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SOLIDS IN MILK

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The use of milk of animals as food by man dates from beyond all recorded history. The oldest existing records which mention the use of milk as a foodstuff were written in India about sixty centuries ago and they clearly show that cow's milk had already become a well established article of diet. Today, many species of mammals besides the cow are kept as dairy animals—certain types of buffalo, goats, ewes, mares, asses and camels. However, when we speak of milk in New Zealand we refer to the milk of the dairy cow.

Milk has often been described as the "perfect food." It is now known that man could not live indefinitely on a diet composed solely of milk or its products. Nevertheless, milk more nearly approaches the ideal foodstuff than any other substance.

Composition of Milk:

Milk contains a wide variety of substances—in fact it is one of the most complex of all foodstuffs. Six constituents, however, are present in much greater amounts than the others. The average proportions of these components in milk are shown in the following table:

Chief Components of Cow's Milk:

Water	87.25
Milk Fat (butterfat)	4.00
Casein	2.60
Albumin and Globulin	0.70
Milk Sugar (Lactose)	4.75
Mineral Matter (Ash)	0.70

It will be seen from the table that water forms the greatest portion of milk. Some of the other ingredients are dissolved in the water and others are held in a very fine state of suspension. Although milk is a fluid, it contains less water than many vegetables and fruit and is very much superior to these in many aspects of food value.

The total solids are made up of fat and solids other than fat—or "solids-not-fat" (S.N.F.) as they are often called. The solids-not-fat portion consists chiefly of casein, albumin, milk sugar, and mineral matter.

New Zealand Government regulations state that "milk shall contain not less than eight and one-half parts per centum of solids other than milk fat and not less than three and one-quarter parts per centum of milk fat."

Factors Influencing the Fat Content of Milk

The fat percentage of milk shows more variation than any other constituent. The more important factors causing this variation are as follows:

1. Breed. The breed differences in the fat content of milk are shown in the following table:—

Breed	Fat	Protein	Lactose	Ash	Total Solids	S.N.F.
	%	%	%	%	%	%
Ayrshire	4.14	3.58	4.69	0.68	13.11	8.97
Friesian	3.55	3.42	4.86	0.68	12.50	8.95
Jersey	5.18	3.86	4.94	0.70	14.69	9.51
Shorthorn	3.94	3.32	4.89	0.73	12.57	8.94

Factors Influencing the Fat Content of Milk:

Breed is the most important factor determining the fat percentage of milk. In general, the breeds producing the largest amounts of milk secrete milk of a lower fat percentage.

2. **Individuality:** The milk of individual cows within a breed may show a considerable variation on either side of the breed average. The variation due to individuality occurs even when conditions of manmagement, environment and feed are identical. Inheritance is the principal cause of these differences. Families of cattle within a breed have been found characteristically to secrete milk either higher or lower in fat percentage than the average for most cattle of the same breed.

3. **Age:** There is a slight irregular tendency for percentage of fat in milk to decline from lactation to lactation. However, the change in fat content caused by increasing age is never very great.

4. **Stage of Lactation:** The stage of lactation affects the fat content. The fat content declines during the first two or three months of lactation and then gradually increases to the end of the lactation period. In the last few weeks of lactation the fat percentage may increase markedly. The protein likewise increases near the end of the lactation period.

5. **Season of the Year:** The average fat content of bulked herd milk is lowest in late winter-early spring and highest in the early summer months. The exact effect of temperature and humidity as against the varying chemical composition of pasture over the season has yet to be determined.

6. **Feed:** In the present opinion of investigators, the feed consumed by a cow has no permanent effect on the fat percentage of milk.

7. **Condition of the Cow at Calving:** The cow's condition at calving influences the fat percentage of milk during the early part of the lactation. If she is in good condition the milk produced will test higher in butterfat than if she is in poor condition. Whether this higher butterfat test persists for only a few days or for several weeks depends on both the animal's condition and her individuality.

8. **Intervals between Milkings:** The variations in fat content from milking to milking will be considerable if the intervals between milkings are not approximately equal. When the intervals are not equal the highest fat content is found in the milk drawn after the shortest interval.

9. **Morning and Evening Milk:** When the intervals between milkings are equal the difference in fat content of milk obtained at the morning and evening milkings is small. As several investigations have shown, milk obtained in the evening is likely to test slightly higher than morning's milk when the intervals are approximately equal. Temperature and the amount of exercise the cow obtains are probably related to the fat content when the intervals are equal.

10. **Variations During Milkings:** The foremilk is lower in fat percentage than are the successive portions collected as milking progresses; the strippings have the highest fat content. The solids other than fat are only slightly affected as milking progresses.

