Issued January 17, 1913.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—BULLETIN 157.
A. D. MELVIN, CHIEF OF BUREAU.

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## LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
*Washington, D. C., July 12, 1912.*

Sir: I have the honor to transmit, and to recommend for publication as a bulletin in the bureau series, the accompanying manuscript entitled "Variations in the Composition and Properties of Milk from the Individual Cow," by Messrs. C. H. Eckles, professor of dairy husbandry, University of Missouri, and Roscoe H. Shaw, of the Dairy Division of this bureau.

This paper is the third in the series of reports on milk-secretion investigations which are being conducted at the Missouri Agricultural Experiment Station in cooperation between the Dairy Division and the Missouri station. The previous reports, which have been prepared for publication as Bulletins 155 and 156 of this bureau, have dealt respectively with the influence of the stage of lactation and the influence of the breed and individuality of the cows upon the composition of the milk.

Respectfully,

A. D. Melvin,
*Chief of Bureau.*

Hon. James Wilson,
*Secretary of Agriculture.*

## CONTENTS.

# VARIATIONS IN THE COMPOSITION AND PROPERTIES OF MILK FROM THE INDIVIDUAL COW.

## INTRODUCTION.

This is the third in a series of reports giving the results of investigations in regard to the influence of certain factors upon the composition and properties of normal milk. Previous publications have given data in regard to variations due to the stage of lactation and variations due to the breed and individuality of the animal.[1] The present paper gives data concerning three factors in the milk from the individual cow, namely, (1) the normal variations from milking to milking, (2) the composition of morning compared with evening milk, and (3) the composition of the first as compared with the last milk drawn.

It is a well-known fact that the composition of milk, at least so far as the percentage of fat is concerned, varies constantly and often quite widely from day to day, and even from milking to milking. No further investigation would be necessary to establish this fact, although it is impossible to set any definite limits as to what may be expected in this respect. Among the causes that are usually assigned for these variations is the influence of weather conditions, changes in the health of the animal, change in milkers, unusual excitement of any kind, and to some extent changes in feed. In many cases it is not possible, with our present knowledge of the physiology of milk secretion, to connect the variations noted with the cause. While the facts regarding the variations in the fat content are well known, the information is very meager regarding the other constituents of the milk, and especially regarding the composition of the fat itself.

Some of the data already published show the variations throughout an entire lactation period. It may be pointed out, however, that a statement of this kind regarding the protein content, for example, really shows the influence due to the stage of lactation rather than to the daily variations. In order to obtain a fair idea as to the amount of daily variations to be expected, the periods covered should not be long enough to introduce variations due to the stage of lactation. Other conditions, as the feed and management of the animal, should remain constant. The variations which will then be found can reasonably be attributed to other causes, such as the physiological condition of the animal.

[1] Bulletins 155 and 156, Bureau of Animal Industry.

A more extensive knowledge regarding the daily variations in the composition of the milk is of importance to those engaged in the manufacture of dairy products on account of the relation it bears to the manufactured article. A knowledge of the extent and nature of these variations from milking to milking is perhaps of the greatest importance in connection with the use of milk as food, especially for infant feeding. For such purposes it is highly desirable to know if the constituents of the milk, such as the protein and sugar, vary from milking to milking, as the fat is known to do, or whether these constituents remain reasonably constant. So far little is known regarding the relation of the nature of the fat to its use as food, but whatever importance may be attributed to this factor, it is well to know what variations to look for from one day to another. The chemist who is concerned with the inspection of milk for the purpose of detecting adulteration is also greatly in need of this information, and he is constantly required to employ all available knowledge on this subject.

Another reason for beginning this particular series of investigations was the question of daily variations in connection with the sampling of milk from individual cows where the period of investigation covers a considerable length of time. The question here concerned is, How long a period must be included in the sample to obtain a fair representation of the composition of the milk the animal is producing? For example, in carrying on investigations in regard to the influence of feed upon the properties of milk it might be possible to obtain an entirely erroneous idea as to the composition of the milk and the nature of the fat if daily variations in the composition of the fat are large and the sampling period is short.

## THE ANIMALS USED, FEED AND MANAGEMENT.

The animals used were all purebred registered animals of the breeds indicated. The following statement gives the details regarding the individuals supplying the samples analyzed:

| Cow No. | Breed. | Age (years). | Days in milk. |
|---|---|---|---|
| 303 (milked twice daily) | Ayrshire | 3 | 180 |
| 205 (milked twice daily) | Holstein | 6 | 89 |
| 209 (milked twice daily) | do | 5 | 289 |
| 320 (milked twice daily) | Jersey | 11 | 98 |
| 400 (milked twice daily) | Shorthorn | 5 | 102 |
| 209 (milked three times daily) | Holstein | 6 | 44 |
| 207 (milked four times daily) | do | 9 | 14 |

In carrying out these experiments the animals were fed a uniform ration both in kind and amount during the period covered by the samples. In this way variations due to the ration fed were eliminated. The cows were milked by the same milker, and the intervals between milkings were uniformly 12 hours, except in the cases of cow 209,

milked three times daily at eight-hour intervals, and cow 207, milked four times daily at six-hour intervals. Cows 205, 320, and 400 were fed a ration consisting of alfalfa hay, 2 parts, and a mixture of corn, bran, and oats, 1 part. Cows 303 and 209 were turned in a blue-grass pasture during the day, and in addition received a uniform grain ration consisting of a mixture of corn 4 parts. bran 2 parts, and linseed-oil meal 1 part.

Cow 209 when milked three times daily and cow 207 when milked four times daily received a still different ration, but the proportion between the constituents was kept the same and the total quantity fed daily was the same in order that the variations found could not be attributed to the feed.

## METHODS OF SAMPLING AND PREPARATION OF SAMPLES FOR ANALYSIS.

The milk was weighed immediately after milking and the entire amount brought to the laboratory. From this a subsample was prepared for analysis. The cream was separated from the remainder of the milk with a small cream separator and the cream secured was churned in a glass jar. This butter was melted to supply the fat sample for analysis. The measurements of color of the butterfat were made with the Lovibond tintometer. The methods followed in the chemical analyses are those recognized by the Association of Agricultural Chemists.[1] Further details in regard to the methods followed will be found in the first report of these investigations in Bulletin 155, Bureau of Animal Industry.

## THE VARIATIONS FROM MILKING TO MILKING.

The detailed analyses of the milk from each of the 7 cows in this investigation are found in the three tables forming the Appendix at at the end of this bulletin. Table I shows the variations from milking to milking of the 5 cows which were milked twice daily. Table II gives the data for cow 209 milked three times daily, and Table III for cow 207 milked four times daily.

### PROTEIN.

Table 1 below is a summary showing the variations in total protein for the 7 animals. The most striking fact in regard to the protein is the comparatively small variation. More than 90 per cent of the analyses made showed a variation of less than 0.2 per cent from the average for the animal supplying the sample, and no samples show a variation of more than 0.3 per cent from the average. As compared with the other constituents of milk and with the composition of the fat these variations are small. The conclusion to be drawn from this is that the variation in the total protein from milking to

[1] See Bulletin 107 (revised), Bureau of Chemistry, U. S. Department of Agriculture, 1908.

milking is comparatively small, and only in exceptional cases would it be sufficient to be of importance in connection with the use of milk as human food. From the standpoint of taking samples for chemical analyses these variations would have to be taken into account, but a fair sample regarding the amount of protein in the milk of a certain cow may be secured by taking the average of a comparatively few samples.

TABLE 1.—*Average variations in total protein from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Total protein. | | | Variations from average. | |
|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 0.2 per cent. | Between 0.2 and 0.3 per cent. |
| | | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 303 (milked twice daily) | Ayrshire | 28 | 3.21 | 3.38 | 2.93 | 93.0 | 7.0 |
| 205 (milked twice daily) | Holstein | 28 | 3.02 | 3.19 | 2.74 | 96.4 | 3.6 |
| 209 (milked twice daily) | do | 28 | 3.31 | 3.45 | 3.13 | 100.0 | ..... |
| 320 (milked twice daily) | Jersey | 28 | 3.58 | 3.83 | 3.32 | 89.3 | 10.7 |
| 400 (milked twice daily) | Shorthorn | 28 | 3.59 | 3.83 | 3.45 | 93.0 | 7.0 |
| 209 (milked three times daily) | Holstein | 21 | 2.75 | 3.19 | 2.55 | 95.0 | 5.0 |
| 207 (milked four times daily) | do | 20 | 2.57 | 2.74 | 2.30 | 90.0 | 10.0 |

## SUGAR.

Table 2 is a summary showing the extent of variations in the sugar content. The sugar is usually considered to be the least variable of any constituent of milk, but our results indicate that it may be expected to vary rather more than the total protein. Some animals seem to show a wider variation in the amount of sugar than others. A variation of 0.5 per cent from the average is not uncommon with certain individuals, but about 90 per cent of the analyses show a variation of less than 0.2 per cent.

TABLE 2.—*Average variations in sugar from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Sugar content. | | | Variations from average. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 0.2 per cent. | 0.2 to 0.4 per cent. | 0.4 to 0.6 per cent. | 0.6 to 0.8 per cent. |
| | | | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| 303 (milked twice daily) | Ayrshire | 28 | 5.32 | 5.65 | 4.98 | 89.3 | 10.7 | ..... | ..... |
| 205 (milked twice daily) | Holstein | 28 | 5.10 | 5.49 | 4.64 | 35.7 | 57.1 | 7.2 | ..... |
| 209 (milked twice daily) | do | 28 | 4.55 | 5.05 | 4.29 | 89.0 | 7.1 | 3.6 | ..... |
| 320 (milked twice daily) | Jersey | 28 | 4.91 | 5.46 | 4.54 | 46.4 | 39.2 | 10.5 | 3.5 |
| 400 (milked twice daily) | Shorthorn | 28 | 5.37 | 5.70 | 4.83 | 81.4 | 14.8 | ..... | 3.7 |
| 209 (milked three times daily) | Holstein | 21 | 4.68 | 5.23 | 4.46 | 85.0 | 10.0 | 5.0 | ..... |
| 207 (milked four times daily) | do | 20 | 4.55 | 4.71 | 4.25 | 90.0 | 10.0 | ..... | ..... |

### FAT.

As already stated, it is a well-known fact that the fat varies from milking to milking. Table 3 gives the variations with this constituent for the 7 cows used in this investigation. The extreme variation reaches almost 2 per cent. Only 56 per cent of the samples come within 0.3 per cent of the average; 27.7 per cent range between 0.3 and 0.6 per cent; 11.7 per cent vary between 0.6 and 0.9 per cent from the average, and 4.6 per cent vary more than 0.9 per cent from the average.

