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STANDARDIZATION OF MILK AND CREAM.

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To standardize milk is to bring the butter-fat content to a given per cent. regardless of the quality of the milk produced by the cow.

If the milk as drawn from the cow contains less butter-fat than is desired, manifestly, it can be brought to the desired standard by adding cream or extracting some skim milk.

If, on the contrary, milk as yielded by the cow contains more butter-fat than is necessary it can be reduced to the desired standard by extracting cream or adding skim milk.

Both of these processes are not only legitimate, but necessary; the first in the interest of the consumer and the second in the interest of the producer, because the latter cannot afford, for example, to produce milk containing five per cent. butter-fat and sell it at the price for which four per cent. milk is sold, any more than the consumer can afford to pay for milk containing five per cent. butter-fat and receive milk which contains only four per cent

butter-fat, (providing they are produced under equal sanitary conditions.)

This increase or reduction of fat can be secured in another way, namely, by the addition of water; but this is not permissible, for it also reduces the percentage of the solids not fat; that is casein, milk sugar, and ash; whereas standardizing with cream or skim milk does not materially alter the proportion of solids other than butter-fat.

The same general methods that will serve to change the butter-fat in milk to any desired quantity will also serve to produce cream of any desired per cent. of butter-fat. The necessity for such standardization is set forth in Circular 51, published in April, 1902. It is the purpose of this Bulletin to discuss at length the practical methods of standardizing.

#### METHODS.

In standardization, the butter-fat in milk or cream is increased or decreased to an arbitrary per cent. or standard which may be fixed by law or by an agreement between parties in which one guarantees to furnish the other a definite quantity of butter-fat in every pound of milk or cream sold for a stated price. This price should vary with the butter-fat in the milk,—the more butter-fat for the same quantity of milk the higher the price and *vice versa*. This is not only because the richer milk is more palatable and nutritious but also because the cost of production is greater.

As was stated before, if milk contains a higher per cent. of butter-fat than is desired this fat can be reduced either by separating the cream out of a portion of the milk or by adding skim milk. In case all the milk is clarified\*, the same result may be obtained by mixing a less portion of the cream with the skim milk than was contained in the original milk. Again, there may be an instance in which no skim milk is on hand, but instead an ample supply of milk with a lower per cent. of butter-fat than is desired. This milk will answer the same purpose as the skim milk, but a larger portion is required to bring the per cent. down to the proper standard.

Again, on the other hand, milk of a lower per cent. of fat than is desired may be standardized by taking out a portion of the skim milk by means of a separator, or by adding reserved cream; or, as

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\*By the term "clarified" is meant milk that has been separated for the purpose of taking out some of the impurities. These impurities remain in the separator bowl and the cream and skim milk are mixed again after passing through the separator.



in the above case, if the cream is clarified, by mixing a greater portion of cream with skim milk than there was in the original milk. Here, as in the above instance, if circumstances should arise in which there is no cream on hand, but instead milk of a higher per cent. of butter-fat than the desired standard this will answer the same purpose for increasing the percentage of fat to the proper standard.

These changes are readily effected by applying a few simple rules in order to calculate the quantity of skim milk to be added or extracted from the whole milk so as to bring the per cent. of butter-fat to the desired point, or to mix milk of different per cents. of butter-fat in such proportions as to reach readily the desired per cent.

#### RULE I.

The amount of skim milk to be added or removed from the whole milk to obtain the desired per cent. of butter-fat may be determined by the following rules:

Multiply the number of pounds of milk by the per cent. of fat in the milk and the product will be the number of pounds of butter-fat in the milk.

Divide the number of pounds of butter-fat in the milk by the decimal representing the desired per cent. of fat, and the quotient will be the number of pounds of standardized milk.

##### *Part 1. Where the Percentage of Fat is too High.*

From the number of pounds of standardized milk take the number of pounds of original milk and the result will be the number of pounds of skim milk to be added to the original milk.

To illustrate: 1,000 pounds of milk containing 4.5 per cent. of butter-fat are to be standardized to 4 per cent.; how many pounds of milk must be added? Since 4.5 per cent. equals the decimal .045 then,  
 $1000 \times .045 = 45$ , the number of pounds of fat in 1000 pounds of 4.5 per cent milk.

$45 \div .04 = 1125$ , the number of pounds of 4 per cent. or standardized milk.

$1125 - 1000 = 125$ , the amount of skim milk to be added.

To formulate this problem:

A : 1000 : : 4.5 : 4

A = the pounds of standardized milk.

$$B = \frac{1000 \times 4.5}{4} - 1000$$

B = the number of pounds of skim milk to be added.

##### *Part 2. Where the Percentage of Fat is too Low.*

With milk that is to be standardized from a lower to a higher per cent. the same rule holds true; but in this case take the num-

ber of pounds of standardized milk from the number of pounds of original milk and the result will be the number of pounds of skim milk to be removed from the original milk.

To illustrate: 1600 pounds of milk containing 3.2 per cent. of butter-fat are to be standardized to 4 per cent.; how much skim milk must be taken from the whole milk ?

$1600 \times .032 = 51.2$  the number of pounds of butter-fat in the original milk.

