TRUE PROTEIN VS. TOTAL PROTEIN

The Final Decision on Federal Milk Marketing Order Reform was issued by the United States Department of Agriculture (USDA) on March 31, 1999. If, as expected, the reformed FMMO program is implemented on October 1, 1999, the formula for pricing protein will change from a total protein basis to a true protein basis.

Most readers are unfamiliar with the difference between total protein and true protein and its implications. Only one state—New York—prices milk on the basis of its true protein content. Protein pricing elsewhere is based upon total nitrogen content, a considerable fraction of which is non-protein nitrogen (NPN). NPN "has little or no effect on dairy product yields," according to USDA.

This article will examine the relationship between "true" protein and "total" protein and illustrate how this relates to Jersey milk.

The Kjeldahl Test

Historically, the Kjeldahl method has been the primary procedure used to test milk protein reference samples. These protein reference samples are used by milk plants, cooperatives and DHIAs, among others, to calibrate automatic milk protein testing equipment.

Milk protein content is not measured directly by the Kjeldahl. The test instead measures the nitrogen content of milk.

Milk protein contains 15.65% nitrogen. To convert the Kjeldahl nitrogen reading to milk protein, the nitrogen measurement is multiplied by a factor of 6.38 (100 ÷ 15.65). For example, if a milk sample is determined to contain .55% nitrogen by Kjeldahl analysis, then its protein content is .55 x 6.38, or 3.5%.

Use of the Kjeldahl method presumes that all of the nitrogen found in milk is contained in protein. However, this is not the case. A portion of the nitrogen in milk comes from non-protein sources, such as urea and uric acid. These other protein sources are called non-protein nitrogen (NPN). The Kjeldahl method therefore actually measures what is termed *total protein*. Total protein is the nitrogen in milk multiplied by 6.38.

True Protein

The *true protein* in milk is the total nitrogen minus the NPN, then multiplied by 6.38. The textbook average level of NPN in milk is about 5%. Dr. David Barbano of Cornell University conducted a yearlong national milk composition study in 1985. His findings showed an average total protein value of 3.27%, a true protein value of 3.11%, and average NPN of 4.78%.

Assuming an average NPN value of 5%, then the true protein content of a milk testing 3.2% total protein would be calculated as follows:

0.5% x 3.2% = 16% NPN

3.20%	Total Protein
– .16%	NPN
3.05%	True Protein

The 5% NPN is an average. The percent NPN varies among breeds, seasons and regions. Table 1 was obtained from a study showing differences in NPN levels by breeds. This table shows that Jersey milk contains less non-protein nitrogen (3.6%) than other dairy breeds.

A University of Vermont study examined seasonal variations in NPN among Vermont cheese plants. The graph in Figure 1 demonstrates these results. Dr. Barbano's work mentioned earlier showed seasonal and regional variations in NPN as well. His research revealed that NPN as a percentage of total nitrogen varied seasonally from 4.33% to 5.22%. Perfect NPN is the highest in the summer and lowest in the winter. The study also found the lowest monthly regional NPN was 3.9% and the highest 5.6%.

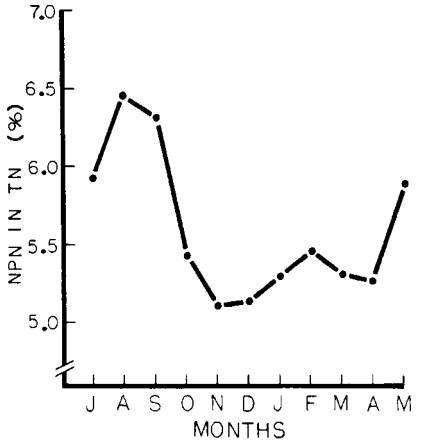

Figure 1. Variation of mean percentage non-protein nitrogen (NPN) of total nitrogen (TN) in milks from seven Vermont cheese plants by months (1980-1981).

Another Barbano project found significant variation among farms. In a limited study on 24 western New York farms, results were obtained showing NPN variation from a low of 2.9% to a high of 6.1%.

What Is The Point?

Why make an issue of whether true protein or total protein is used? Fifteen years ago, Vernal Packard, food scientist at the University of Minnesota, addressed this question and gave the following reasons for why true protein should be used instead of total protein.

1. NPN does not have biological value as protein. For the most part, it cannot be used by the body to perform functions characteristic of protein.

