Cent Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cured One Month ...</td>
<td>2622.5</td>
<td>2441.0</td>
<td>181.5</td>
<td>6.94</td>
</tr>
<tr>
<td>Cured Two Months ...</td>
<td>9045.5</td>
<td>8328.0</td>
<td>717.5</td>
<td>7.93</td>
</tr>
<tr>
<td>Cured Three Months</td>
<td>6016.5</td>
<td>5477.0</td>
<td>539.5</td>
<td>8.97</td>
</tr>
<tr>
<td>Cured Four Months.</td>
<td>763.0</td>
<td>691.5</td>
<td>71.5</td>
<td>9.37</td>
</tr>
<tr>
<td>Cured Five Months...</td>
<td>1292.0</td>
<td>1180.0</td>
<td>112.0</td>
<td>9.39</td>
</tr>
<tr>
<td>Cured Six Months...</td>
<td>129.0</td>
<td>117.0</td>
<td>12.0</td>
<td>9.30</td>
</tr>
</tbody>
</table>

Table 9 shows the loss in holding cheese. The data are arranged by months. These cheese were all weighed when taken from the press and again at the end of stated periods, or when sold. It will be noted at the end of one month the cheese had lost nearly 7% of their green weight. The loss continued till the fourth month when the cheese has lost about 9½% of their green weight. More than two-thirds of the loss takes place during the first month. There seems to be little or no loss after the fourth month.

This seems to indicate, as was rather to be expected, that there is a greater loss in curing cheese in this State than in the East. In the Wisconsin Station Report for 1894, page 144, the loss on cheese at twenty-five days is given as 4.34%, at forty-one days 5.41% and for cheese over two months old the loss was 8.11%. I am inclined to think that under conditions, as cheese are kept in many curing rooms, the loss is much greater than reported in these tests.

(3) DIP-CURD CHEESE.

Some years ago a large number, and even recently, some of the cheese factories of the State, made what was known as a dip-curd cheese. The process of making was the same as the cheddar up to the time of dipping. When the curd was dipped it was stirred for ten to fifteen minutes, to drain off the whey, then salted and put to press immediately. This process gave usually a soft open bodied cheese. A few tests were made to determine the amount and character of this cheese as compared with the regular cheddars. Table 10 gives the results of their tests.
TABLE 10—SUMMARY OF RESULTS IN MAKING DIP-CURD CHEESE.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>359</td>
<td>37</td>
<td>11.55</td>
<td>3.12</td>
<td>9.70</td>
<td>10.03</td>
<td>32</td>
<td>2.79</td>
<td>11.22</td>
</tr>
<tr>
<td>3.6</td>
<td>1325</td>
<td>148</td>
<td>47.70</td>
<td>3.10</td>
<td>8.95</td>
<td>11.17</td>
<td>129</td>
<td>2.70</td>
<td>10.27</td>
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<td>11.43</td>
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<td>2.72</td>
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<td>371</td>
<td>116.66</td>
<td>3.18</td>
<td>8.31</td>
<td>12.03</td>
<td>319</td>
<td>2.73</td>
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<td>2554</td>
<td>307</td>
<td>103.51</td>
<td>2.98</td>
<td>8.61</td>
<td>11.48</td>
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<td>2.62</td>
<td>9.78</td>
</tr>
<tr>
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<td>710</td>
<td>86</td>
<td>28.40</td>
<td>3.03</td>
<td>8.25</td>
<td>12.12</td>
<td>74</td>
<td>2.61</td>
<td>9.59</td>
</tr>
<tr>
<td>4.3</td>
<td>630</td>
<td>72</td>
<td>27.07</td>
<td>2.66</td>
<td>8.68</td>
<td>11.52</td>
<td>62</td>
<td>2.29</td>
<td>9.84</td>
</tr>
<tr>
<td>Total &amp; Av.</td>
<td>10485.3</td>
<td>1219.5</td>
<td>309.46</td>
<td>3.02</td>
<td>8.60</td>
<td>11.39</td>
<td>1200.5</td>
<td>2.66</td>
<td>9.89</td>
</tr>
</tbody>
</table>