$51.2 \div .04 = 1280$ , the number of pounds of standardized milk.

$1600 - 1280 = 320$ , the number of pounds of skim milk to be separated from the original milk, or

$$A = \frac{1600 \times 3.2}{4} = 1280.$$

A = the number of pounds of standardized milk.

B =  $1600 - 1280 = 320$ .

B = the number of pounds of skim milk to be removed.

## RULE II.

The same results may be reached by the following rule which is often more convenient than the one above given.

Divide the per cent. of butter-fat that is in the original milk by the per cent. that is desired in the standardized milk. The quotient multiplied by the given number of pounds of milk will be the amount of standardized milk. If the quantity of standardized milk is greater than the original amount of milk the difference must be added in the form of skim milk; if less then that difference must be separated out as skim milk.

### *Part 1. Where the Percentage of Fat is too High.*

To illustrate: 200 pounds of milk containing 6 per cent. of fat are to be standardized to 4 per cent.; how many pounds of skim milk must be added ?

$.06 \div .04 = 1.5$ , hence 200 pounds of 6 per cent. milk must be increased by one-half with skim milk, or to 300 pounds. The difference between 200 pounds and 300 pounds is the amount of skim milk that must be added, or

$$A = \frac{.06}{.04} \times 200, \text{ in which } A = \text{the final amount of standardized milk.}$$

### *Part 2. Where the Percentage of Fat is too Low.*

To illustrate: 652 pounds of milk containing 3.1 per cent. of butter-fat are to be standardized to 4.5 per cent.; how many pounds of skim milk must be extracted ?

$3.1 \div 4.5 = .691$ , or the fractional part of 652 pounds of 3.1 per cent. milk to which the amount must be reduced in order to have the milk contain 4.5 per cent. butter-fat.

$652 \times .691 = 450$ , the number of pounds of 4.5 per cent. milk.

$652 - 450 = 202$ , the number of pounds of skim milk to be removed, or

$$A = \frac{3.1}{4.5} \times 652, \text{ in which } A = \text{the final amount of standardized milk.}$$

## RULE III.

Occasionally there may be a quick demand for milk of a per cent. of fat which is not commonly produced, as is often the case with city dairy companies. However, milk of a known standard is always on hand. In this case a definite quantity of milk is wanted and the exact proportions of milk or cream to be added to the skim milk may be calculated in percentage or amount as follows:

Divide the per cent. of fat in the milk that is desired by the per cent. of fat in the milk that is on hand. The result will be the per cent. of the milk on hand to be taken; the remaining per cent. of milk will be the skim milk to be used.

To illustrate: 120 pounds of milk containing 4 per cent. of butter-fat is desired and milk of 6 per cent. fat and skim milk are on hand to be used. What per cent. of the standardized milk must be milk with 6 per cent. fat and what portion must be skim milk; that is, how much of each must be taken in order that the mixture may be 4 per cent. milk?

$.04 \div .06 = .66\frac{2}{3}$  or  $66\frac{2}{3}$  per cent. which is the portion of 6 per cent. milk that the 120 pounds of standardized milk should contain. The remaining  $33\frac{1}{3}$  per cent. must be skim milk which it is necessary to add to bring the fat down to 4 per cent.

$66\frac{2}{3}$  per cent. of 120 pounds = 80 pounds, the amount of 6 per cent. milk which must be mixed with 40 pounds of skim milk to bring the mixture to 120 pounds of 4 per cent. milk.

## RULE IV.

*Part 1. The actual number of pounds instead of the per cent. of the different kinds of milk to be added may be ascertained as follows :*

Multiply the number of pounds of standardized milk desired, by the per cent. of butter-fat that the milk is to contain. This gives the number of pounds of butter-fat in the mixture. Divide this amount by the per cent. of butter-fat contained in the milk on hand and the result will be the number of pounds of that milk which the standardized milk should contain. The remainder would be skim milk.

To illustrate: 50 pounds of milk containing 3 per cent. fat is wanted, and milk containing 5 per cent. fat is to be used.

$50 \times .03 = 1.5$ , the number of pounds of butter-fat in the 3 per cent. milk.

$1.5 \div .05 = 30$ , the number of pounds of 5 per cent. milk which the standardized milk should contain.

$50 - 30 = 20$ , the number of pounds of skim milk to be added.

*Part 2. In case there is no whole milk on hand but instead skim milk and cream of a known per cent. of butter-fat, then the cream may be substituted and the fat reduced to the desired per cent. with*

skim milk. The proportionate amounts may be calculated as in the two foregoing methods.

To illustrate: To make 50 pounds of milk containing 3 per cent. of fat or 1.5 pounds of butter-fat as in the above illustration. If 25 per cent. cream is to be substituted for 5 per cent. milk then the standardized milk would have to contain 6 pounds of 25 per cent. cream and 44 pounds of skim milk.

As a matter of convenience the results of the above rules calculated on the per cent. or 100 pound basis can be tabulated in such a manner as to reduce the calculation to a minimum.