A sample taken from a single milking is of little value as an indication of the quality of milk produced by any cow. When the number of milkings per day is increased to three or four the variations in the fat content become greater.

TABLE 3.—*Average variations in fat content from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Fat content. | | | Variations from average. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 0.3 per cent. | Between 0.3 and 0.6 per cent. | Between 0.6 and 0.9 per cent. | Over 0.9 per cent. |
| | | | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| 303 (milked twice daily). | Ayrshire | 27 | 3.93 | 4.36 | 3.49 | 77.7 | 22.3 | ..... | ..... |
| 205 (milked twice daily). | Holstein | 28 | 3.07 | 3.79 | 2.40 | 39.3 | 46.4 | 14.3 | ..... |
| 209 (milked twice daily). | do | 28 | 3.18 | 3.67 | 2.71 | 85.7 | 14.3 | ..... | ..... |
| 320 (milked twice daily). | Jersey | 28 | 5.31 | 6.31 | 4.56 | 50.0 | 25.0 | 17.9 | 7.1 |
| 400 (milked twice daily). | Shorthorn | 27 | 4.08 | 5.29 | 3.46 | 63.0 | 29.6 | 3.7 | 3.7 |
| 209 (milked three times daily). | Holstein | 20 | 2.98 | 3.63 | 2.24 | 45.0 | 30.0 | 25.0 | ..... |
| 207 (milked four times daily). | do | 19 | 2.62 | 4.15 | 1.67 | 31.6 | 26.2 | 21.1 | 21.1 |

### THE REICHERT-MEISSL NUMBER.[1]

Table 4 gives the data regarding this constant of the fat and shows what may be expected in the way of variations. The limit of error in making this determination is generally considered to be 0.5. Fifty-eight per cent of the determinations vary less than 1 from the average; 23.4 per cent vary between 1 and 2; 13.4 per cent between 2 and 3; 4.6 per cent between 3 and 4; and 0.5 per cent more than 4.

[1] This and the succeeding constants of the fat were determined by official methods, the details of which may be found in Bulletin 107 (revised), Bureau of Chemistry, United States Department of Agriculture. For the benefit of those who may be unfamiliar with the terms the following explanation may be helpful. The Reichert-Meissl number is an arbitrary measure of the volatile acids of which butyric is the principal one in butterfat. The figures do not show the percentages of the acid, but serve as a means of comparing different fats with reference to their volatile constituents. The iodin absorption number indicates relatively the amount of iodin a fat will absorb. Since the only fatty acid found to exist in butterfat which has the property of absorbing iodin is oleic acid, the iodin absorption number shows relatively the amount of this fatty acid present, but in common with the Reichert-Meissl number the figures do not represent percentages. The saponification number is the number of milligrams of potassium hydroxid required to saponify 1 gram of fat. Since the amount of potassium hydroxid required depends upon the molecular weight of the fat, the saponification number serves as an indicator of the relative percentages of the fatty acids of high and low molecular weights present.

On the whole, the fluctuation in the Reichert-Meissl number is quite marked. It is impossible to say with our present knowledge what are the causes of this wide fluctuation. It is evident that to obtain a fair sample for this determination more than one milking should be represented. The authors have been unable to find any data regarding the significance of the amount of volatile acids from the standpoint of human food.

TABLE 4.—*Average variations in the Reichert-Meissl number from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Reichert-Meissl number. | | | Variations from average. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 1. | Between 1 and 2. | Between 2 and 3. | Between 3 and 4. | Above 4. |
| | | | | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 303 (milked twice daily) | Ayrshire | 27 | 21.99 | 24.14 | 18.46 | 44.4 | 33.3 | 18.5 | 3.7 | ..... |
| 205 (milked twice daily) | Holstein | 28 | 27.35 | 30.81 | 25.90 | 68.0 | 25.0 | 3.5 | 3.5 | ..... |
| 209 (milked twice daily) | do | 27 | 19.24 | 23.65 | 18.39 | 70.4 | 18.6 | 7.4 | ..... | 3.6 |
| 320 (milked twice daily) | Jersey | 27 | 25.89 | 28.01 | 23.77 | 51.9 | 37.0 | 11.1 | ..... | ..... |
| 400 (milked twice daily) | Shorthorn | 27 | 26.15 | 28.81 | 23.45 | 70.4 | 11.1 | 18.5 | ..... | ..... |
| 209 (milked three times daily) | Holstein | 21 | 29.16 | 30.43 | 27.69 | 81.0 | 19.0 | ..... | ..... | ..... |
| 207 (milked four times daily) | do | 20 | 30.67 | 34.28 | 27.15 | 20.0 | 20.0 | 35.0 | 25.0 | ..... |

## THE IODIN NUMBER.

Table 5 shows the variations in the iodin number. The limit of error in making this determination is generally considered to be 0.5. The table shows that only 48 per cent of the total came within 1 of the average for the cow supplying the sample; 27.4 per cent varied between 1 and 2; while 15.8 per cent ranged between 2 and 3 from the average; and 8.8 per cent varied more than 3. These data indicate that rather wide variations are to be expected in the iodin number from day to day.

TABLE 5.—*Average variations in the iodin number from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Iodin number. | | | Variations from average. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 1. | Between 1 and 2. | Between 2 and 3. | Above 3. |
| | | | | | | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| 303 (milked twice daily) | Ayrshire | 28 | 41.32 | 44.62 | 40.04 | 25.9 | 25.9 | 29.6 | 18.5 |
| 205 (milked twice daily) | Holstein | 28 | 32.70 | 34.46 | 30.17 | 71.4 | 25.0 | 3.6 | ..... |
| 209 (milked twice daily) | do | 28 | 41.98 | 45.37 | 34.28 | 18.5 | 33.3 | 22.2 | 26.0 |
| 320 (milked twice daily) | Jersey | 28 | 24.18 | 28.27 | 21.98 | 59.3 | 22.2 | 11.1 | 7.4 |
| 400 (milked twice daily) | Shorthorn | 28 | 30.63 | 31.91 | 28.77 | 63.0 | 37.0 | ..... | ..... |
| 209 (milked three times daily) | Holstein | 21 | 32.73 | 34.49 | 30.73 | 47.6 | 33.3 | 19.1 | ..... |
| 207 (milked four times daily) | do | 20 | 41.17 | 44.34 | 38.28 | 50.0 | 15.0 | 25.0 | 10.0 |

## THE SAPONIFICATION NUMBER.

Table 6 is a summary of the variations in the saponification number as found with the 7 cows. The limit of error in making this determination is considered as being 2. The table shows that on the average 62.2 per cent of the determinations varied less than 2 from the average, or no more than the limit of error; 24.7 per cent ranged between 2 and 4 of the average; 9.3 per cent between 4 and 6; while 3.7 per cent varied more than 6. As with the other constants of the fat, we find here considerable variation from milking to milking. A study of the tables fails to indicate any relation between the iodin number and the amount of fat or of any other constituent. An increase in the iodin number in most cases is accompanied by a decline in the Reichert-Meissl number and in the saponification value. This relation is commonly found in butterfat.

TABLE 6.—*Average variations in the saponification number from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Saponification number. | | | Variations from average. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 2. | Between 2 and 4. | Between 4 and 6. | Above 6. |
| | | | | | | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| 303 (milked twice daily). | Ayrshire.. | 28 | 236.2 | 247.3 | 231.2 | 48.2 | 33.3 | 11.1 | 7.4 |
| 205 (milked twice daily). | Holstein.. | 28 | 227.9 | 234.0 | 224.6 | 67.8 | 21.4 | 7.2 | 3.6 |
| 209 (milked twice daily). | .....do.... | 28 | 234.2 | 242.4 | 226.1 | 42.3 | 19.2 | 30.8 | 7.7 |
| 320 (milked twice daily). | Jersey..... | 28 | 235.3 | 240.8 | 232.1 | 66.7 | 22.2 | 11.1 | ..... |
| 400 (milked twice daily). | Shorthorn. | 28 | 232.7 | 239.7 | 224.2 | 70.4 | 22.2 | ..... | 7.4 |
| 209 (milked three times daily). | Holstein.. | 21 | 230.1 | 232.1 | 226.6 | 90.5 | 9.5 | ..... | ..... |
| 207 (milked four times daily). | .....do..... | 20 | 226.3 | 231.0 | 223.1 | 50.0 | 45.0 | 5.0 | ..... |

## THE MELTING POINT.

A summary of the data showing this constant of the fat is given in Table 7. The range in variation here is small. It may be seen that 96.5 per cent of all vary less than 1° from the average. This result corresponds with our data already published in indicating that the melting point of the fat is not influenced to any great extent by a small change in the other constants of the fat. The melting point of a mixture of fats can not be predicted from the melting points of the fats themselves, according to Lewkowitsch.[1]

[1] Lewkowitsch, J. Chemical technology and analysis of oils, fats, and waxes. London, 1909. See vol. 1, p. 94.

TABLE 7.—*Average variations in the melting point from milking to milking.*

| Cow No. | Breed. | Number of milkings. | Melting point. | | | Variations from average. | |
|---|---|---|---|---|---|---|---|
| | | | Average. | Highest. | Lowest. | Less than 1 degree. | Between 1 and 2 degrees. |
| | | | ° C. | ° C. | ° C. | *Per cent.* | *Per cent.* |
| 303 (milked twice daily) | Ayrshire | 28 | 33.34 | 34.45 | 32.30 | 88.9 | 11.1 |
| 205 (milked twice daily) | Holstein | 28 | 34.09 | 35.05 | 33.30 | 100.0 | ..... |
| 209 (milked twice daily) | do | 28 | 33.46 | 34.40 | 32.95 | 96.3 | 3.7 |
| 320 (milked twice daily) | Jersey | 28 | 35.43 | 36.10 | 34.55 | 100.0 | ..... |
| 400 (milked twice daily) | Shorthorn | 28 | 33.92 | 34.40 | 33.45 | 100.0 | ..... |
| 209 (milked three times daily) | Holstein | 21 | 32.54 | 34.27 | 31.57 | 90.5 | 9.5 |
| 207 (milked four times daily) | do | 20 | 34.01 | 34.97 | 33.40 | 100.0 | ..... |

## COMPARISON OF MORNING AND EVENING MILK.

The data which have been given make it possible to compare the composition of morning milk with that milked in the evening. A large amount of data is already available regarding the variation in the fat content of milk as brought about by this factor. Practically none, however, has been published regarding the variations in the constituents other than the fat or regarding changes in the nature of the fat itself.