By comparing this with table 9 it will be seen that this process gave somewhat more green cheese to each 100 pounds of milk and for each pound of fat in the milk. With the cured cheese, however, there is very little difference. The explanation of this is seen when we note the loss of weight in curing. The dip-curd cheese lost nearly twice as much in one month's curing as the regular cheddars. Cheese made in this way contained a large amount of whey, thus cured quickly and went off flavor rapidly. At one month old, and generally two months if kept at a cool temperature, they were moist with very fair flavor and fairly well cured, after this, however, they generally got strong and became soft and sticky. Cheese that are to be put on the market in a month or six weeks and used locally, there may be some advantage in making this way, but any cheese for export out of the State, or that is to be held in storage, will prove more satisfactory if made by the regular cheddar process. The dip-curd method has an advantage in shortening the time of making but as a rule the cheese lacks uniformity of quality.
(4) FAT LOST IN THE WHEY.

A question sometimes asked is what portion of the fat of the milk is lost in the whey? A tabulation of the data gathered in our cheese-making work gave the following:

**RELATION OF PER CENT. FAT IN MILK TO PER CENT. LOST IN WHEY.**

<table>
<thead>
<tr>
<th>No. of Tests</th>
<th>Per Cent. Fat in Milk</th>
<th>Per Cent. Fat Lost in Whey</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>3.4-3.7</td>
<td>.138</td>
</tr>
<tr>
<td>105</td>
<td>3.8-4.2</td>
<td>.144</td>
</tr>
<tr>
<td>22</td>
<td>4.5-4.7</td>
<td>.16</td>
</tr>
<tr>
<td>Average</td>
<td>..</td>
<td>.154</td>
</tr>
</tbody>
</table>

The average shows that the whey tested .154% fat. It will be noted too, that there is practically no difference in the test of the whey, whether the cheese was made from milk averaging 3.5% fat, or from milk averaging 4.5% fat, the richer milk can be handled so as not to give any greater loss in the whey than the poorer milk. The results given are probably better than usually obtained in factory practice, but shows what may be done with careful handling.

(5) EXPERIMENT IN CURING CHEESE FOR SEASON OF 1899.

During the summer of 1899, cheese were cured in the curing room for some time and then put in cold storage. The purpose was to note the effect on the character of the cheese and upon the loss in weight by holding in the different ways. The comparison on this latter point is not quite correct, but is here given, to afford comparison with another experiment the following year. Table 11 gives the data in regard to this test.

As will be noted, 5,104 pounds of cheese are considered in the test, or 170 cheese of about 30 pounds each. They were held on the average thirty-five days in the curing room, followed by forty-seven days in cold storage. The cold room was held at a temperature of 45° to 50°. In the curing room the cheese lost 7% of their green weight, and in the cold room 1.68% of their storage weight, or a total of 8.6% in 102 days. This showed a loss slightly below that which occurred when the cheese were kept continually in the curing room.

The most interesting part of the test was that while kept
TABLE II—EXPERIMENTS IN CURING CHEESE FOR THE SEASON OF 1899.

<table>
<thead>
<tr>
<th>In Curing Room</th>
<th>Green Weight</th>
<th>Average Time in Curing Room</th>
<th>Weight Put in Cold Storage</th>
<th>Loss in Curing Room</th>
<th>Per Cent Age Loss of Weight in Curing Room</th>
<th>Loss per Day in Curing Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>lbs.</td>
<td>days</td>
<td>lbs.</td>
<td>lbs.</td>
<td>7.03</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>5104</td>
<td>55</td>
<td>4745</td>
<td>359</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In Cold Storage</th>
<th>Average Time in Cold Storage</th>
<th>Weight Sold</th>
<th>Loss in Cold Storage</th>
<th>Per Cent Age Loss of Weight in Cold Storage</th>
<th>Loss per Day in Cold Storage</th>
<th>Total Loss in Weight</th>
<th>Per Cent Age of Green Weight Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>days</td>
<td>lbs.</td>
<td>lbs.</td>
<td></td>
<td></td>
<td></td>
<td>lbs.</td>
<td>8.6</td>
</tr>
<tr>
<td>47</td>
<td>4665</td>
<td>80</td>
<td>1.68</td>
<td>1.7</td>
<td>439</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

in cold storage the cheese almost without exception improved in flavor, and were better tasting cheese when they came out of cold storage, though a month and a half older. Had they been held in the curing room at its normal temperature for this one and a half months, many of the cheese would have been decidedly off flavor.