TABLE 1 INDICATES QUANTITY OF SKIM MILK TO, BE ADDED TO OR SUBTRACTED FROM 100 POUNDS OF MILK TO MAKE THE DESIRED PER CENT.

| *A  | 3.25    | 3.50    | 3.75    | 4.0     | 4.25    | 4.50    | 4.75    | 5.0     |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|
| †B  |         |         |         |         |         |         |         |         |
| 3.  | - 7.693 | -14.285 | -20.000 | -25.000 | -29.412 | -33.333 | -36.842 | -40.000 |
| 3.1 | - 4.616 | -11.428 | -17.333 | -22.50  | -27.059 | -31.111 | -34.737 | -38.000 |
| 3.2 | - 1.539 | - 8.571 | -14.666 | -20.000 | -24.706 | -28.888 | -32.632 | -36.000 |
| 3.3 | + 1.539 | - 5.714 | -12.000 | -17.50  | -22.353 | -26.666 | -30.527 | -34.000 |
| 3.4 | + 4.616 | - 2.857 | - 9.333 | -15.00  | -20.000 | -24.444 | -28.422 | -32.000 |
| 3.5 | + 7.693 | - 0.000 | - 6.666 | -12.50  | -17.647 | -22.222 | -26.317 | -30.000 |
| 3.6 | +10.760 | + 2.857 | - 4.000 | -10.00  | -15.294 | -20.000 | -24.212 | -28.000 |
| 3.7 | +13.837 | + 5.714 | - 1.333 | - 7.50  | -12.941 | -17.777 | -22.107 | -26.000 |
| 3.8 | +16.914 | + 8.571 | + 1.333 | - 5.00  | -10.588 | -15.555 | -20.000 | -24.000 |
| 3.9 | +19.991 | +11.428 | + 4.000 | - 2.50  | - 8.235 | -13.333 | -17.897 | -22.000 |
| 4.0 | +23.068 | +14.285 | + 6.666 | - 0.00  | - 5.882 | -11.111 | -15.792 | -20.000 |
| 4.1 | +26.145 | +17.142 | + 9.333 | + 2.50  | - 2.429 | - 8.888 | -13.687 | -18.000 |
| 4.2 | +29.222 | +19.999 | +12.000 | + 5.00  | - 0.076 | - 6.666 | -11.582 | -16.000 |
| 4.3 | +32.299 | +22.856 | +14.666 | + 7.50  | + 0.076 | - 4.444 | - 9.477 | -14.000 |
| 4.4 | +35.376 | +25.713 | +17.333 | +10.00  | + 2.429 | - 2.222 | - 7.372 | -12.000 |
| 4.5 | +38.453 | +28.57  | +20.000 | +12.50  | + 5.882 | - 0.000 | - 5.267 | -10.000 |
| 4.6 | +41.530 | +31.427 | +22.666 | +15.00  | + 8.235 | + 2.222 | - 3.162 | - 8.000 |
| 4.7 | +44.607 | +34.284 | +25.333 | +17.50  | +10.588 | + 4.444 | - 1.057 | - 6.000 |
| 4.8 | +47.684 | +37.141 | +28.000 | +20.00  | +12.941 | + 6.666 | + 1.057 | - 4.000 |
| 4.9 | +50.761 | +39.998 | +30.666 | +22.50  | +17.647 | + 8.888 | + 3.162 | - 2.000 |
| 5.0 | 53.838  | 42.855  | 33.333  | 25.000  | 20.000  | 11.111  | + 5.267 | - 0.000 |

To find the pounds of skim milk to be added or removed trace the vertical column of the per cent. of fat you desire down to where the horizontal column representing the per cent. of fat in the milk on hand intersects and the result will be the number of pounds of skim milk to be added or removed, as indicated by a plus or minus sign before the result.

To illustrate: If milk containing 4.5 per cent. is desired and milk containing 3.8 per cent. fat is on hand, then 15.5 pounds for every hundred pounds or 15.5 per cent. of the quantity must be separated out as skim milk.

\*Top line A represents the per cent. of fat that is desired in milk.

†Left hand column B represents the per cent. of fat in milk on hand.

## TO STANDARDIZE WITH WHOLE MILK OR CREAM INSTEAD OF SKIM MILK.

### RULE V.

*Part 1. An instance may occur in which milk is to be raised to a higher per cent. with milk of a still higher per cent. of butter-fat. The quantity to be added may be found in the following manner.*

From the desired per cent. of fat in the standardized milk subtract the per cent. of fat in the milk that is on hand which contains the lower per cent. of fat. Subtract the per cent. of fat that is desired in milk from the per cent. of fat in the milk that is on hand which contains a higher per cent. of butter-fat. Divide the difference between the lower per cent. and the per cent. desired by the difference between the higher per cent. and the per cent. desired. The quotient will be that part of any given quantity of milk containing the higher per cent. that should be taken. Multiply the quotient by the quantity of milk of the lower per cent. this will equal the quantity of milk of the higher per cent. to be added to the milk of the lower per cent. and the sum will equal the amount of the mixture containing the desired per cent.