Fleischmann[1] found morning milk slightly richer than evening, but decided that the fat content varied with the interval between milkings. Sufficient data have been published by various authors to show the accuracy of the above statement. As a rule, when a cow is milked twice daily at intervals of equal length there is only a small variation in the average fat content of the milk. The variations found under these conditions seem to depend upon the individuality of the animals.

Table 8 is compiled from those that have preceded and gives the average figures for the morning and evening milking for each animal. Taking first the animals where the interval between milking was uniformly 12 hours, it will be noted that with 4 out of the 5 cows the yield of milk was slightly greater in the morning.

No variation in the protein content can be observed that may be attributed to the factor under consideration. The same may be said of the sugar. The fat is noticeably higher in the morning with 3 of the cows and apparently unchanged with 2.

The Reichert-Meissl number with each of the 5 animals is lower in the evening.

The iodin number in each case is higher in the evening sample.

The saponification value for the evening sample is decidedly lower with 2, slightly lower with 2, and higher for 1.

The melting point shows no variation sufficient to be taken into account. The same is true in regard to the size of the fat globules.

[1] Fleischmann, Wilhelm. Untersuchung der Milch von sechszehn Kühen. Landwirtschaftliche Jahrbücher, vol. 20, sup. 2. Berlin, 1891.

The physical constants of the fat show slight variations, but hardly sufficient to be taken into account.

The samples from the 2 animals that were milked three and four times daily showed wider variations than those from the cows milked twice only, although no appreciable variation was found with the total protein, sugar, and ash.

The per cent of fat varied considerably with the different milkings. The highest fat content was found in milk drawn near the middle of the day.

In general the composition of the milk plasma does not seem to vary appreciably from morning to evening when the interval between milkings is the same. This statement also holds good when the number of milkings is increased from two to three or four per day. The per cent of fat shows some variation, mostly depending upon the individual, and this variation is wider when the cow is milked more than twice daily. The fat content of morning milk is usually slightly higher. There seems to be a fairly constant variation in the chemical and physical constants of the fat between morning and evening. This is most noticeable with the volatile acids, which tend to be higher in morning milk, and with the iodin number, which is generally higher in the evening sample.

TABLE 8.—*Comparison of morning and evening milk—Average determinations for each milking.*

COWS MILKED TWICE DAILY.

| Cow No. | Hour milked. | Average yield of milk. | Total protein. | Ash. | Sugar. | Fat. | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point of fat. | Relative size of fat globules. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Pounds.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | | | | °*C.* | |
| 303 | 5.30 a. m. | 11.2 | 3.16 | ..... | 5.37 | 3.96 | 22.92 | 39.94 | 238.1 | 33.37 | 132 |
| | 5.30 p. m. | 12.2 | 3.24 | ..... | 5.26 | 3.92 | 21.12 | 43.33 | 234.4 | 33.31 | 139 |
| 205 | 5.30 a. m. | 9.2 | 3.09 | ..... | 5.24 | 3.45 | 27.52 | 32.53 | 227.7 | 34.13 | 161 |
| | 5.30 p. m. | 8.0 | 2.95 | ..... | 4.96 | 2.70 | 27.17 | 32.87 | 228.2 | 34.05 | 133 |
| 209 | 5.30 a. m. | 14.4 | 3.28 | ..... | 4.57 | 3.17 | 20.52 | 41.60 | 235.5 | 33.35 | 68 |
| | 5.30 p. m. | 13.6 | 3.33 | ..... | 4.54 | 3.18 | 19.43 | 42.34 | 231.9 | 33.56 | 68 |
| 320 | 5.30 a. m. | 10.1 | 3.63 | ..... | 4.92 | 5.64 | 26.24 | 23.59 | 235.8 | 35.45 | 373 |
| | 5.30 p. m. | 9.2 | 3.54 | ..... | 4.84 | 4.98 | 25.55 | 24.53 | 234.9 | 35.40 | 322 |
| 400 | 5.30 a. m. | 10.1 | 3.57 | ..... | 5.41 | 4.26 | 26.54 | 29.59 | 232.8 | 33.98 | 420 |
| | 5.30 p. m. | 9.3 | 3.61 | ..... | 5.32 | 3.88 | 25.88 | 30.97 | 232.7 | 33.85 | 384 |

COW MILKED THREE TIMES DAILY.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 209 | 5 a. m. | 23.7 | 2.73 | 0.73 | 4.77 | 2.47 | 29.49 | 31.75 | 231.1 | 32.40 | 70 |
| | 1 p. m. | 19.1 | 2.70 | .71 | 4.53 | 3.26 | 29.39 | 33.01 | 230.2 | 32.38 | 67 |
| | 9 p. m. | 14.9 | 2.82 | .72 | 4.73 | 3.25 | 28.60 | 33.43 | 229.1 | 32.83 | 73 |

COW MILKED FOUR TIMES DAILY.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 207 | 4 a. m. | 28.1 | 2.62 | 0.72 | 4.61 | 2.07 | 30.41 | 40.63 | 226.4 | 34.27 | 160 |
| | 10 a. m. | 23.0 | 2.57 | .72 | 4.48 | 3.46 | 30.75 | 41.19 | 226.0 | 33.99 | 166 |
| | 4 p. m. | 23.2 | 2.63 | .73 | 4.61 | 2.51 | 30.82 | 41.06 | 226.4 | 33.77 | 153 |
| | 10 p. m. | 22.3 | 2.46 | .70 | 4.50 | 2.60 | 30.68 | 41.79 | 226.3 | 33.98 | 224 |

## THE COMPOSITION OF THE FIRST AND LAST MILK DRAWN.

It has long been well known that the last milk drawn from a cow, commonly known as the strippings, contains a much larger per cent of fat than does the first milk drawn from the same cow, often spoken of as the foremilk. Kirchner [1] gives figures typical of this variation. According to his data the fat content increases gradually as the milking progresses, while the solids other than fat remain practically constant in all parts of the milking.

The investigation herein reported was made for the purpose of supplying additional data on this factor, especially in regard to the variation in the composition and nature of the fat in the foremilk and the strippings. This information is given in Tables 9 and 10. In taking the samples of foremilk represented in Table 9, 100 c. c. of milk was taken from each teat of the cow, the 4 portions being mixed to form the sample for analysis. The sample of strippings was secured when the milk was nearly out of the udder. A sample of 100 c. c. was then taken from each teat. If more could be drawn after taking this amount it was drawn into a second flask and sufficient added from the first to make up 100 c. c. One sample was then made by mixing the 100 c. c. sample from each teat.

It is probable that a still more marked variation would have been found between the first and last milk drawn had the samples taken been smaller and thus represented the extremes of the milking. The samples supplying the fat for the analyses given in Table 10 were taken in the manner already described, except that the samples from each cow were put together in the form of a composite sample representing 7 days. This was done in order to secure sufficient fat from which to make the determinations.

The following is the average analysis of the first and last milk, taken from Table 9:

| | Total protein. | Sugar. | Fat. | Ash. | Total solids. | Relative size of fat globules. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| First milk | 3.58 | 5.30 | 1.87 | 0.75 | 10.67 | 139 |
| Strippings | 3.38 | 5.33 | 6.28 | .70 | 14.86 | 215 |

[1] Kirchner, W. Handbuch der Milchwirtschaft. Berlin, 1898. See p. 56.

The only difference that is at all striking is that of the fat. Since the variation in this constituent is so marked, the following figures are given, which represent the composition of the milk plasma or the milk minus the fat:

| | Total protein. | Sugar. | Ash. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| First milk | 3.65 | 5.40 | 0.77 |
| Strippings | 3.60 | 5.68 | 0.75 |

It is evident from these figures that the change in composition of the first milk drawn to the last is confined to the amount of fat present. The milk plasma remains practically the same in composition.

The data given in Table 9 show that the larger the quantity of milk produced the greater is the variation in fat content and in the relative size of the fat globules between the first and last milk drawn. From the further data in Table 10 it may be observed that the quantity of milk produced is an important factor in determining the extent of the variation from the foremilk to the strippings. With the cows producing the small quantity of milk the strippings range from twice to three times the fat content of the foremilk, while with those producing large quantities the strippings contain 3 to 10 times as much as the foremilk.

The higher fat content of the last milk drawn has been explained in several ways. The most plausible seems to be that given by Kirchner.[1] According to this author the fat globules are held back mechanically in the fine passageways of the udder and escape in larger quantities in the last milk drawn. The data given support this theory by the additional fact, not given by the authority quoted, that the larger the production of milk the greater is the increase in fat as the milking progresses. This may be explained by the supposition that in the heavier milking cows the udder is more congested and the opening of the ducts made smaller by compression.

The larger fat globules would also be held back in the small ducts more than the smaller ones. This would account for the larger fat globules in the strippings and for the greater variation in size from foremilk to strippings when the production of milk is large.

[1] Kirchner, W. Handbuch der Milchwirtschaft. Berlin, 1898 See p. 58.