(6) EXPERIMENT IN CHEESE-MAKING FOR THE YEAR 1900.

During the summer of 1900 a few experiments in cheese-making were made to test the following points:

(a) The effect of setting milk at different temperatures.

(b) The effect of salt on the curing of a moist cheese.

(c) The effect of curing cheese at different temperatures.

(a) EFFECT OF SETTING MILK AT DIFFERENT TEMPERATURES.

The milk received at the College dairy was thoroughly mixed and then divided into two vats. One was always set at 86° F., and the other was set at varying temperatures 75°, 80°, 84°, 90° and 96° F.

Only one test was made in setting the milk at 75° F. With the same rennet test (with the milk at 86° F.) the vat set at 75° F. took fifty-two minutes to coagulate, and twenty-six minutes for the controlling vat, three ounces of rennet per 1000 pounds of milk being used. When cut the curd was very tender and broke into fine pieces, thus when cooked to 98° F. it was considerably dryer than the control vat. There was about
.5% of fat lost is the whey, compared to .2% in the control vat, while 5% less cheese was made. The experimental cheese took a longer time to make, as the acid was slow in developing and they cured more slowly. Almost the same remarks apply to the vat set at 80°F as to that set at 75°F., except that the curd was not quite so soft and the loss in the whey was less.

Two tests were made setting at 90°F. At this temperature the rennet acted more quickly and the curd was tough and very tenacious, requiring constant and almost vigorous stirring to keep it apart. The butter fat in the whey, however, did not vary much from that in the control vat.

Two tests were made setting at 96°F. The curd coagulated quickly and soon became quite tough. It was thus hard to keep the curd apart in cooking. When ready for dipping the curd appeared about as dry as in the control vat, but when ground and salted much more whey ran from the curd, showing that the high heat had hardened the outside of the curd particles before the whey was all forced out, thus giving a moist cheese. About one-third more fat was lost in the whey from the vat set at 96°F. and slightly less cheese was made. When examined two months after it was made, the cheese set at the high temperature was rather soft, showing the effect of the retention of moisture.

The test bears out the results of past experience, which has decided that when set at a temperature of 86°F. or thereabout, milk may be handled to the best advantage in cheese-making.

(b.) EFFECT OF SALT ON THE CURING OF A MOIST CHEESE.

The local market in Utah calls for a soft mild cheese, uniform in quality. For some years observations have been made on the best method to produce this article. The following method gives us the best results:

Set the milk at a temperature of 80°F. and at a rennet test that will permit of dipping in about one and three-fourths to two hours with one-eighth inch of acid. Use four to five ounces of rennet extract per 1000 pounds of milk. Stir little at the time of dipping, but otherwise handle the milk and curd by the regular cheddar method. Salt at three pounds per 1000 pounds of milk. The short cooking and slight development of acid
leaves more moisture in the curd but the extra salt tends to correct this in a measure. We have kept cheese made in this way for sixty-five to seventy days in an ordinary curing room at a temperature of 60° to 70° F. and the cheese have had a soft body and a quite mild flavor.

(c.) EXPERIMENTS IN CURING CHEESE AT DIFFERENT TEMPERATURES.

During 1899 we made some observations on holding cheese in cold storage after being kept in the curing room for varying lengths of time. This work was preliminary, but indicated that as a rule the earlier the cheese was put into the cold room and kept at a uniform temperature the better the cheese.

During 1900 a series of experiments were undertaken to further investigate this point. From the same vat, one lot of cheese was taken from the press and put at once into the cold storage and held at 45° to 50° F. Another lot was put in the curing room, held for a month and then put in cold storage, and the other lot was kept in the curing room throughout the experiment.*

The cheese put in the curing room were divided into three lots, one being put on the top shelf, another on the middle shelf, and the other on the bottom shelf or close to the floor of the room. This division of the cheese was made because as a rule the top of the curing room is warmer than at the floor. Our system of ventilation brought the cold air in at the floor. The cheese placed on the center shelf was at the end of one month placed in the cold room. The following table, No. 12, gives some data in regard to the test.

Probably the most interesting part of this test is the effect on the curing of the cheese. The two most important points are the rapidity of the curing and the quality of the cured cheese. Unfortunately on these points it was possible to get the physical examination only.