To illustrate: Standardize 200 pounds of milk containing 3 per cent. butter-fat to 4 per cent. fat with 5.2 per cent. milk; how many pounds of the latter must be added to bring the fat up to 4 per cent.?

$$.04 - .03 = .01.$$

$$.052 - .04 = .012.$$

$$.01 \div .012 = .833.$$

$$200 \times .833 = 166.6, \text{ the number of pounds of 5.2 per cent. milk to be added.}$$

$$200 + 166.6 = 366.6, \text{ the number of pounds of 4 per cent. milk to be used.}$$

*Part 2. To standardize milk of a higher per cent. than is desired with milk of a lower per cent. of fat, the same rule applies except that the difference between the desired per cent. and the higher per cent. must be divided by the difference between the desired per cent. and the lower per cent. of butter-fat.*

To illustrate: 54 pounds of milk containing 5.3 per cent. of butter-fat are to be standardized to 4 per cent. with milk containing 3.1 per cent. butter-fat; how many pounds of the 3.1 per cent. milk will be required?

$$.053 - .04 = .013$$

$$.04 - .031 = .009$$

$$.013 \div .009 = 1.44$$

$54 \times 1.44 = 77.76$ , the number of pounds of milk containing 3.1 per cent. of fat to be added to the 54 pounds to decrease the fat content to 4 per cent.

## RULE VI.

*To Find the Ratio of the Number of Pounds of Milk of the Different Per Cents.*

Subtract the per cent. of fat in the milk of the lower fat content from the per cent. of fat desired in the standardized milk and divide this result by the difference between the fat per cents. in the milk of the higher fat content and the lower fat content, the quotient represents the per cent. of milk of the higher fat content to be used in standardizing.

To illustrate: Find the ratio of the pounds of milk for mixing 5 with 3.5 to give 4 per cent. milk.

$$4 - 3.5 = .5$$

$$5 - 3.5 = 1.5$$

$.5 \div 1.5 = .33\frac{1}{3}$  or  $33\frac{1}{3}$  per cent. which is that part of the standardized milk containing 5 per cent, which is used in mixing with milk of 3.5 per cent. fat content. Supposing 400 pounds of milk of 4 per cent butter-fat is desired then  $33\frac{1}{3}$  per cent. of the 400 pounds or 133.3 pounds are to be milk containing 5 per cent. butter-fat and  $400 - 133.3 = 266.6$ , the number of pounds of milk of 3.5 per cent. butter-fat that are to be taken to bring the fat content to 4 per cent.

Where whole milk is used for standardizing the results can be tabulated equally as well as when skim milk is used. In this case the whole milk has a constant per cent. in each table.

TABLE 2. TO STANDARDIZE CREAM WITH MILK CONTAINING 4 PER CENT. OF BUTTER-FAT.

| *A | 17      | 20      | 22      | 25      | 27      | 30     |
|----|---------|---------|---------|---------|---------|--------|
| †B |         |         |         |         |         |        |
| 18 | 92.857  | .....   | .....   | .....   | .....   | .....  |
| 19 | 86.666  | .....   | .....   | .....   | .....   | .....  |
| 20 | 81.250  | 100.    | .....   | .....   | .....   | .....  |
| 21 | 76.4706 | 94.706  | .....   | .....   | .....   | .....  |
| 22 | 72.2222 | 88.8888 | 100.    | .....   | .....   | .....  |
| 23 | 68.4222 | 84.2222 | 94.2125 | .....   | .....   | .....  |
| 24 | 65.0000 | 80.0000 | 90.0000 | .....   | .....   | .....  |
| 25 | 61.905  | 76.1905 | 85.7143 | 100.    | .....   | .....  |
| 26 | 59.0909 | 72.7272 | 81.8181 | 95.4545 | .....   | .....  |
| 27 | 56.5217 | 69.5651 | 78.2608 | 91.3044 | 100.    | .....  |
| 28 | 54.1666 | 66.6666 | 75.0000 | 87.5000 | 95.8333 | .....  |
| 29 | 52.0000 | 64.0000 | 72.0000 | 84.0000 | 92.0000 | .....  |
| 30 | 50.0000 | 61.5385 | 69.2308 | 80.3461 | 88.4615 | 100.00 |

\*A represents the per cent. of fat that is desired in cream.

†Left hand column B represents the per cent. of fat in cream on hand.

If cream is to be standardized with whole milk the result found by the intersecting columns represents the pounds per hundred or the per cent. of the quantity which is cream of the per cent. of fat on hand.

To illustrate: If cream containing 20 per cent. of butter-fat is desired and cream containing 26 per cent. of butter-fat is on hand then 72.7 per cent. of the quantity desired must be cream containing 26 per cent. of butter-fat and 27.3 per cent. of the quantity must be 4 per cent. milk.

### STANDARDIZATION OF CREAM.

As stated above, the principal difference between milk and cream is that in cream a larger portion of the water is displaced with butter-fat and since the variations lie mainly between the butter-fat and the water the same methods that apply to the standardization of milk will apply to the standardization of cream.

### APPARATUS.

The apparatus that is required for standardizing milk or cream is a creamer, or much better a cream separator, a Babcock tester, scales, and a mixing vat.