TABLE 9.—*Analysis of first milk and strippings.*

| Breed. | Milk yield per day. | Date of milking. | | Specific gravity of milk. | Water. | Total solids. | Ash. | Total nitrogen. | Total protein (N. x 6.38). | Casein nitrogen. | Albumin nitrogen. | Sugar. | Fat. | Relative size of fat globules. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Pounds.* | | | | *Per cent.* | *Per cent.* | *Per ct.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Jersey | 36.8 | Aug. 23 | Foremilk | 1.0349 | 89.54 | 10.46 | 0.71 | 0.54 | 3.45 | 0.42 | 0.048 | 5.79 | 1.59 | 139 |
| | | | Strippings | 1.0314 | 85.44 | 14.56 | .69 | .51 | 3.25 | .41 | .055 | 5.64 | 5.92 | 213 |
| | 41.1 | Aug. 25 | Foremilk | 1.0358 | 89.94 | 10.06 | .75 | .52 | 3.32 | .36 | .070 | 5.23 | 1.37 | 122 |
| | | | Strippings | 1.0274 | 84.85 | 15.16 | .70 | .49 | 3.13 | .26 | .060 | 4.75 | 6.92 | 313 |
| Holstein | 34.5 | Aug. 19 | Foremilk | 1.0323 | 90.57 | 9.43 | .73 | .47 | 3.00 | .36 | .052 | 5.31 | 1.42 | 87 |
| | | | Strippings | 1.0265 | 86.43 | 13.57 | .69 | .44 | 2.81 | .33 | .056 | 6.06 | 5.82 | 139 |
| | 38.9 | Aug. 25 | Foremilk | 1.0333 | 90.76 | 9.24 | .77 | .47 | 3.00 | .36 | .041 | 5.23 | .88 | 87 |
| | | | Strippings | 1.0284 | 87.14 | 12.66 | .72 | .45 | 2.87 | .34 | .053 | 4.85 | 4.80 | 149 |
| Shorthorn | 39.6 | Aug. 19 | Foremilk | 1.0343 | 90.16 | 9.84 | .74 | .50 | 3.19 | .36 | .076 | 5.71 | 1.31 | 91 |
| | | | Strippings | 1.0283 | 85.62 | 14.38 | .63 | .48 | 3.06 | .35 | .078 | 6.10 | 6.23 | 190 |
| | 41.9 | Aug. 25 | Foremilk | 1.0350 | 89.66 | 10.34 | .77 | .51 | 3.25 | .39 | .059 | 5.44 | 1.35 | 85 |
| | | | Strippings | 1.0298 | 85.68 | 14.32 | .69 | .50 | 3.19 | .37 | .059 | 5.74 | 5.54 | 235 |
| Jersey | 15.4 | Aug. 25 | Foremilk | 1.0300 | 89.19 | 10.81 | .75 | .52 | 3.32 | .37 | .057 | 4.46 | 2.96 | 183 |
| | | | Strippings | 1.0298 | 87.28 | 12.72 | .70 | .51 | 3.25 | .41 | .047 | 4.39 | 4.39 | 226 |
| | 14.1 | Sept. 8 | Foremilk | 1.0300 | 89.84 | 10.16 | .76 | .53 | 3.84 | .39 | .068 | 4.51 | 2.45 | 180 |
| | | | Strippings | 1.0272 | 85.82 | 14.18 | .70 | .52 | 3.32 | ..... | .061 | ..... | 6.05 | 309 |
| Ayrshire | 11.3 | Aug. 25 | Foremilk | 1.0340 | 89.86 | 10.14 | .70 | .58 | 3.70 | .45 | .069 | ..... | 1.09 | 52 |
| | | | Strippings | 1.0244 | 81.65 | 18.35 | .64 | .54 | 3.45 | .42 | .048 | 4.91 | 10.00 | 200 |
| | 12.9 | Oct. 12 | Foremilk | 1.0384 | 88.50 | 11.50 | .79 | .65 | 4.15 | .53 | .067 | ..... | 1.64 | 116 |
| | | | Strippings | 1.0283 | 82.83 | 17.17 | .73 | .59 | 3.76 | .52 | .070 | 5.35 | 7.88 | 207 |
| Jersey | 6.3 | Sept. 8 | Foremilk | 1.0357 | 86.97 | 13.03 | .75 | .66 | 4.21 | .52 | .085 | ..... | 3.34 | 186 |
| | | | Strippings | 1.0310 | 83.92 | 16.08 | .71 | .64 | 4.08 | .50 | .080 | 5.50 | 6.92 | 183 |
| | 7.3 | Sept. 27 | Foremilk | 1.0357 | 86.99 | 13.01 | .75 | .70 | 4.47 | .55 | .074 | 6.06 | 3.07 | 342 |
| | | | Strippings | 1.0310 | 85.06 | 14.94 | .75 | .68 | 4.34 | .55 | .103 | 5.35 | 4.91 | 215 |

TABLE 10.—*The composition of the foremilk and strippings as influenced by the quantity of milk produced.*

| Breed. | Total milk. | Fat content. | | | Relative size of fat globules. | | |
|---|---|---|---|---|---|---|---|
| | | Foremilk. | Entire milk. | Strippings. | Foremilk. | Entire milk. | Strippings. |
| | *Pounds.* | *Per cent.* | *Per cent.* | *Per cent.* | | | |
| Jersey | 3.0 | 3.7 | 6.2 | 10.3 | 206 | 250 | 264 |
| Do | 3.0 | 3.5 | 5.3 | 7.4 | 88 | 148 | 178 |
| Do | 3.3 | 3.2 | 5.2 | 7.6 | 125 | 120 | 158 |
| Do | 4.0 | 3.8 | 5.4 | 10.0 | 76 | 84 | 109 |
| Shorthorn | 7.8 | 1.4 | 3.8 | 8.7 | 152 | 232 | 280 |
| Do | 8.1 | 1.0 | 3.8 | 8.8 | 244 | 140 | 224 |
| Do | 15.5 | 0.9 | 3.1 | 7.5 | 51 | 145 | 254 |
| Do | 16.7 | 0.4 | 2.5 | 7.0 | 24 | 94 | 108 |
| Holstein | 12.7 | 2.0 | 3.0 | 5.2 | 118 | 146 | 150 |
| Do | 14.0 | 1.0 | 2.0 | 3.0 | 21 | 29 | 48 |
| Do | 15.7 | 1.2 | 3.0 | 5.2 | 56 | 67 | 90 |
| Do | 20.2 | 0.2 | 1.3 | 4.0 | 13 | 59 | 68 |
| Do | 20.2 | 0.4 | 1.6 | 5.3 | 27 | 70 | 122 |
| Do | 22.5 | 1.0 | 1.6 | 3.4 | 60 | 70 | 102 |

Table 11 gives the physical and chemical constants of the fat as found in the first and last milk drawn. The following is an average of this table:

| | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point. | Yellow color. |
|---|---|---|---|---|---|
| | | | | °C. | |
| First milk | 27.25 | 34.14 | 230.1 | 33.88 | 39 |
| Strippings | 26.32 | 33.82 | 228.3 | 33.91 | 39 |

The Reichert-Meissl number on the average is 0.93 lower in the strippings. It is lower with 6 out of the 8 cows supplying the samples.

The iodin number is 0.32 lower on the average in the fat from the strippings and 7 out of the 8 cows show the same variation, the eighth being practically the same. This tendency for a lower iodin number in the strippings while not great enough to be of much importance seems to be the rule.

The saponification number also is lower on the average in the strippings and occurred with 6 out of the 8 animals.

The melting point of the fat and the yellow color seem to be unchanged.

TABLE 11.—*Analysis of fat from first and last milk.*

| Cow No. | Average milk per day. | Date of milking. | | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point. | Color. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Yellow. | Red. | Light. |
| | *Pounds.* | | | | | | °*C.* | | | |
| 57 | 14.4 | Sept. 28 to Oct. 5 | Foremilk... | 28.14 | 34.09 | 231.3 | 34.03 | 50 | 2.7 | 0.3 |
| | | | Strippings.. | 28.68 | 33.47 | 229.2 | 33.80 | 54 | 3.0 | .3 |
| 55 | 15.1 | Sept. 28 to Oct. 5 | Foremilk... | 26.15 | 36.10 | 226.8 | 35.20 | 52 | 2.2 | .3 |
| | | | Strippings.. | 26.25 | 35.88 | 224.4 | 35.07 | 52 | 3.0 | .3 |
| 206 | 32.9 | Sept. 28 to Oct. 5 | Foremilk... | 26.43 | 39.64 | 225.0 | 33.20 | 45 | 1.6 | .2 |
| | | | Strippings.. | 26.38 | 38.96 | 226.3 | 32.73 | 45 | 1.6 | .2 |
| 210 | 42.3 | Sept. 28 to Oct. 5 | Foremilk... | 28.40 | 30.87 | 229.9 | 34.67 | 21 | 2.0 | .2 |
| | | | Strippings.. | 25.59 | 30.63 | 230.4 | 34.80 | 22 | 2.0 | .2 |
| 300 | 27.4 | Sept. 28 to Oct. 5 | Foremilk... | 27.59 | 28.60 | 235.4 | 34.03 | 50 | 3.0 | .3 |
| | | | Strippings.. | 27.27 | 28.25 | 231.2 | 34.20 | 50 | 3.0 | .3 |
| 301 | 27.5 | Sept. 28 to Oct. 5 | Foremilk... | 28.06 | 33.32 | 232.3 | 33.27 | 20 | 1.5 | .2 |
| | | | Strippings.. | 25.43 | 33.59 | 230.7 | 33.67 | 16 | 1.7 | .2 |
| 403 | 36.7 | Sept. 28 to Oct. 5 | Foremilk... | 26.53 | 31.56 | 233.3 | 33.17 | 28 | 1.7 | .2 |
| | | | Strippings.. | 25.01 | 31.37 | 229.1 | 33.27 | 26 | 1.7 | .2 |
| 6 | 12.2 | Sept. 28 to Oct. 5 | Foremilk... | 26.73 | 38.94 | 226.9 | 33.50 | 50 | 1.6 | .2 |
| | | | Strippings.. | 25.97 | 38.40 | 225.1 | 33.73 | 47 | 1.6 | .2 |

## APPENDIX.

The following tables give the detailed analyses of the milk at each milking from the 7 cows specially used in this investigation. Table I contains the data for the 5 cows milked twice daily, Table II gives the analyses for the cow milked 3 times daily, and Table III for the cow milked 4 times daily.

TABLE I.—*Showing variation from milking to milking—Detailed analyses of milk from cows milked twice daily.*

COW NO. 303.