The cheese were first examined on October 10th when they were between one and two months old, tested the second time on November 13th, the third time, January 28th, and

* It should be noted perhaps that later I learned that a similar test was in progress at some two or three Stations whose facilities are much better than ours. At the time the work was planned, however, I was not aware of the fact.
### TABLE 12—EXPERIMENTS IN CHEESE-CURING FOR SEASON 1900.

<table>
<thead>
<tr>
<th>Date Made</th>
<th>Lot</th>
<th>Character of Curd</th>
<th>Condition of Curd at Salting</th>
<th>Where Kept</th>
<th>Date Cheese Placed in Cold Storage</th>
<th>Weig't of Cheese from Press</th>
<th>Weig't of Cheese Sept. 24th</th>
<th>Weig't of Cheese Oct. 10th</th>
<th>Weig't of Cheese Nov. 15th</th>
<th>Weig't of Cheese May 1st</th>
<th>Lbs. Loss in Weig't to Nov. 15th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 18...</td>
<td>1</td>
<td>Gassy</td>
<td>Gas holes flattened</td>
<td>Placed in cold storage from press</td>
<td>Aug. 19...</td>
<td>28½ lbs.</td>
<td>27 lbs.</td>
<td>26½ lbs.</td>
<td>26 lbs.</td>
<td>2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>Placed on center shelf in curing room and in cold storage after one month</td>
<td>Sept. 24...</td>
<td>26½ lbs.</td>
<td>25 lbs.</td>
<td>24½ lbs.</td>
<td>2 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 22...</td>
<td>1</td>
<td>Very Gassy</td>
<td>Gas holes flattened</td>
<td>Placed in cold storage from press</td>
<td>Aug. 23...</td>
<td>30½ lbs.</td>
<td>29 lbs.</td>
<td>28½ lbs.</td>
<td>27½ lbs.</td>
<td>2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>Placed on center shelf of curing room and in cold storage after one month</td>
<td>Sept. 24...</td>
<td>25 lbs.</td>
<td>23½ lbs.</td>
<td>23 lbs.</td>
<td>2 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 31...</td>
<td>1</td>
<td>Slightly Gassy</td>
<td></td>
<td>Placed in cold storage from press</td>
<td>Sept. 1...</td>
<td>26 lbs.</td>
<td>24½ lbs.</td>
<td>24 lbs.</td>
<td>23 lbs.</td>
<td>2 lbs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>Placed on center shelf of curing room and in cold storage later</td>
<td>Oct. 11...</td>
<td>26 lbs.</td>
<td>24½ lbs.</td>
<td>24 lbs.</td>
<td>2 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>On top shelf of curing room</td>
<td>26 lbs.</td>
<td>25 lbs.</td>
<td>24½ lbs.</td>
<td>1½ lbs.</td>
<td>2 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>On bottom shelf of curing room</td>
<td>26 lbs.</td>
<td>24½ lbs.</td>
<td>24 lbs.</td>
<td>2 lbs.</td>
<td>2 lbs.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the fourth test on May 1st. Quite a difference was noticed in the cheese according to the place they were kept.

The cheese cured on the top shelf of the curing room cured more rapidly and when first examined were of good quality and well ripened. When examined one month later they were past their best and deteriorating in flavor.

The cheese cured on the lower shelves of the curing room ripened more slowly and were better flavored cheese than that cured on the top shelf. At the time of the 2nd test the cheese were of excellent flavor and well cured. The above two lots were sold after the test on November 13th as they were ripe enough to suit the market.

The cheese put in cold storage after being in the curing room one month, continued to ripen, though slowly in the cold room. The flavor was good even up to the time when sold February 1st, though slightly bitter at that time. The flavor was more developed and the cheese ripened more than those held in cold storage from the press.

The cheese put in cold storage from the press were kept until May 1st when they were over eight months old. The ripening changes seem to have gone along slowly yet continuously during all this time: When sold the cheese were not all equally good. The cheese made August 18th was the best, really a fine cheese, though very slightly bitter. The cheese made August 22nd was quite bitter and that made on August 31st had a peculiar flavor, not disagreeable and yet not characteristic. These cheese where held at a temperature of 45° to 50° F., the room being cooled by ice.

It should be noted that the milk from which all these were made was not first class, all making a gassy curd. In every instance, however, the gas was controlled before the cheese was put to press, and none of them "huffed" on the shelves.