It requires considerable time to raise cream with a creamer and on account of this, cream that is produced by this method invariably has an increased number of bacteria which when mixed with fresh milk is apt to lessen the keeping quality of the standardized milk. It is, therefore, far more desirable and also more practical to use the cream separator and since this machine is used by many of the large distributing concerns for clarifying milk, it at the same time answers for standardizing. Another advantage is that a portion of the milk can be readily separated and the cream and skim milk mixed again in the proper proportions without delaying the delivery of the milk. Since mixing old cream with the fresh milk has a tendency to increase the fermentation, the cream separator should certainly supersede the old creamer for standardization.

Nearly every cream separator has some contrivance by which the richness of the cream can be regulated but these regulations are far from accurate. A fairly uniform cream delivered by the separator in daily operation may have a range of variations of five per cent. above or below the per cent. desired. These variations even in a minimum case would result in great profit or loss, as the case may be, too great for a healthy legitimate business. To illustrate: Take 50 gallons of cream containing 20 per cent. of butter-fat and as a variation, let there be 5 per cent. more butter-fat than the standard requires. Assume that the cream is sold at an average price of 80 cents a gallon. The loss to the party selling the cream would amount to \$10.00, on the 50 gallons, which

could have been saved by standardization. Even though each separator has a regulating contrivance there are always some conditions in practical operations which influence separation and cause variation in the richness of the cream. These conditions can be controlled, to a certain extent, but in order to secure as little variation as by standardizing the operation will require such vigilance and close supervision that it would become impracticable for the creamery man as well as for the dairyman.

The first and probably the most important cause of these variations is due to the speed of the bowl in the cream separator for anything that tends to change the speed must necessarily influence the per cent. of fat in the cream. Second, the temperature of the milk has considerable influence on the per cent. of fat in the cream. A difference of ten or more degrees in the temperature of the milk will cause a decided variation in the per cent. of butter-fat in the cream. If milk is warm the cream will be thicker, if cold it will be thinner, other conditions being equal. Third, the per cent. of fat changes with the amount separated per hour. If milk is fed into a separator at an uneven rate or if the flow of milk is stopped, the thickness of the cream will be greatly influenced. Although cream separators are nearly all provided with floats to regulate the inflow of the milk into the machine, yet a slight variation of pressure as that due to the difference in the height of milk in the receiving can or tempering vat influences the per cent. of fat in the cream. Fourth, the amount of water or skim milk used to flush out the bowl at the end of separation will naturally tend to affect the cream test. Fifth, the condition of the milk changes the per cent. by having small clots obstruct the cream or skim milk passage in the bowl of the separator. Of course, it is assumed that milk or cream to be standardized for direct consumption ought to be in better condition, yet it is not uncommon to find fresh milk in which a part of the casein is in such flocculent masses that when subject to the pressure in the separator bowl they are readily deposited on or near the opening of the skim milk tube which slightly obstructs the opening and tends to force more skim milk out with the cream, hence it lowers the per cent. of fat in the cream. On the other hand a mass of partially churned cream which will lodge near and slightly obstruct the cream opening will produce an opposite effect by forcing more skim milk out of the skim milk opening, thus increasing the per cent. of fat in the cream. From this it will be seen that it is practically impossible to separate cream to such a constant per cent. that it is sufficiently accurate to avoid testing and standardizing.



Since it is absolutely necessary to know the butter-fat content of the milk to be standardized it is essential to have a Babcock tester which at any rate should comprise a part of the apparatus in every dairy.

The scales and can or vat should be so arranged that the milk or cream can be easily weighed and if a vat is used it should be provided with a cooling coil. It is essential that milk be cooled as soon as it is milked or separated. Cream should also be cooled after separating. The cost of this apparatus for standardizing depends on the amount of milk handled daily. For a small dairy the cost need not exceed \$6.00.

#### SUGGESTIONS.

While it is true that a slight variation in the per cent. of butter-fat in milk or cream handled on a large scale will more than pay for the extra labor in testing the milk daily, yet on the other hand it does not justify the outlay of money for labor in testing milk on a small scale. This difficulty, however, can be overcome in a manner which is sufficiently accurate for the average milk producer, provided all milk is to be of one standard per cent. of butter-fat.

As is stated in Circular 51, the quality of milk from individual cows varies from day to day, still it is a fact that the mixed milk of a herd of cows milked regularly and kept under uniform conditions will remain practically constant in butter-fat content during a period of at least three days and unless a change of cows takes place in a herd or the ration is abruptly changed it will not be necessary to test the mixed milk for butter-fat more than once in three days,

Immediately after milking the weight of the milk is taken and it is then poured into a vat to be cooled, when all milk is in the vat it is sampled and tested for butter-fat content. The proper standard can then be reached by applying the foregoing methods and rules.

It is quite necessary for large dairy companies to test their milk daily as slight variations in large quantities will warrant good returns for the extra effort in securing a more uniform product.

In creameries it ought to be an object to bring milk and cream to a desired standard in butter-fat content and on account of the extreme variations in the per cent. of fat in milk brought to creameries it is essential that the output should be tested daily. The cream is weighed while separating and run into a cooling vat where it may be standardized.

Creameries that supply cream of different standards should be provided with several vats in order to have the run continuous. The cream in each vat must be weighed and tested to find the amount of butter-fat before it can be standardized.

#### HOW TO OBTAIN THE COST OF CREAM ON A BUTTER-FAT BASIS.

It is essential in dealing with cream to know the price for which a gallon of cream can be bought or sold which will be equivalent to the price of the butter-fat it contains or the comparative price of cream containing different per cents. of butter-fat.

