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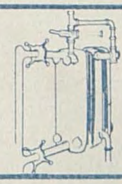
MINNESOTA DAIRY PRODUCTS PROCESSOR



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Protein and/or solids-not-fat (SNF) testing and component pricing continue to be of interest in the dairy industry. Some facts and findings in the scientific literature might be helpful in understanding some of the issues involved. A summary follows:

MILK PROTEINS

Sometimes milk protein is referred to in the singular, as if it were one protein. Actually there are several proteins in milk, all uniquely different. Casein makes up the largest fraction, at about 2.5 percent. It is a protein consisting of several unique parts, at least two of which have genetic ties. Casein is the main protein in most cheeses. Whey proteins, those leftover after casein is coagulated during cheesemaking, are the next largest protein fraction, occurring in milk at about 0.7 percent. These consist chiefly of beta-lactoglobulin and alpha-lactalbumin and have a higher (more nutritious) biological value than casein. Last come immunoproteins, found mostly in colostrum milk. The level of immunoproteins drops quickly in the first few days following calving.

LEVEL OF PROTEIN IN MILK

Several researchers have found protein in milk to average between 3.1 and 3.4 percent. However, the level of protein associated with milk of 3.5 percent fat, is about 3.1 - 3.2 percent. That fat level serves as the baseline above and below which milk pricing compensations are currently made. Protein level varies by breed of cow, with Jersey ranking highest, followed by Brown, Swiss, Guernsey, Ayrshire, and Holstein.

STAGE OF LACTATION

Both protein and fat respond similarly during lactation. Content of both components is high at freshening, declines to a low about 50 days after calving, and then trends upward throughout the remainder of lactation.

SEASONAL INFLUENCES

Again, fat and protein follow a similar pattern, at lower levels during spring and summer, higher levels in fall and winter.

RELATION BETWEEN FAT AND PROTEIN

Milk which is high in fat usually runs high in protein. The thumb rule, based on a number of studies, suggests: For every 0.1 percent rise in fat test, expect a 0.04 percent rise in protein. While the thumb rule applies generally, exceptions do occur. And the relationship is not precise enough to serve as a pricing mechanism per se. As well, the ratio of protein to fat varies seasonally. In spring and summer, it runs 0.032 percent protein to 0.1 percent fat, and, in fall and winter, near 0.048 percent protein to 0.1 percent fat.

INFLUENCE OF MASTITIS

There are varying opinions in the literature on this subject. Nonetheless, certain facts seem to be suggested. Mastitis does influence milk composition. In summary form, changes are as follows:

Component or factors that decrease	Component or factors that increase	Potential effect
casein or certain fractions of casein, SNF, total solids	whey proteins, immunoproteins, total protein	cheese curd less firm, lower cheese yield
calcium, phosphorus, potassium	zinc, iron, copper magnesium	milk less stable
lactose	sodium, chloride	milk tastes salty
fat, fat globule membrane material, long-chain fatty acids, saturated fatty acids	number of small fat globules, short-chain fatty acids, lipase activity	milk more susceptible to rancidity
titratable acidity	pH	milk more alkaline

In University of Wisconsin studies comparing milk from quarters of the same cow, casein content decreased at cell counts over one million. The average casein level went from 2.79 to 2.25 percent in Holstein milk. In a study made of individual cow samples at Pennsylvania State University, casein remained fairly constant, but whey protein, thus total protein, increased significantly in milk of high somatic cell count. Average protein content for all samples was 3.4 percent. Milk of 500,000 cell count or over ranged from 3.4 to 3.9 percent protein. Since whey proteins are lost in cheesemaking, and since a low casein/whey protein ratio (also noted in the study) also reduces cheese yield, the net effect of high cell counts would be lowered cheese yield.

GENETIC INFLUENCES

Both fat and protein are influenced similarly, according to the literature. That is, if breeding solely for an increase in fat percentage, total milk yield goes down. If breeding solely for an increase in protein percentage, yield likewise suffers. But if breeding for increases in yield of fat or yield of protein and/or SNF, total milk yield can increase. What this says is that it is better to select for yield traits, no matter what the component, then for percentage traits.

NON-PROTEIN NITROGEN (NPN)

The reference method for protein testing is the kjeldahl procedure which measures total nitrogen. All proteins contain amino acids which themselves contain nitrogen. By means of a factor, this nitrogen value is converted to protein. But remember-- the kjeldahl method measures nitrogen. If nitrogen other than that found in protein is present, it is measured also. In milk, a small amount of such nitrogen is found: A number of compounds like urea, uric acid, orotic acid, creatine, etc., contain nitrogen, but are not protein. Nonetheless, the kjeldahl procedure measures this nitrogen as well as protein (amino acid) nitrogen.

In milk the NPN level averages about 5 percent of total nitrogen. It ranges between 3 and 7 percent or higher. NPN varies seasonally, and inversely to casein level. It also varies with breed and feed. Unless it is accounted for and factored out of test results, protein content, as measured by the kjeldahl or any test procedure standardized on the kjeldahl method, will be somewhat exaggerated, i.e., higher than the true value.

PRECISION AND ACCURACY OF METHODS

The University of Minnesota is currently doing a study to evaluate the precision and accuracy of dye-binding and infra-red methods of protein analysis. In the meantime, other researchers have found the manual kjeldahl to be repeatable on the same sample to within 3-5 percent, the dye binding to within 1 percent. The Kjel-Foss automated kjeldahl method has been found repeatable to 0.7 percent at 3.0 percent protein. That is, at this level of protein the method would repeat within a range of 2.979 to 3.021.

The amido black dye-binding procedure has been found to yield a standard deviation of 0.045 percent. At an average test of 3.2 percent, the method would vary from this level by no more than 0.09 percent in either direction 95 times out of 100. On the other hand, an infra-red device has shown a standard deviation from regression on herd milk samples of 0.029 percent. With the average test again at 3.2 percent, results would be expected to fall, at 95 percent probability, at 3.2% ± 0.058% (2 x 0.029).

Note: On certain samples of milk, the dye-binding and infra-red methods may disagree rather widely, even though both methods are standardized against the kjeldahl. In work currently underway, the University of Minnesota hopes to find out why.

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