| Date of milking. | | Yield of milk. | Specific gravity of milk. | Water. | Total solids. | Total nitrogen. | Total protein (N. x 6.38). | Casein nitrogen. | Albumin nitrogen. | Sugar. | Fat. | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point of fat. | Relative size of fat globules. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1909. | | *Pounds.* | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | | | ° *C.* | |
| June 2 | a. m. | 11.8 | 1.0320 | 87.16 | 12.84 | 0.51 | 3.25 | 0.41 | 0.061 | 5.41 | 4.09 | 22.79 | 39.99 | 240.1 | 34.10 | 204 |
| | p. m. | 12.2 | 1.0314 | 87.33 | 12.67 | .51 | 3.25 | .41 | .068 | 5.38 | 3.49 | 22.11 | 40.81 | 234.3 | 33.80 | 98 |
| 3 | a. m. | 12.9 | 1.0315 | 87.37 | 12.63 | .50 | 3.19 | .39 | .077 | 5.43 | 3.71 | 22.75 | 37.97 | 239.5 | 33.40 | 120 |
| | p. m. | 12.5 | 1.0320 | 87.47 | 12.53 | .52 | 3.32 | .39 | .060 | 5.31 | 3.97 | 21.22 | 42.66 | 233.1 | 33.65 | 131 |
| 4 | a. m. | 11.1 | 1.0318 | 87.07 | 12.93 | .50 | 3.19 | .45 | .056 | 5.30 | 4.08 | 23.21 | 33.55 | 237.4 | 33.60 | 125 |
| | p. m. | 12.7 | 1.0315 | 87.85 | 12.15 | .52 | 3.32 | .40 | .057 | 5.19 | 3.72 | 19.79 | 42.61 | 233.6 | 33.55 | 125 |
| 5 | a. m. | 12.2 | 1.0313 | 87.18 | 12.82 | .51 | 3.25 | .39 | .057 | 5.24 | 4.01 | 24.06 | 37.37 | 237.4 | 33.70 | 121 |
| | p. m. | 12.1 | 1.0324 | 87.43 | 12.57 | .53 | 3.38 | .41 | .063 | 5.18 | 3.79 | 21.91 | 43.41 | 234.3 | 33.30 | 135 |
| 6 | a. m. | 12.5 | 1.0320 | 87.67 | 12.33 | .50 | 3.19 | .39 | .066 | 5.08 | 3.94 | 23.28 | 40.65 | 238.1 | 32.95 | 59 |
| | p. m. | 11.8 | 1.0328 | 87.62 | 12.38 | .53 | 3.38 | .41 | .047 | 5.36 | 4.28 | 22.11 | 42.86 | 233.0 | 32.75 | 142 |
| 7 | a. m. | 12.7 | 1.0320 | 88.03 | 11.97 | .50 | 3.19 | .40 | .052 | 5.36 | 3.62 | 24.14 | 39.24 | 240.4 | 33.80 | 117 |
| | p. m. | 12.7 | 1.0318 | 87.16 | 12.84 | .51 | 3.25 | .38 | .052 | 4.98 | 4.00 | 22.11 | 43.56 | 233.0 | 32.30 | 168 |
| 8 | a. m. | 10.5 | 1.0319 | 87.23 | 12.77 | .50 | 3.19 | .41 | .052 | 5.43 | 4.05 | 24.08 | 40.04 | 247.3 | 32.15 | 129 |
| | p. m. | 12.5 | 1.0319 | 87.50 | 12.50 | .51 | 3.25 | .39 | .057 | 5.25 | 3.85 | 22.00 | 43.30 | 233.1 | 33.15 | 177 |
| 9 | a. m. | 12.7 | 1,0309 | 87.48 | 12.52 | .51 | 3.25 | .39 | .056 | 5.25 | ..... | 21.85 | 42.26 | 236.7 | 33.40 | ..... |
| | p. m. | 12.5 | 1.0322 | 87.58 | 12.42 | .52 | 3.32 | .41 | .052 | 5.20 | 4.04 | 22.70 | 41.87 | 236.4 | 33.13 | 159 |
| 10 | a. m. | 11.6 | 1.0314 | 88.02 | 11.98 | .49 | 3.13 | .40 | .051 | 5.33 | 3.77 | 23.10 | 39.98 | 238.1 | 33.68 | 142 |
| | p. m. | 12.5 | 1.0316 | 87.11 | 12.89 | .50 | 3.19 | .39 | .047 | 5.23 | 4.24 | 21.04 | 44.09 | 231.2 | 33.48 | 205 |
| 11 | a. m. | 11.6 | 1.0308 | 87.20 | 12.80 | .48 | 3.06 | .39 | .049 | 5.26 | 4.19 | 23.30 | 41.76 | 233.3 | 33.45 | 155 |
| | p. m. | 12.1 | 1.0321 | 87.27 | 12.73 | .51 | 3.25 | .39 | .053 | 5.30 | 4.20 | 20.31 | 44.46 | 232.8 | 34.45 | 123 |
| 12 | a. m. | 11.7 | 1.0318 | 87.50 | 12.50 | .51 | 3.25 | .39 | .046 | 5.65 | 3.80 | 20.18 | 44.15 | 235.7 | 32.65 | 116 |
| | p. m. | 12.5 | 1.0314 | 87.89 | 12.11 | .50 | 3.19 | .38 | .043 | 5.20 | 4.03 | 18.46 | 44.62 | 234.8 | 33.10 | 110 |
| 13 | a. m. | 11.7 | 1.0316 | 87.51 | 12.49 | .49 | 3.13 | .37 | .050 | 5.63 | 4.21 | ..... | ..... | ..... | ..... | 177 |
| | p. m. | 11.5 | 1.0315 | 87.95 | 12.05 | .50 | 3.19 | .38 | .055 | 5.35 | 3.84 | 21.41 | 44.02 | 232.1 | 32.75 | 144 |
| 14 | a. m. | 12.6 | 1.0304 | 87.71 | 12.29 | .48 | 3.06 | .36 | .045 | 5.30 | 4.36 | 22.50 | 41.45 | 235.0 | 33.45 | 145 |
| | p. m. | 11.8 | 1.0312 | 88.03 | 11.97 | .46 | 2.93 | .37 | .052 | 5.33 | 3.56 | 19.97 | 44.12 | 243.3 | 33.65 | 100 |
| 15 | a. m. | 11.5 | 1.0313 | 87.91 | 12.09 | .47 | 3.00 | .37 | .043 | 5.46 | 3.68 | 22.77 | 40.81 | 236.1 | 33.45 | 113 |
| | p. m. | 11.7 | 1.0323 | 87.65 | 12.35 | .50 | 3.19 | .40 | .049 | 5.44 | 3.80 | 20.54 | 44.21 | 236.8 | 33.30 | 127 |

TABLE I.—*Showing variation from milking to milking—Detailed analyses of milk from cows milked twice daily*—Continued.

COW NO. 205.

| Date of milking. | Yield of milk. | Specific gravity of milk. | Water. | Total solids. | Total nitrogen. | Total protein (N. x 6.38). | Casein nitrogen. | Albumin nitrogen. | Sugar. | Fat. | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point of fat. | Relative size of fat globules. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1908. | *Pounds.* | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | | | ° *C.* | |
| Nov. 16 a. m. | 9.5 | 1.0334 | 87.22 | 12.78 | 0.49 | 3.13 | 0.39 | 0.066 | 5.30 | 3.64 | 25.90 | 33.58 | 226.8 | 34.25 | 176 |
| Nov. 16 p. m. | 7.0 | 1.0332 | 89.11 | 10.89 | .46 | 2.93 | .34 | .060 | 4.89 | 2.61 | 26.38 | 32.15 | 225.7 | 35.05 | 131 |
| 17 a. m. | 10.6 | 1.0331 | 87.96 | 12.04 | .49 | 3.13 | .34 | .066 | 4.94 | 3.33 | 28.83 | 33.23 | 228.4 | 33.90 | ..... |
| 17 p. m. | 9.2 | 1.0329 | 88.77 | 11.23 | .46 | 2.93 | .36 | .042 | 4.83 | 2.98 | 27.97 | 34.35 | 234.0 | 33.30 | 198 |
| 18 a. m. | 9.0 | 1.0333 | 87.87 | 12.13 | .50 | 3.19 | .38 | .058 | 5.20 | 3.32 | 26.43 | 33.93 | 233.1 | 34.15 | 145 |
| 18 p. m. | 9.6 | 1.0331 | 88.96 | 11.04 | .45 | 2.87 | .35 | .050 | 4.86 | 2.88 | 26.15 | 34.46 | 224.8 | 33.95 | 111 |
| 19 a. m. | 9.1 | 1.0333 | 87.55 | 12.45 | .50 | 3.19 | .39 | .053 | 5.41 | 3.39 | 28.64 | 33.25 | 224.6 | 33.45 | 175 |
| 19 p. m. | 8.7 | 1.0331 | 89.08 | 10.92 | .48 | 3.06 | .37 | .040 | 5.33 | 2.57 | 28.09 | 32.56 | 226.7 | 34.10 | 129 |
| 20 a. m. | 9.7 | 1.0333 | 88.02 | 11.98 | .50 | 3.19 | .39 | .050 | 5.43 | 3.04 | 25.97 | 32.92 | 225.5 | 34.80 | 141 |
| 20 p. m. | 8.4 | 1.0332 | 89.37 | 10.63 | .46 | 2.93 | .35 | .059 | 4.84 | 2.32 | 26.04 | 31.67 | 226.6 | 34.50 | 118 |
| 21 a. m. | 10.2 | 1.0331 | 87.92 | 12.08 | .47 | 3.00 | .37 | .057 | 5.36 | 3.36 | 26.64 | 31.20 | 227.8 | 34.85 | 175 |
| 21 p. m. | 8.9 | 1.0339 | 89.09 | 10.91 | .46 | 2.93 | .35 | .048 | 5.05 | 2.41 | 26.32 | 32.45 | 233.7 | 33.35 | 108 |
| 22 a. m. | 10.1 | 1.0335 | 87.58 | 12.42 | .48 | 3.06 | .38 | .052 | 5.23 | 3.61 | 26.84 | 33.07 | 227.6 | 34.00 | 150 |
| 22 p. m. | 9.0 | 1.0333 | 88.75 | 11.25 | .47 | 3.00 | .37 | .039 | 5.35 | 2.77 | 27.37 | 32.45 | 227.7 | 34.65 | 133 |
| 23 a. m. | 10.3 | 1.0348 | 87.62 | 12.38 | .48 | 3.06 | .37 | .044 | 5.49 | 3.54 | 28.03 | 31.50 | 229.2 | 33.80 | 158 |
| 23 p. m. | 9.0 | 1.0330 | 88.95 | 11.05 | .46 | 2.93 | .36 | .040 | 4.86 | 2.72 | 27.23 | 32.73 | 226.4 | 34.00 | 129 |
| 24 a. m. | 9.5 | 1.0354 | 87.50 | 12.50 | .49 | 3.13 | .37 | .048 | 5.46 | 3.46 | 30.81 | 30.17 | 230.1 | 34.40 | 126 |
| 24 p. m. | 9.1 | 1.0325 | 88.78 | 11.22 | .47 | 3.00 | .36 | .041 | 4.89 | 2.72 | 29.66 | 31.15 | 231.1 | 34.70 | 105 |
| 25 a. m. | 10.5 | 1.0325 | 87.74 | 12.26 | .49 | 3.13 | .38 | .042 | 5.38 | 3.32 | 27.45 | 32.65 | 226.0 | 34.35 | 139 |
| 25 p. m. | 8.9 | 1.0304 | 89.35 | 10.65 | .43 | 2.74 | .32 | .044 | 4.76 | 2.56 | 26.41 | 33.47 | 226.4 | 34.30 | 95 |
| 26 a. m. | 9.5 | 1.0315 | 88.03 | 11.97 | .46 | 2.93 | .37 | .059 | 4.68 | 3.24 | 26.89 | 32.15 | 226.2 | 34.30 | 127 |
| 26 p. m. | 8.6 | 1.0318 | 88.86 | 11.14 | .46 | 2.93 | .36 | .046 | 4.64 | 2.68 | 26.49 | 33.13 | 227.0 | 33.95 | 156 |
| 27 a. m. | 10.1 | 1.0314 | 87.43 | 12.57 | .47 | 3.00 | .37 | .039 | 4.89 | 3.67 | 27.79 | 32.42 | 227.9 | 34.10 | 164 |
| 27 p. m. | 8.0 | 1.0327 | 89.20 | 10.80 | .46 | 2.93 | .37 | .043 | 4.94 | 2.40 | 27.83 | 33.60 | 228.8 | 33.35 | 139 |
| 28 a. m. | 10.4 | 1.0327 | 87.63 | 12.37 | .47 | 3.00 | .37 | .034 | 5.25 | 3.57 | 27.62 | 32.96 | 228.2 | 33.30 | 202 |
| 28 p. m. | 8.0 | 1.0324 | 88.33 | 11.67 | .49 | 3.13 | .37 | .053 | 5.08 | 3.11 | 27.78 | 32.91 | 228.8 | 33.45 | 143 |
| 29 a. m. | 9.4 | 1.0324 | 87.35 | 12.65 | .48 | 3.06 | .36 | .048 | 5.29 | 3.79 | 27.48 | 32.38 | 226.6 | 34.20 | 213 |
| 29 p. m. | 9.4 | 1.0304 | 88.70 | 11.30 | .46 | 2.93 | .34 | .050 | 5.05 | 3.12 | 26.70 | 33.17 | 226.8 | 34.05 | 168 |