Since cream is usually sold by volume it becomes necessary to know the approximate weight. Average milk weighs 8.6 pounds a gallon but as cream has a wide range of variations in the per cent. of butter-fat it contains, it therefore, varies in weight in proportion to the change in the per cent. of fat. This is due to the fact that butter-fat is the lightest constituent in milk, having a specific gravity of .93 while the average specific gravity of milk is 1.032. Hence, cream containing a low per cent. of fat and much skim milk weighs heavier than cream of a high per cent. of fat which necessarily contains little skim milk, for this reason the weight of cream varies with the per cent. of fat which it contains. Since the difference in weight is but a trifle, and to avoid many standard weights in commercial work, cream that ranges from 18 to 40 per cent. is usually put on one basis, weighing 8.3 pounds per gallon. Any per cent. below 18 is estimated on the same basis as milk; *i. e.*, 8.6 pounds per gallon and any per cent. above 40 is estimated at the rate of 8 pounds per gallon.

#### THE PRICE PER GALLON OF CREAM EQUIVALENT TO THE PRICE OF BUTTER-FAT.

Multiply the pounds of cream per gallon by the per cent. of butter-fat in the cream, the product will equal the pounds of fat per gallon of cream.

Divide the number representing the price per gallon of cream by the number of pounds of butter-fat, the quotient will equal the price per pound of butter-fat.

To illustrate: What is the price per pound of butter-fat if cream containing 20 per cent. fat sells for 50 cents per gallon?

As stated before a gallon of 20 per cent. cream weighs 8.3 pounds.

$8.3 \times .20 = 1.66$ , the pounds of butter-fat in one gallon which is worth 50 cents.

$50 \div 1.66 = 30$ , the price of one pound of butter-fat.

#### TO FIND THE PRICE PER GALLON OF CREAM AT A CERTAIN PRICE PER POUND OF BUTTER-FAT.

Multiply the pounds of cream per gallon by the per cent. of

fat in the cream, the product will be the number of pounds of butter-fat in one gallon of cream.

Multiply this product by the price per pound of butter-fat you desire, the product will be the price per gallon for cream.

To illustrate: At 32 cents per pound of fat what would be the price per gallon of cream containing 27 per cent. butter-fat?

$$8.3 \times .27 = 2.241 \text{ pounds of fat in 1 gallon.}$$

$$2.241 \times 32 = 71.712, \text{ or } 72 \text{ cents the price of the 27 per cent. cream.}$$

#### TO CALCULATE THIS ON A BUTTER BASIS $\frac{1}{6}$ MUST BE ADDED TO THE BUTTER-FAT.

To illustrate: At 32 cents per pound for butter what price per gallon would cream containing 27 per cent. fat be worth?

$$8.3 \times .27 = 2.241, \text{ the pounds of butter-fat,}$$

$$1.6 \text{ of } 2.241 = .373.$$

$$2.241 + .373 = 2.614$$

$$2.614 \times 32 = 83.648, \text{ or } 83.6 \text{ cents the price per gallon of 27 per cent. cream with butter worth 32 cents a pound.}$$

#### HOW TO FIND THE EQUIVALENT PRICE PER GALLON FOR CREAM CONTAINING DIFFERENT PER CENTS. OF BUTTER-FAT.

This is best calculated on the basis of proportion.

Divide the means by the extremes.

To illustrate: If cream containing 20 per cent. butter-fat is worth 60 cents per gallon what is cream worth containing 25 per cent. butter-fat?