Contrary to what might be expected each lot of cheese lost the same in weight during the curing, whether kept in the curing room or in cold storage.
SUMMARY.

All styles of separators will do close skimming, if they are properly run. The inflow of the milk, the speed of the bowl, and the temperature of the milk should be carefully noted and regulated according to the teaching of the Babcock test of the skim milk.

The tests in the factories indicate that a machine in which the inflow of the milk is regulated automatically, and thus cannot be crowded, generally gives better results.

The tests of skim milk and buttermilk by the Babcock test when the amount of fat present is small, are generally .1% to .2% too low, as compared with chemical analyses.

By using the double-necked bottles, and by special manipulation, the Babcock tests of the skim milk, etc., will read much nearer to chemical analyses.

This difficulty in getting a correct reading with the Babcock test does not apply to whole milk.

Under average conditions cream from a separator testing about 30% fat, will churn, at a lower temperature and more exhaustively than thinner cream.

Cream with a very high per cent. of fat becomes so thick that it sticks to the side of the churn, and thus a portion of it may be lost in the buttermilk. When properly handled, however, the very thick cream will churn exhaustively.

The churning temperature of cream is the temperature that will bring the butter in proper condition and in a reasonable time. In these tests cream was put into the churn from 43° to 59° F., and when the butter gathered was from 52° to 62° F. In this matter experience has to be the guide.

The acidity of the cream seems to have little or no effect upon the thoroughness of churning within the limits of these tests .4% to .64% of acidity.

The especial value of the acidity test is to give control of the fermentation and to give uniformity to the ripening of the cream from day to day.

Butter made from cows fed on lucern, as contrasted to that made when the cows were fed on corn fodder, shows that the lucern gave to the butter a peculiar flavor, which those not familiar with it would call weedy, though not objected to by those used to it.
The butter from the lucern fed cows had a higher color and firmer body than the butter from the cows fed on corn fodder.

The experiments recorded show that on the average 2.77 pounds of green cheese was made for each pound of fat in the milk, but the milk lowest in fat made proportionately more cheese than the milk richest in fat, milk testing 3.4% fat made 2.94 pounds of green cheese for each pound of fat in the milk, while milk testing 4.8% fat made only 2.52 pounds of cheese to each pound of fat.

From one hundred pounds of rich milk more cheese was made than from one hundred pounds of poor milk. One hundred pounds of milk testing 4.8% fat made 12.09 pounds of cheese, while one hundred pounds of milk testing 3.4% fat made only 10.15 pounds of cheese, or practically two pounds more from the richer milk.

Cheese in curing continues to lose in weight till four months old. The greatest loss, however, is during the first month, when 7% of the green weight was lost, on the average. From this time the loss was very gradual, till at the fourth month the cheese had lost 9 3/4% of the green weight.

This loss in curing is greater than reported from the humid eastern states, but is probably less than from the average curing room over the State.

Cheese made on the "dip-curd" process produces a larger amount of green cheese than the regular "cheddar" process. It dries rapidly, however, and loses nearly twice as much the first month in the curing room as does the "cheddar." The cheese are soft, are quick to cure, but lack uniformity.

The fat lost in the whey in making cheese averaged about .15% fat, and there was little difference in the loss from milk testing 3.4% to 4.7% fat.

Milk set for cheese-making at or about 86° F. gave most satisfactory results. When set much below this temperature it was hard to keep the curd particles apart, and they did not cook properly.

In making a moist cheese for local consumption an extra amount of salt, up to three pounds per 1,000 pounds of milk, tends to retard ripening and gave a mild tasting cheese at two months of age or over.
Even when held at a low temperature, cheese will cure perfectly when sufficient time is given, showing that changes are progressing in the cheese even at a temperature when bacterial life is practically inactive.

Observations made during the test seem to indicate that cheese, to be successfully cured and to develop a proper flavor, must be made from good milk.

Cheese made in the same vat developed different flavors, according to the conditions surrounding them, particularly when held at various temperatures.

Further experiments are needed to determine positively the full effect of curing cheddar cheese at a low temperature.

A high temperature in the curing room is conducive to rapid changes in the cheese, and probably if held for several months, it would rapidly deteriorate in quality.

The experiment indicates that cheese ripened in the curing room at 60° to 65° F. for one month, and then put in cold storage, will retain its flavor for several months, and even improve in flavor.