Nutritional and Management Factors Affecting Solids-Not-Fat, Acidity and Freezing Point of Milk[1]

B. Harris and K.C. Bachman[2]

Solids-Not-Fat

Milk produced by an individual cow or a group of cows of the same breed is generally quite uniform in composition so long as the cows are receiving diets adequate in roughage and balanced for other nutrients. Milk of different breeds of cows varies in fat, solids-not-fat (SNF), energy value, and certain vitamins. Average composition of milk from cows of different breeds is given in Table 1.

Table 1. Average composition of cow's milk.

Breed	Fat	Protein	Lactose	Ash	SNF
	-----%-----				
Ayrshire	3.90	3.40	4.81	0.68	8.89
Brown Swiss	3.30	3.00	5.08	0.72	8.80
Guernsey	3.60	3.20	4.96	0.74	8.90
Holstein	3.40	3.20	4.87	0.68	8.75
Jersey	4.40	3.60	5.00	0.70	9.30

Nutrition of the cow has a marked effect on milk composition, particularly the fat content of milk. The solids nonfat component of milk, which consists of proteins, lactose and minerals, may also vary with changes in the diet but to a lesser degree than the fat content. Specific factors that have been reported to affect solids nonfat milk production include: 1) nutrition, 2) genetics, 3) disease, 4) stage of lactation, 5) season of year.

Nutrition

Changes that occur in SNF are primarily due to changes in the protein and occasionally the lactose content of milk. Feeding more protein than indicated by feeding standards (above National Research Council recommendations) appears to have no effect on protein content of milk. However, feeding extra energy to high producing cows may increase the SNF by about 0.2 percentage units. For example, when four increasing levels of concentrate (0, 2, 4, 6#/gal milk) were fed, SNF increased from 8.3 to 8.6%. Also, reducing the energy-fed to high-producing cows below requirements may decrease SNF as much as 0.2 - 0.5 percentage units.

Response to pasture exposure depends upon the feeding status prior to turnout. If cows are receiving 100% or less of their energy recommendation prior to turnout, an increase in SNF can occur; however; if cows are on full feed or are receiving 130% of energy recommendations, a decrease in SNF will usually be observed upon exposure to pasture.

Addition of whole cottonseed or added fat to dairy cattle rations may reduce the SNF content of milk. A

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2. B. Harris, professor, and K.C. Bachman, associate professor, Dairy Science Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

Florida study using whole cottonseed (WCS) resulted in a lower protein percent (Table 2).

Table 2. Effects of increasing whole cottonseed (WCS) level on production responses.*

Responses	% WCS in Diet Dry Matter (DM)		
	0	15	30
DMI (lb/d)	53.2	50.5	45.1
WCS Intake (lb/d)	0	7.6	13.5
Milk Yield	59.0	50.1	47.2
Milk Fat (%)	3.46	3.37	3.19
Milk Protein (%)	3.52	3.37	3.31

* Beede and Chik, Florida Dairy Production Conference, 1985.

In an Arizona study, the addition of fat to the diet had no effect on the protein or lactose content in milk when concentrate contained either 6% tallow or 6% cottonseed oil. Similar results have been reported by a number of researchers using animal-vegetable fats. Responses, however, may vary depending on roughage source. Cows seem to respond more favorably to added fat when rations contain alfalfa hay.

Forage quality and quantity may affect milk SNF. Increasing the intake of roughage such as grass and sorghum silage usually reduces SNF and milk production. The decrease is largely due to reduced energy or dry matter intake. Increasing energy or dry matter intake usually restores the SNF to normal. Good quality hay tends to increase SNF, but poor quality hay may reduce both intake and SNF.

Adding more roughage to the ration has little to no effect on SNF. However, a minimum amount of roughage is needed for normal milk fat percent and health maintenance of the cow.

Alterations in the physical form of the ration have had variable effects on milk SNF. In general, physical size of roughage particles affects milk composition through changes in the production of rumen volatile fatty acids. Pelleting concentrate and hay or grinding the roughage may reduce fat percent of milk but has little to no effect on SNF content.

Buffers are sometimes used in rations to help maintain milk composition. Their effect is primarily on the fat content of milk with little to no effect on SNF content.

Inherited Factors

Heritability estimates for SNF and fat yield are 0.20 to 0.30. Selection depends upon variation. Since variation in SNF (protein and lactose) content of milk is less than the variation in fat content, less selection intensity can be practiced.

If increased SNF or protein content become the objective of dairy production, multi-component testing programs must continue. A relatively high fat test will usually, but not always, guarantee satisfactory SNF content. However; selection for high fat test would be a poor approach to selectively increase SNF content.

Disease Effects

Disease and climatic conditions (temperature, humidity) that causes elevated body temperature of the lactating cow, affect milk yield and composition. A decline in SNF, protein, and lactose content is associated with subclinical and clinical mastitis.

Age, Stage of Lactation, and Gestation Effects

SNF content of milk decreases with age of the cow. Within any given lactation, SNF content is relatively high the first month, drops to a low the second, then rises as lactation progresses. Cows that conceive generally show a steeper rise in SNF content than cows that remain open through their lactation. Why? Because pregnancy causes a decline in milk yield, therefore percent of SNF increases.

Seasonal Effects

Some research has shown an increase in SNF percent when cows go on spring pasture. Generally, it is believed that the increase is due to an increased energy intake. However, **cows receiving adequate to excess energy prior to exposure to pasture will usually show a drop in SNF when shifted to pasture.** The latter is believed to more nearly approach the situation in Florida, since most Florida dairymen tend to feed an adequate amount of energy.

In general, summer SNF values are lower than fall or winter SNF values. Periods of drought, high temperatures and high humidity tend to result in lower SNF values.