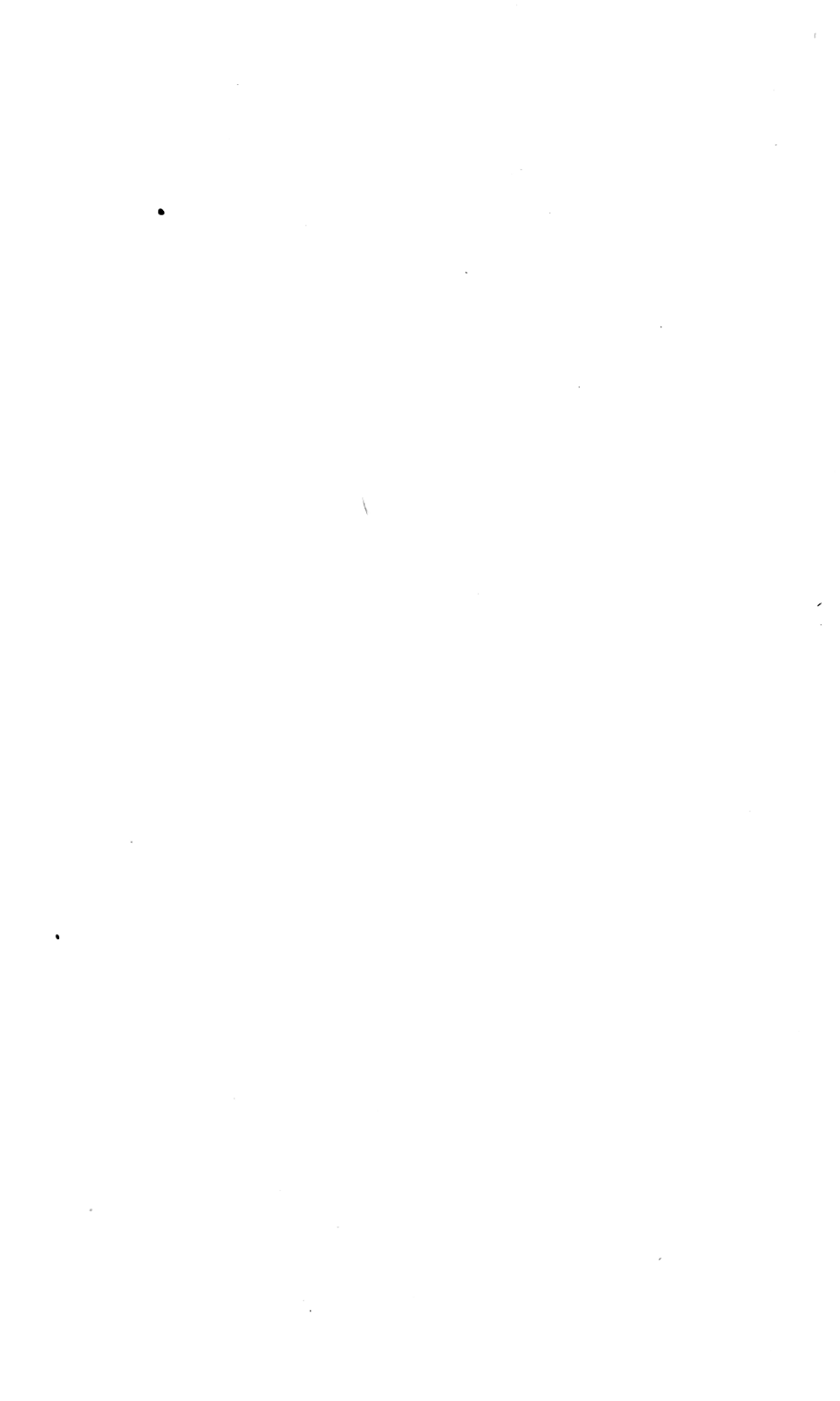
$$.20 : .25 :: .60 : x$$

$$60 \times .25 = 15$$

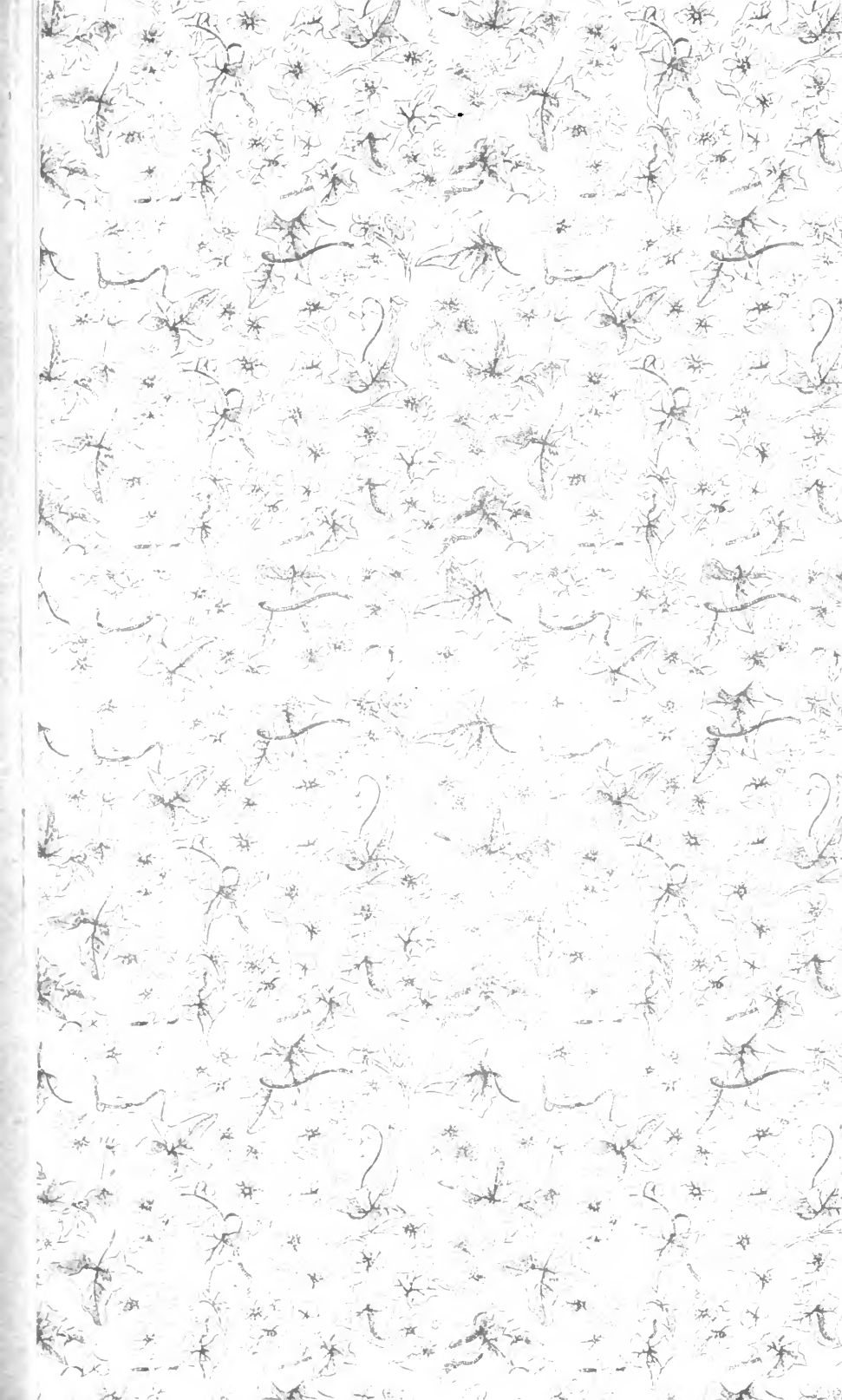
$$15 \div .20 = 75, \text{ or } 75 \text{ cents, the equivalent worth of 25 per cent. cream in comparison to the worth of 20 per cent. cream at 60 cents a gallon.}$$