COW NO. 209.

| 1909. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 2 | a. m. | 14.4 | 1.0305 | 88.71 | 11.29 | 0.53 | 3.38 | 0.38 | 0.077 | 4.65 | 3.07 | 20.19 | 38.00 | 234.8 | 33.45 | 73 |
| | p. m. | 14.1 | 1.0305 | 88.25 | 11.75 | .53 | 3.38 | .37 | .076 | 4.63 | 2.95 | 20.36 | 37.72 | 234.8 | 34.40 | 73 |
| 3 | a. m. | 15.2 | 1.0305 | 88.79 | 11.21 | .50 | 3.19 | .37 | .054 | 5.05 | 2.71 | 21.19 | 40.07 | 235.7 | 32.95 | 58 |
| | p. m. | 13.2 | 1.0310 | 88.41 | 11.59 | .54 | 3.45 | .38 | .061 | 4.61 | 3.34 | 18.93 | 34.28 | 230.2 | 33.90 | 67 |
| 4 | a. m. | 14.4 | 1.0300 | 88.60 | 11.40 | .52 | 3.32 | .40 | .057 | 4.53 | 3.26 | 19.68 | 40.84 | 239.1 | 33.30 | 61 |
| | p. m. | 13.1 | 1.0306 | 88.74 | 11.26 | .52 | 3.32 | .39 | .057 | 4.64 | 2.88 | 20.95 | 36.81 | 228.2 | 33.30 | 72 |
| 5 | a. m. | 14.0 | 1.0294 | 88.39 | 11.61 | .51 | 3.25 | .38 | .082 | 4.53 | 3.49 | | | | | 85 |
| | p. m. | 13.3 | 1.0306 | 88.51 | 11.49 | .52 | 3.32 | .38 | .069 | 4.61 | 3.41 | 19.24 | 45.04 | 228.7 | 33.75 | 86 |
| 6 | a. m. | 14.0 | 1.0299 | 88.75 | 11.25 | .51 | 3.25 | .36 | .061 | 4.50 | 3.67 | 18.83 | 44.58 | 229.8 | 33.68 | 82 |
| | p. m. | 13.9 | 1.0304 | 88.60 | 11.40 | .52 | 3.32 | .40 | .062 | 4.60 | 3.65 | 19.06 | 45.00 | 234.0 | 34.00 | 88 |
| 7 | a. m. | 14.3 | 1.0297 | 89.24 | 10.76 | .53 | 3.38 | .35 | .062 | 4.49 | 3.15 | 21.56 | 41.46 | 238.8 | 33.05 | 91 |
| | p. m. | 14.5 | 1.0300 | 88.59 | 11.41 | .52 | 3.32 | .38 | .068 | 4.48 | 3.19 | 19.23 | 44.41 | 226.1 | 33.65 | 70 |
| 8 | a. m. | 14.8 | 1.0294 | 88.80 | 11.20 | .53 | 3.38 | .34 | .057 | 4.59 | 3.29 | 20.88 | 43.21 | 250.7 | 33.20 | 81 |
| | p. m. | 13.6 | 1.0306 | 88.91 | 11.09 | .52 | 3.32 | .36 | .059 | 4.59 | 3.05 | 19.86 | 40.65 | 236.9 | 33.25 | 59 |
| 9 | a. m. | 14.3 | 1.0293 | 88.66 | 11.34 | .53 | 3.38 | .37 | .059 | 4.55 | 3.19 | 23.65 | 40.57 | 242.4 | 33.05 | 56 |
| | p. m. | 12.6 | 1.0304 | 88.64 | 11.36 | .53 | 3.38 | .38 | .071 | 4.56 | 3.15 | 19.72 | 44.84 | 230.0 | 33.40 | 72 |
| 10 | a. m. | 13.4 | 1.0294 | 88.81 | 11.19 | .50 | 3.19 | .38 | .060 | 4.48 | 3.23 | 19.96 | 39.51 | 233.2 | 34.30 | 67 |
| | p. m. | 14.1 | 1.0305 | 88.85 | 11.15 | .52 | 3.32 | .38 | .052 | 4.53 | 3.05 | 19.37 | 43.23 | 230.1 | 33.20 | 75 |
| 11 | a. m. | 14.8 | 1.0290 | 88.88 | 11.12 | .51 | 3.25 | .34 | .062 | 4.38 | 3.09 | 20.62 | 43.01 | 237.4 | 33.10 | 58 |
| | p. m. | 13.9 | 1.0304 | 88.84 | 11.16 | .52 | 3.32 | .37 | .054 | 4.34 | 2.88 | 19.10 | 44.57 | 233.9 | 33.10 | 57 |
| 12 | a. m. | 14.5 | 1.0301 | 88.60 | 11.40 | .52 | 3.32 | .37 | .059 | 4.66 | 3.31 | 19.92 | 43.18 | 234.9 | 33.05 | 62 |
| | p. m. | 13.5 | 1.0301 | 89.16 | 10.84 | .50 | 3.19 | .37 | .061 | 4.29 | 3.06 | 19.20 | 44.90 | 233.6 | 33.40 | 52 |
| 13 | a. m. | 14.3 | 1.0296 | 89.36 | 10.64 | .49 | 3.13 | .36 | .061 | 4.50 | 2.98 | 19.20 | 41.89 | 232.7 | 33.75 | 65 |
| | p. m. | 14.0 | 1.0301 | 89.06 | 10.94 | .52 | 3.32 | .37 | .057 | 4.61 | 3.26 | 18.42 | 43.28 | 229.9 | 33.55 | 54 |
| 14 | a. m. | 14.3 | 1.0296 | 89.12 | 10.88 | .49 | 3.13 | .36 | .071 | 4.33 | 2.94 | 21.45 | 41.66 | 235.7 | 33.50 | 57 |
| | p. m. | 13.3 | 1.0301 | 88.66 | 11.34 | .52 | 3.32 | .37 | .059 | 4.49 | 3.40 | 20.13 | 42.69 | 233.6 | 32.95 | 51 |
| 15 | a. m. | 14.3 | 1.0303 | 88.94 | 11.06 | .53 | 3.38 | .38 | .067 | 4.71 | 3.06 | 19.65 | 42.80 | 232.0 | 33.25 | 60 |
| | p. m. | 13.1 | 1.0306 | 88.85 | 11.15 | .53 | 3.38 | .38 | .057 | 4.59 | 3.21 | 18.39 | 45.37 | 237.3 | 34.00 | 73 |

TABLE I.—*Showing variation from milking to milking—Detailed analyses of milk from cows milked twice daily*—Continued.

COW NO. 320.