11. **Heat, or Oestrum:** The effect of oestrum on milk composition has been studied extensively. It is probable that the slight decrease in yield of milk and the variations in fat test often produced during this period are due to increased excitability or nervousness. Some animals hold up their milk for one or more milkings, whereas others actually secrete less milk. In the first instance the yield will be less and the fat content lower because the strippings are not obtained. In the second case the low milk yield is accompanied by an increase in fat test—a result that usually occurs when the lower yield is caused by decreased milk secretion rather than by the holding up of the milk.

12. **Excitement:** Change of milkers, frightening by dogs, strange noises, or other reasons often cause a cow to hold up part of her milk. The result is a lowered fat content since the strippings are not obtained.

13. **Combination of Conditions:** Obviously, considering the many factors that influence the fat content of milk, certain combinations of conditions might cause the fat content to vary in a manner contrary to expectations.

Factors Influencing the Solids-not-fat Content

In general, the variations in the fat content of milk are accompanied by changes in the same direction in the solids-not-fat content, but at a slower rate. On the average, an increase of 1% fat is accompanied by an increase of about 0.4% solids-not-fat. The environmental factors, therefore, that influence the fat content also influence the solids-not-fat percentage. An exception to this rule is a low fat test due to incomplete milking or the "holding up" of milk in the udder; such milk is higher in solids-not-fat than the fat test would indicate. This result occurs because the solids-not-fat percentage of milk is constant throughout the milking process whereas the fat content increases during milking.

The fat content of milk is not permanently changed by feeds consumed by the cow and the effects on solids-not-fats are still more difficult to trace. Recent research indicates that feed factors including hormones may exert a noticeable effect on the solids content of milk. The periods of minimum fat content of milk (i.e., in the dry summer months and in the later winter-early spring period) are accompanied by minima solids-not-fat content; such milk may be below the minimum legal standards.

There is some evidence for believing that the season and temperature are largely responsible for the decline in solids-not-fat content of milk produced during the summer.

The variations in the solids-not-fat content of milk of individual cows are largely explained by changes in the casein and lactose percentages.

Milk abnormally low in solids-not-fat because of udder infection is low in lactose and protein.

Relation of Fat to Solids-not-Fat in Normal Milk:

Whilst it has been known for some time that a connexion exists between the content of fat and protein in milk, until recently its exact nature for individual cows was still undetermined. Two recent Swedish investigations, one of which involved the use of identical twins, show that an increase in fat percentage is accompanied by an increase in protein percentage. With the help of this relationship between milk-fat and protein the investigators draw the conclusion that fat percentage and protein percentage are closely related in inheritance. It is also shown, however, that there are further inherited factors which influence the protein and not the fat content of milk. Thus it is possible, by a careful breeding policy, to change the relation between the content of fat and protein in the milk.

Because of the partially independent inheritance of S.N.F. and because of the variations in the response of individual cows to environmental influences, it is impossible to predict precisely the change in S.N.F. from a change in fat percentage.

Practical Implications in Town Milk-Supply Dairying

As stated earlier, milk for town supply in New Zealand is required by law to contain not less than 3.25% fat and 8.5% solids-not fat.

It will be apparent from consideration of the various factors listed above that both the fat and solids-not-fat content of milk from individual cows may vary considerably from one day to another. The variation in the fat and S.N.F. test of the mixed milk of a herd are, as might be expected, of considerably less magnitude than those found for individual cows. Moreover, variations caused by some conditions affecting individual cows, such as inherited characteristics, ill-health, oestrum, will disappear through dilution of abnormal samples by the large volume of other milk present.

However, the factors which tend to influence the fat test of individual cows in the same direction do not cancel out, and have a considerable effect on the test of the mixed herd milk. Breed is the most important of these factors, while feed, stage of lactation, season of the year, and weather, together with efficiency and method of milking also contribute.

It must be appreciated that while some of these factors are within the control of the producer (for example, the breed of stock used), others are, in the present inadequate state of knowledge, largely beyond his control (for example, seasonal effects).

Arising out of consideration of the foregoing facts the practises recom-

Practical Implications in Town Milk-Supply Dairying:

mended for the production of milk which is consistently above the quality required by law are as follows:

1. Use a breed, or strain within a breed, which has an average fat and S.N.F. test well above the legal minima. If this is done, it is unlikely that the fat and S.N.F. test of a herd will at any time fall below the legal minima.

2. Feed dairy stock, particularly cows in milk, with as much good quality feed as they will eat. There is no one type of feed, or combination of feeds, which are known to have a permanent stimulating effect on fat and S.N.F. test. However, recent research suggests that short, leafy, mixed pasture may be the best feed to maintain the S.N.F. at a normal level.

3. Efficient milking methods—rapid and complete milking—will help maintain the test of the whole herd.

4. By calving the winter-milking cows in March and April, as recommended for highest yields of milk, the lowest fat and S.N.F. levels in the herd milk will probably occur in the later winter months. This is due to the "stage of lactation" effect referred to earlier. Nevertheless, if a high testing strain or breed is used, milk above the legal limit in regard to fat and S.N.F. content can be produced in this period.

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