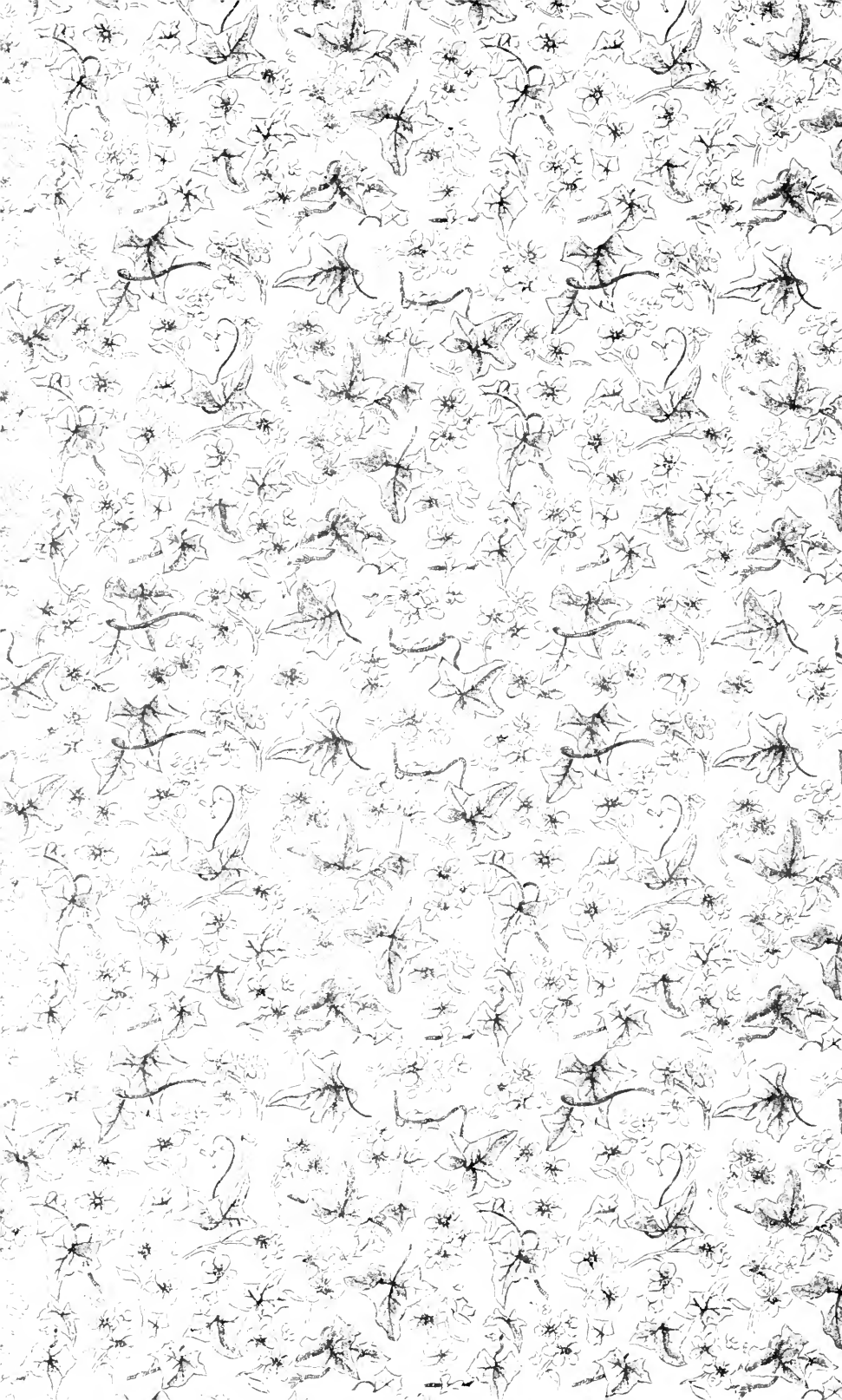












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