| Date of milking. | | Yield of milk. | Specific gravity of milk. | Water. | Total solids. | Total nitrogen. | Total protein (N. x 6.38). | Casein nitrogen. | Albumin nitrogen. | Sugar. | Fat. | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point of fat. | Relative size of fat globules. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1909. | | *Pounds.* | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | | | ° *C.* | |
| Jan. 23 | a. m. | 10.6 | 1.0310 | 85.53 | 14.47 | 0.55 | 3.51 | 0.45 | 0.043 | 4.81 | 5.54 | 26.15 | 23.19 | 234.3 | 35.45 | 418 |
| | p. m. | 10.0 | 1.0321 | 86.55 | 13.45 | .52 | 3.32 | .42 | .046 | 5.18 | 4.70 | 27.73 | 23.30 | 235.6 | 35.20 | 450 |
| 24 | a. m. | 10.5 | 1.0335 | 85.47 | 14.53 | .56 | 3.57 | .45 | .049 | 5.40 | 5.39 | 26.00 | 23.34 | 240.0 | 35.15 | 481 |
| | p. m. | 10.0 | 1.0321 | 86.30 | 13.70 | .54 | 3.45 | .43 | .048 | 4.94 | 4.96 | 26.61 | 24.04 | 238.4 | 35.35 | 274 |
| 25 | a. m. | 9.8 | 1.0322 | 85.97 | 14.03 | .57 | 3.64 | .45 | .059 | 4.66 | 5.11 | 23.77 | 26.35 | 234.4 | 35.20 | 365 |
| | p. m. | 8.5 | 1.0327 | 85.89 | 14.11 | .58 | 3.70 | .45 | .044 | 4.58 | 5.10 | 24.65 | 28.27 | 232.3 | 34.80 | 317 |
| 26 | a. m. | 10.1 | 1.0330 | 85.44 | 14.56 | .56 | 3.57 | .46 | .052 | 5.00 | 5.40 | 26.84 | 24.56 | 233.7 | 35.50 | 424 |
| | p. m. | 9.1 | 1.0331 | 86.48 | 13.52 | .56 | 3.57 | .45 | .041 | 4.78 | 4.62 | 25.24 | 25.20 | 234.5 | 35.70 | 293 |
| 27 | a. m. | 10.4 | 1.0331 | 85.32 | 14.68 | .56 | 3.57 | .46 | .053 | 5.03 | 5.45 | 26.94 | 24.62 | 237.8 | 35.20 | 347 |
| | p. m. | 8.9 | 1.0328 | 86.33 | 13.67 | .57 | 3.64 | .44 | .059 | 4.80 | 4.65 | 27.15 | 23.62 | 240.3 | 35.70 | 259 |
| 28 | a. m. | 10.4 | 1.0316 | 85.90 | 14.10 | .55 | 3.51 | .42 | .054 | 4.55 | 5.33 | 28.01 | 22.92 | 240.8 | 34.85 | 389 |
| | p. m. | 10.4 | 1.0312 | 86.61 | 13.39 | .54 | 3.45 | .44 | .051 | 4.78 | 4.90 | 27.08 | 23.01 | 235.1 | 34.55 | 462 |
| 29 | a. m. | 9.5 | 1.0335 | 85.20 | 14.80 | .57 | 3.64 | .47 | .047 | 5.05 | 5.76 | 27.89 | 23.73 | 235.9 | 34.85 | 335 |
| | p. m. | 10.2 | 1.0327 | 85.78 | 14.22 | .54 | 3.45 | .42 | .048 | 4.70 | 5.19 | 26.58 | 24.48 | 235.1 | 34.80 | 352 |
| 30 | a. m. | 10.4 | 1.0325 | 85.26 | 14.74 | .55 | 3.51 | .42 | .057 | 5.11 | 5.64 | 26.62 | 23.29 | 235.1 | 35.95 | 284 |
| | p. m. | 8.7 | 1.0335 | 85.47 | 14.53 | .58 | 3.70 | .47 | .052 | 5.14 | 5.25 | 26.30 | 24.00 | 234.2 | 35.30 | 448 |
| 31 | a. m. | 10.3 | 1.0334 | 84.43 | 15.57 | .60 | 3.83 | .43 | .066 | 4.66 | 6.30 | 26.47 | 24.08 | 234.6 | 35.65 | 324 |
| | p. m. | 7.9 | 1.0326 | 85.51 | 14.49 | .57 | 3.64 | .43 | .054 | 4.88 | 5.32 | 22.97 | 26.11 | 234.5 | 35.35 | 256 |
| Feb. 1 | a. m. | 9.3 | 1.0332 | 84.29 | 15.71 | .57 | 3.64 | .45 | .067 | 4.75 | 6.31 | | | | | 532 |
| | p. m. | 8.0 | 1.0338 | 85.80 | 14.20 | .57 | 3.64 | .47 | .053 | 5.03 | 4.88 | 24.86 | 24.20 | 232.3 | 35.65 | 313 |
| 2 | a. m. | 10.2 | 1.0333 | 85.08 | 14.92 | .60 | 3.83 | .46 | .052 | 5.59 | 5.52 | 26.21 | 22.53 | 235.5 | 35.85 | 303 |
| | p. m. | 8.8 | 1.0326 | 86.54 | 13.46 | .56 | 3.57 | .44 | .053 | 4.66 | 4.56 | 24.83 | 23.66 | 233.9 | 35.65 | 292 |
| 3 | a. m. | 9.7 | 1.0340 | 84.82 | 15.18 | .59 | 3.76 | .45 | .060 | 5.46 | 5.80 | 25.94 | 22.42 | 235.7 | 35.65 | 410 |
| | p. m. | 10.0 | 1.0317 | 86.56 | 13.44 | .54 | 3.45 | .41 | .049 | 4.54 | 4.69 | 24.39 | 23.24 | 234.9 | 35.80 | 346 |
| 4 | a. m. | 9.7 | 1.0328 | 84.75 | 15.25 | .56 | 3.57 | .42 | .067 | 4.73 | 5.90 | 25.28 | 21.98 | 233.2 | 35.95 | 417 |
| | p. m. | 9.2 | 1.0318 | 86.05 | 13.95 | .54 | 3.45 | .43 | .052 | 4.81 | 5.30 | 25.21 | 22.70 | 235.3 | 36.10 | 274 |
| 5 | a. m. | 10.5 | 1.0320 | 85.70 | 14.30 | .57 | 3.64 | .45 | .043 | 5.13 | 5.50 | 25.09 | 23.69 | 234.3 | 35.65 | 187 |
| | p. m. | 9.0 | 1.0326 | 85.61 | 14.39 | .55 | 3.51 | .43 | .057 | 4.88 | 5.58 | 24.17 | 27.62 | 232.1 | 35.65 | 172 |

| 1909. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 23 | a. m. | 10.6 | 1.0335 | 86.54 | 13.46 | 0.54 | 3.45 | 0.44 | 0.044 | 5.25 | 4.16 | 25.68 | 29.25 | 232.5 | 33.85 | 456 |
| | p. m. | 9.5 | 1.0343 | 86.96 | 13.04 | .56 | 3.57 | .44 | .051 | 5.39 | 3.66 | 26.43 | 31.19 | 233.1 | 34.05 | 457 |
| 24 | a. m. | 10.2 | 1.0348 | 86.29 | 13.71 | .56 | 3.57 | .44 | .052 | 5.46 | 4.23 | 28.31 | 29.31 | 224.2 | 34.25 | 505 |
| | p. m. | 9.7 | 1.0342 | 86.51 | 13.49 | .57 | 3.64 | .45 | .051 | 5.50 | 4.12 | 25.48 | 30.79 | 234.1 | 34.05 | 345 |
| 25 | a. m. | 10.2 | 1.0342 | 86.20 | 13.80 | .55 | 3.51 | .44 | .057 | 5.48 | 4.44 | 28.81 | 29.66 | 234.4 | 33.80 | 540 |
| | p. m. | 9.4 | | | | | | | | | | | | | | |
| 26 | a. m. | 10.5 | 1.0341 | 86.12 | 13.88 | .55 | 3.51 | .46 | .054 | 5.50 | 4.42 | 28.16 | 29.29 | 233.1 | 33.85 | 355 |
| | p. m. | 9.7 | 1.0348 | 86.86 | 13.14 | .57 | 3.64 | .46 | .052 | 5.40 | 3.78 | 27.12 | 31.91 | 234.8 | 33.65 | 415 |
| 27 | a. m. | 10.0 | 1.0344 | 86.32 | 13.68 | .56 | 3.57 | .46 | .057 | 5.65 | 4.22 | 26.16 | 30.41 | 235.5 | 33.80 | 445 |
| | p. m. | 9.6 | 1.0340 | 86.88 | 13.12 | .54 | 3.45 | .43 | .056 | 5.23 | 3.83 | 26.77 | 31.27 | 233.7 | 34.20 | 608 |
| 28 | a. m. | 10.1 | 1.0345 | 86.46 | 13.54 | .55 | 3.51 | .45 | .054 | 5.35 | 4.13 | 26.60 | 30.65 | 239.7 | 34.30 | 612 |
| | p. m. | 9.6 | 1.0351 | 86.54 | 13.46 | .57 | 3.64 | .46 | .056 | 5.40 | 3.96 | 25.49 | 31.64 | 230.4 | 33.95 | 477 |
| 29 | a. m. | 10.4 | 1.0347 | 86.07 | 13.93 | .55 | 3.51 | .46 | .056 | 5.05 | 4.48 | 26.44 | 30.39 | 233.3 | 34.05 | 687 |
| | p. m. | 8.9 | 1.0344 | 86.96 | 13.04 | .57 | 3.64 | .43 | .079 | 5.36 | 3.59 | 25.75 | 30.77 | 229.5 | 33.85 | 260 |
| 30 | a. m. | 11.0 | 1.0332 | 86.89 | 13.11 | .56 | 3.57 | .43 | .057 | 5.50 | 3.89 | 26.21 | 30.52 | 229.6 | 34.30 | 243 |
| | p. m. | 8.5 | 1.0360 | 86.28 | 13.72 | .60 | 3.83 | .47 | .045 | 5.46 | 3.86 | 27.28 | 30.69 | 233.8 | 33.45 | 243 |
| 31 | a. m. | 10.2 | 1.0352 | 85.73 | 14.27 | .60 | 3.83 | .47 | .062 | 5.68 | 4.54 | 26.06 | 30.50 | 233.1 | 33.60 | 333 |
| | p. m. | 8.8 | 1.0346 | 86.23 | 13.77 | .58 | 3.70 | .45 | .058 | 5.04 | 4.12 | 23.45 | 30.22 | 230.4 | 33.95 | 366 |
| Feb 1 | a. m. | 9.2 | 1.0350 | 86.27 | 13.73 | .57 | 3.64 | .46 | .061 | 5.53 | 4.15 | 25.26 | 28.77 | 233.5 | 34.40 | 357 |
| | p. m. | 9.2 | 1.0341 | 86.43 | 13.57 | .58 | 3.70 | .46 | .062 | 5.70 | 4.07 | 26.98 | 30.86 | 233.7 | 33.90 | 337 |
| 2 | a. m. | 9.6 | 1.0335 | 85.39 | 14.61 | .58 | 3.70 | .46 | .059 | 5.51 | 5.29 | 25.85 | 28.72 | 230.9 | 34.25 | 410 |
| | p. m. | 9.5 | 1.0342 | 87.07 | 12.93 | .58 | 3.70 | .45 | .059 | 5.19 | 3.46 | 25.80 | 29.87 | 233.8 | 34.05 | 481 |
| 3 | a. m. | 9.8 | 1.0345 | 86.80 | 13.20 | .56 | 3.57 | .43 | .069 | 5.33 | 3.74 | 25.98 | 28.87 | 232.8 | 33.90 | 447 |
| | p. m. | 9.7 | 1.0331 | 87.24 | 12.76 | .54 | 3.45 | .44 | .061 | 4.83 | 3.68 | 23.63 | 31.32 | 231.2 | 33.65 | 564 |
| 4 | a. m. | 9.9 | 1.0341 | 86.73 | 13.27 | .55 | 3.51 | .44 | .059 | 5.16 | 3.88 | 24.93 | 28.99 | 232.8 | 33.75 | 297 |
| | p. m. | 9.7 | 1.0340 | 86.75 | 13.25 | .55 | 3.51 | .42 | .054 | 5.53 | 4.09 | 26.19 | 31.18 | 234.3 | 33.60 | 218 |
| 5 | a. m. | 10.1 | 1.0344 | 86.37 | 13.63 | .55 | 3.51 | .45 | .062 | 5.34 | 4.14 | 27.11 | 28.99 | 233.5 | 33.65 | 193 |
| | p. m. | 8.8 | 1.0338 | 86.78 | 13.22 | .55 | 3.51 | .42 | .051 | 5.18 | 4.16 | 26.12 | 30.88 | 232.3 | 33.65 | 226 |