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Table 1. Nitrogen distribution in milk *(milk total N equals 100%).*

	NPN (%)	Protein N (%)	Casein N (%)
Jersey	3.6	96.4	80.2
Guernsey	3.9	96.1	77.7
Holstein	4.9	95.1	78.2
Ayrshire	4.9	95.1	78.7
Brown Swiss	5.4	94.6	77.4
Milking Shorthorn	7.5	92.5	74.8
Average	4.9	95.1	77.9

Source: J. Dairy Sci. 58: 417

True vs. Total Protein

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2. NPN does not add cheese yield. It has no place in a purchase plan for milk in which cheese yield is the major consideration.
3. If all dairy plants are not on the same program—either true or total protein—the difference becomes a source of confusion.
4. Level of NPN is highly variable in milk. Because the Kjeldahl method is used as the official method for calibration and daily control of infrared and dye binding testing devices, NPN becomes a source of variability in these other methods, even though they do not measure NPN as such.
5. Seasonal variations in NPN–and these are significant–must either be ignored or adjustments in equipment made on a seasonal basis.
6. Breeding programs for protein can be more tightly monitored on true than total protein. Because increases in percentage of protein come very slowly and in very small increments, NPN may mask these changes. In other words, true protein is by far the better basis for evaluating progress of breeding programs.

Packard noted, "Of the several factors that have some influence on NPN level in milk, feeding practices on the farm may be the most important. Whenever the ratio of protein to energy in the feed goes up, NPN level increases. Feed more protein and less grain, and not protein but NPN level (%) increases in milk. This kind of change in protein/energy ratio is characteristic, in some parts of the country, of the change from winter to summer (pasture) feeding. As a rule, NPN % increases in summer and drops in the winter.

"Considering the preceding factors," Packard concluded, "compelling reasons appear to exist for basing protein purchase on the true rather than total protein, as is done in most European nations. In doing so, a regional policy and, preferably, a national policy to that effect becomes essential, so that neighboring plants and states are all testing on the same basis."

Testing For True Protein

The Kjeldahl method can still be used to prepare true protein calibration samples. The difference in testing for true protein rather than total protein involves sample preparation and additional procedures. As with total protein, the Kjeldahl procedure for true protein produces accurate and reliable true protein calibration samples.

Adjustments In MCP Plans Using True Protein

In 1988, the New York State Department of Agriculture and Markets required all protein payment programs to use true protein instead of total protein. Protein pricing programs in New York state were adjusted accordingly. For example, Eastern Cooperative previously paid a protein premium of 10 cents for each 0.1% of protein above 3.3%. Using true protein, the cooperative lowered its base to 3.1%.

On the average, most dairy farmers did not see any change in their total protein premium dollars. Their true protein tests were approximately 5% lower than their total protein tests. However, the difference was compensated for by lowering the protein base.

For those plants using End Product Pricing (EPP), an adjustment was made in the percentage of protein that is casein. The original cheese yield formula estimates casein to be 78% of total protein. If true protein is used, casein is 82% of true protein.

Implications For Jersey Milk

The Federal Order Reform decision requiring the use of true protein instead of total protein is a positive one for Jersey producers, because of the lower percent of non-protein nitrogen in Jersey milk compared to average milk. Payment on the basis of true protein will make milk pricing more equitable.

Consider the example of a plant paying a protein premium of 10¢ per 0.1% above 3.2% based upon total protein. Jersey milk testing 4.0% total protein would receive a premium of 80¢ per hundredweight (8 points x 10¢).

On a true protein basis, using an average NPN of 5%, the base would be adjusted to 3.04% to reflect true protein. Non-protein nitrogen in Jersey milk is 3.6%, leaving a true protein content of 3.86%. At 10¢ for each point of protein, the premium for Jersey milk increases from 80¢ to 82¢ per hundredweight.

In addition, cheese yield is more accurately predicted using true protein measures. The value of Jersey milk sold under End Product Pricing therefore increases when true protein is the basis for calculating payment.

For example, assume that a plant is using a cheese yield value of $1.20 per pound. Jersey milk testing 4.8% butterfat and 4.0% protein and producing 12.90 lbs. cheese would be valued at $15.49 under EPP. Jersey milk testing 4.8% butterfat and 3.86% *true* protein would yield 12.98 lbs. cheese, which is worth $15.58 at $1.20 per pound.

Summary

In the years ahead, it will become more important for us to learn about how management and genetics affect the levels of true protein in Jersey milk. For examples, does feeding affect true protein? How? Do some bulls transmit more true protein than others? Do some cows transmit more true protein?

The change from total protein to true protein is a positive development for the dairy industry. It will allow plants to pay only for the usable protein in producer milk. For producers, this is another step toward receiving equity in the marketplace.

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