Summary

A higher SNF content in milk is easier to maintain under good feeding and management practices. Feeding for peak production tends to reduce the possibility of a SNF problem since energy intake is more closely associated with the SNF content of milk. Grouping cows has an advantage since cows with similar nutrient requirements can be fed and managed as a separate unit. Early lactating cows can be fed more liberally because high producing cows are more profitable.

Feeding protein over and above the National Research Council recommendations will not increase the SNF or protein content of milk, but underfeeding protein will reduce both milk yield and SNF. Underfeeding total digestible nutrients (TDN) or net energy will reduce milk yield, SNF, and protein. The best approach is to feed more energy in early lactation in order to attain peak production. SNF content of milk is highest at parturition, and reaches a minimum at the time of maximum milk yield, after which it increases to the end of lactation.

Generally, a depressed SNF problem is caused by a lack of energy to the higher producing cows. This condition may result from the use of pasture and more hay with a reduction in grain consumption or the feeding of high-fiber low-energy rations. Also, feeding all cows as a single group may result in overfeeding the low producing cows and underfeeding the high producing cows. Separating out the early lactation cows (under 120 days) or the higher producing cows and providing an extra feeding to them is recommended to correct the problem.

High Milk Acidity: Good or Bad?

Have you ever been told that your milk shipment had a high acidity level? Did you react with a smile or a frown? The usual implication of a high acidity value is that the milk contains an elevated level of lactic acid. The cause of the high lactic acid would be bacteria that convert the milk sugar lactose to lactic acid. Therefore, a high acidity **implies** a high lactic acid content which, in turn, **implies** a high bacterial count. The acidity test **does not** measure the number of bacteria present in milk. It **does** measure the concentration of acidic compounds in milk. Therefore, although fresh milk samples analyzed directly from individual cows contain few bacteria and no lactic acid, they still have acidity values that range from .10 to .3. For pooled herd milk the range is usually .14- .18. The milk components that are acidic and contribute to these normal acidity values are carbon dioxide, protein, phosphates and citrates. The higher the concentration of these components, the higher the acidity level observed. Therefore, fresh milk from a Jersey will have a higher acidity than fresh milk from a Holstein because the Jersey milk has a higher percentage of protein. Because the concentration of milk components that contribute to the acidity measurement is variable, we will observe a range of acidity levels that must be considered normal in the absence of lactic acid produced by bacteria. This normal range must be established for each milk supplier because the composition of the herd will influence the composition of the bulk tank milk sample. Only by routine testing of each producer's milk shipments can a historical acidity value be established that subsequently can be used as a normal value which, when exceeded, **might** indicate high bacterial count. If a high bacterial count is suspected because the acidity value that is considered normal for that herd has been exceeded, the shipment should not be rejected or diverted to other usage until the presence of high bacterial count has been confirmed by approved methods such as Standard Plate Count or Direct Microscopic Count.

High Milk Acidity: Good or Bad? Good (smile) if it is due to high solids but bad (frown) if it is due to lactic acid that originated from bacterial contamination. Bacterial quality of raw milk shipments must be monitored since high quality milk is in the best interest of all segments of the dairy industry; however; use of milk acidity measurements to grade milk (reject or divert) can result in an injustice when a milk shipment has a high solids content. If a receiving plant sets an upper acidity level of.18 and two separate producer shipments are received that measure .19 and .17, the .19 shipment would be rejected, although the producer had a historical normal of .18 while the .17 shipment would be accepted although that producer had a historical normal of.14. Clearly, the better quality milk would be rejected while the poorer quality milk would be accepted under a policy that does not consider the historical normal value for each producer. Milk acidity values can be used to screen, but any suspicion of high bacteria must be confirmed by approved standardized methods.

Freezing Point of Raw Milk

Do you add antifreeze to your car radiator? The reason for doing this is to lower the temperature at which freezing will occur. It also increases the temperature at which boiling occurs. How does it work? The ingredients in the antifreeze dissolve in the water that is present in the radiator. Only the ingredients that dissolve change the freezing point. The same is true of milk ingredients. Only lactose (a sugar) and minerals (salts) are dissolved in the water present in milk. Neither fat nor protein are dissolved in milk and therefore do not affect the freezing point of milk. For example, if a milk sample has a freezing point of-.540 degrees centigrade, and I remove the fat from that milk, the remaining skim milk which contains no fat still has a freezing point of -.540 degrees centigrade. Remember, the fat test of your milk does not change the freezing point of that milk.

In my example, I used a freezing point value of -.540 degrees centigrade. Milk samples have a freezing point range of-.525 to -.566°C. The value for your herd milk will be fairly constant from shipment to shipment because the amount of lactose plus minerals is constant. Since the freezing point is constant, it can be used as an easy and accurate indication of whether water has been illegally or accidentally added to your milk. How do we determine whether a milk sample contains added water? If your shipments routinely have a freezing point of around -.540°C and we have a shipment that freezes at -.525°C and the next shipment is around .540°C, we can positively say that the shipment with the freezing point of -.525°C had about three percent water added. That is 30 gallons of water in 1000 gallons of milk.

We can draw this conclusion because changes in feeding and management practices do not change the freezing point enough to interfere with our detection of added water. For that matter, mastitic milk will have a freezing point close to that of a normal milk from the same cow because the lactose plus mineral total is not changed.

When you add water to the antifreeze in your radiator, it will freeze at a higher temperature. When water is added to milk, it will freeze at a higher temperature. If the normal freezing point for your milk shipments is known, added water (intentionally or accidentally) can easily be detected. Make certain milking equipment rinse water does not enter your milk shipment. It could freeze your assets.