TABLE II.—*Variation from milking to milking of cow No. 209, milked three times daily.*

| Date of milking. | Yield of milk. | Specific gravity of milk. | Water. | Total solids. | Ash. | Total nitrogen. | Casein nitrogen. | Sugar. | Fat. | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point of fat. | Relative size of fat globules. | Color of fat. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Yellow. | Red. | Light. |
| 1910. | *Pounds.* | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | | | ° *C.* | | | | |
| Feb. 28 | 23.6 | 1.0300 | 90.01 | 9.99 | 0.76 | 0.43 | 0.30 | 4.65 | 2.24 | 30.43 | 31.91 | 231.8 | 32.47 | 83 | 19 | 1.7 | 0.2 |
| | 19.2 | 1.0282 | 89.47 | 10.53 | .68 | .44 | .31 | 4.50 | 2.89 | 30.20 | 33.22 | 230.8 | 31.57 | 73 | 20 | 1.7 | .2 |
| | 14.7 | 1.0299 | 89.14 | 10.86 | .73 | .44 | ..... | 4.69 | 3.19 | 29.04 | 33.52 | 231.2 | 31.57 | 75 | 22 | 1.7 | .2 |
| Mar. 1 | 24.2 | 1.0305 | 89.74 | 10.26 | .75 | .44 | .33 | 4.72 | 2.82 | 29.04 | 31.79 | 232.1 | 32.10 | 82 | 20 | 1.7 | .2 |
| | 18.5 | 1.0290 | 88.91 | 11.09 | .73 | .43 | .30 | 4.48 | 3.60 | 29.14 | 32.56 | 231.5 | 32.57 | 62 | 34 | 2.0 | .2 |
| | 15.4 | 1.0290 | 88.67 | 11.33 | .72 | .43 | .30 | 4.80 | 3.63 | 28.14 | 32.21 | 229.9 | 32.33 | 77 | 28 | 1.8 | .2 |
| 2 | 24.5 | 1.0300 | 89.74 | 10.26 | .72 | .43 | .31 | 4.81 | 2.38 | 28.81 | 30.73 | 231.2 | 32.47 | 73 | 21 | 1.7 | .2 |
| | 21.2 | 1.0294 | 89.18 | 10.82 | .71 | .43 | .31 | 4.55 | 3.29 | 29.52 | 32.10 | 230.6 | 31.90 | 64 | 19 | 1.7 | .2 |
| | 15.3 | 1.0294 | 89.11 | 10.89 | .73 | .44 | .31 | 4.61 | 3.27 | 29.36 | 32.21 | 231.1 | 32.10 | 77 | 25 | 1.7 | .2 |
| 3 | 24.1 | 1.0302 | 89.72 | 10.28 | .72 | .43 | .32 | 4.49 | 2.43 | 29.25 | 31.90 | 231.0 | 31.77 | 56 | 26 | 1.7 | .2 |
| | 18.2 | 1.0286 | 89.26 | 10.74 | .69 | .41 | .31 | 4.56 | 3.19 | 29.08 | 34.20 | 229.4 | 31.80 | 64 | 24 | 1.7 | .2 |
| | 14.6 | 1.0295 | 89.08 | 10.92 | .71 | .43 | .31 | 4.75 | 3.05 | 29.11 | 34.24 | 229.0 | 33.30 | 60 | 22 | 1.7 | .2 |
| 4 | 24.0 | 1.0303 | 89.74 | 10.26 | .74 | .41 | .30 | 4.78 | 2.65 | 29.32 | 31.76 | 230.2 | 33.27 | 74 | 21 | 1.7 | .2 |
| | 18.3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 28.83 | 32.90 | 229.8 | 32.50 | 70 | 20 | 1.7 | .2 |
| | 15.5 | 1.0283 | 89.62 | 10.38 | .71 | .43 | .31 | 4.51 | 2.96 | 28.25 | 33.29 | 227.4 | 32.33 | 70 | 17 | 1.7 | .2 |
| 5 | 22.3 | 1.0301 | 89.68 | 10.32 | .76 | .40 | .31 | 4.68 | 2.50 | 29.83 | 32.00 | 230.5 | 32.73 | 61 | 25 | 1.7 | .2 |
| | 19.0 | 1.0290 | 89.37 | 10.63 | .75 | .42 | .29 | 4.46 | 2.98 | 29.83 | 32.75 | 230.2 | 32.90 | 67 | 22 | 1.7 | .2 |
| | 14.4 | 1.0317 | 88.22 | 11.78 | .75 | .50 | .36 | 5.00 | 3.22 | 27.69 | 34.49 | 226.6 | 34.27 | 77 | 19 | 1.7 | .2 |
| 6 | 23.3 | 1.0312 | 89.59 | 10.41 | .69 | .44 | .31 | 5.23 | 2.30 | 29.74 | 32.16 | 231.0 | 31.97 | 58 | 21 | 1.7 | .2 |
| | 19.7 | 1.0278 | 89.11 | 10.89 | .69 | .41 | .29 | 4.63 | 3.60 | 29.10 | 33.36 | 229.3 | 33.43 | 67 | 27 | 2.2 | .2 |
| | 14.2 | 1.0284 | 89.02 | 10.98 | .68 | .42 | .29 | 4.73 | 3.45 | 28.64 | 34.06 | 228.2 | 33.93 | 77 | 22 | 1.7 | .2 |

TABLE III.—*Variations from milking to milking of cow No. 207 milked four times daily.*

| Date of milking. | Yield of milk. | Specific gravity of milk. | Water. | Total solids. | Ash. | Total nitrogen. | Total protein (N. x 6.38). | Casein nitrogen. | Sugar. | Fat. | Reichert-Meissl number. | Iodin number. | Saponification number. | Melting point of fat. | Relative size of fat globules. | Color of fat. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | Red. | Yellow. | Light. |
| 1910. | *Lbs.* | | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | | | | ° *C.* | | | | |
| Feb. 1 4 a. m. | 29.5 | 1.0296 | 89.94 | 10.06 | 0.72 | 0.43 | 2.74 | 0.31 | 4.53 | 2.25 | 34.28 | 38.52 | 227.9 | 34.00 | 239 | 1.7 | 33 | 0.2 |
| 10 a. m. | 25.6 | 1.0274 | 88.64 | 11.36 | .70 | .41 | 2.62 | .29 | 4.34 | 3.05 | 34.00 | 39.12 | 226.9 | 34.52 | 185 | 1.6 | 28 | .2 |
| 4 p. m. | 24.1 | 1.0298 | 89.95 | 10.05 | .75 | .41 | 2.62 | .30 | 4.53 | 2.36 | 33.62 | 38.95 | 228.3 | 33.78 | 141 | 1.7 | 30 | .2 |
| 10 p. m. | 25.5 | 1.0291 | 90.40 | 9.60 | .72 | .41 | 2.62 | .29 | 4.46 | 2.12 | 33.13 | 39.55 | 226.9 | 33.87 | 213 | 1.7 | 30 | .2 |
| 2 4 a. m. | 28.3 | 1.0299 | 90.37 | 9.63 | .69 | .43 | 2.74 | .30 | 4.69 | 1.67 | 30.37 | 40.50 | 226.3 | 34.97 | 99 | 1.7 | 28 | .2 |
| 10 a. m. | 21.7 | 1.0299 | ..... | ..... | .73 | .42 | 2.70 | .30 | 4.46 | ..... | 30.47 | 40.40 | 225.5 | 34.03 | ..... | 1.7 | 24 | .2 |
| 4 p. m. | 28.4 | 1.0295 | 90.22 | 9.78 | .72 | .41 | 2.62 | .27 | 4.55 | 2.29 | 33.83 | 38.28 | 228.8 | 33.70 | 162 | 1.7 | 31 | .2 |
| 10 p. m. | 23.0 | 1.0284 | 89.22 | 10.78 | .72 | .39 | 2.49 | .27 | 4.66 | 3.23 | 32.01 | 41.19 | 228.0 | 34.45 | 243 | 1.7 | 25 | .2 |
| 6 4 a. m. | 31.9 | 1.0295 | 90.77 | 9.23 | .72 | .39 | 2.49 | .29 | 4.46 | 1.68 | 31.95 | 40.59 | 228.3 | 33.93 | 119 | 1.7 | 25 | .2 |
| 10 a. m. | 27.1 | 1.0287 | 89.33 | 10.67 | .72 | .40 | 2.55 | .28 | 4.66 | 3.10 | 33.52 | 40.60 | 231.0 | 33.70 | 178 | 1.7 | 29 | .2 |
| 4 p. m. | 24.2 | 1.0296 | 89.92 | 10.08 | .72 | .40 | 2.55 | .28 | 4.71 | 2.52 | 31.38 | 41.70 | 227.8 | 33.97 | 161 | 1.7 | 25 | .2 |
| 10 p. m. | 27.0 | 1.0275 | 91.15 | 8.85 | .68 | .36 | 2.30 | .24 | 4.25 | 1.88 | 32.96 | 41.62 | 229.8 | 33.40 | 252 | 1.7 | 28 | .2 |
| 15 4 a. m. | 22.8 | 1.0306 | 90.35 | 9.65 | .73 | .39 | 2.49 | .19 | 4.70 | 1.98 | 27.15 | 40.59 | 226.4 | 34.20 | 201 | 2.0 | 45 | .2 |
| 10 a. m. | 22.3 | 1.0279 | 90.86 | 9.14 | .71 | .38 | 2.42 | .25 | 4.53 | 3.56 | 27.74 | 41.97 | 223.3 | 33.98 | 162 | 1.7 | 43 | .2 |
| 4 p. m. | 19.0 | 1.0305 | 89.51 | 10.49 | .73 | .41 | 2.62 | .27 | 4.71 | 2.78 | 27.81 | 42.16 | 223.8 | 34.03 | 171 | 1.7 | 43 | .2 |
| 10 p. m. | 18.6 | 1.0295 | 90.03 | 9.97 | .63 | .37 | 2.36 | .24 | 4.52 | 2.45 | 27.82 | 42.29 | 223.7 | 34.10 | 295 | 1.7 | 43 | .2 |
| 16 4 a. m. | 28.0 | 1.0306 | 89.46 | 10.54 | .76 | .41 | 2.62 | .27 | 4.65 | 2.75 | 28.31 | 42.95 | 223.3 | 34.23 | 142 | 1.7 | 40 | .2 |
| 10 a. m. | 18.4 | ..... | 88.15 | 11.85 | .73 | ..... | ..... | .26 | 4.41 | 4.15 | 28.02 | 43.90 | 223.4 | 33.73 | 138 | 1.7 | 40 | .2 |
| 4 p. m. | 20.3 | 1.0301 | 89.47 | 10.53 | .75 | .43 | 2.74 | .25 | 4.53 | 2.62 | 27.46 | 44.23 | 223.5 | 33.47 | 132 | 1.7 | 43 | .2 |
| 10 p. m. | 17.5 | 1.0289 | 88.92 | 11.08 | .73 | .40 | 2.55 | .25 | 4.61 | 3.31 | 27.48 | 44.34 | 223.1 | 34.07 | 118 | 1.7 | 42 | .2 |