

# Milk Protein

Holstein milk normally contains about 3.2% crude protein, which is comprised of 78% casein, 17% whey (true proteins) and 5% non-protein nitrogen (NPN: see article **1P1**). In the laboratory, milk protein concentration is determined using one of two methods:

- the Kjeldahl method measures the amount of nitrogen (N) in a milk sample. Milk protein contains approximately 15.67% N. Therefore, the milk protein concentration is calculated by multiplying the Kjeldahl N concentration by 6.38 (1 ÷ 15.67). Since the NPN content of milk can vary considerably among herds, the Kjeldahl method may not accurately reflect true protein content or the manufacturing value of milk.
- infrared analysis detects the specific chemical bonds present in protein. Therefore, NPN is not included and the result is true milk protein.

## Genetic variation of milk protein

Table 1 shows the variation of true milk protein among the five major breeds of dairy cattle. Several studies have estimated the heritability of protein yield and have shown an average value of 0.49. Other studies have shown that the heritability of milk protein is near 0.60. This means that approximately 49% to 60% of the variation in milk protein can be attributed to genetics. The genetic correlation between protein and fat contents is approximately 0.45. Although milk protein and fat generally increase or decrease together, there is evidence that protein can be increased without increasing milk fat.

## Variation during lactation

The concentration of milk protein is highest early and late in lactation and lowest when production is highest. Normally, an increase in milk yield depresses the percentages of milk protein and fat, but milk protein and fat yield will increase or stay the same. Percentages of whey and casein proteins slowly decline during the first five weeks of lactation. After week five, milk protein percentage increases through the rest of lactation while milk production declines (see figure 1).

BREED	TRUE PROTEIN %		
	CASEIN	WHEY	TOTAL
Ayrshire	2.68	0.60	3.28
Brown Swiss	2.63	0.55	3.18
Guernsey	2.88	0.61	3.49
Holstein	2.49	0.53	3.02
Jersey	3.02	0.63	3.65

Table 1 : Breed variation of milk true protein.

## Mastitis, SCC and milk protein

Mammary infections and high SCC (>200,00) are known to depress milk protein concentration. Cows that have high SCC have a high level of plasmin and plasminogen, enzymes which degrade milk protein, especially certain casein proteins. Therefore, casein percentage and amount are lower for cows with high SCC. One study has shown that Growth Hormone (BST) reduces the plasmin content of milk which would reduce protein degradation and increase milk protein.

## Maximizing rumen function

The importance of maximizing rumen function to achieve high milk protein levels cannot be overemphasized. High degradable protein (DIP) rations probably will not affect true milk protein, but will increase NPN in milk due to an increase in milk urea nitrogen (MUN). Not providing enough rumen fermentable carbohydrate will also raise MUN, but will not increase true milk protein concentration.

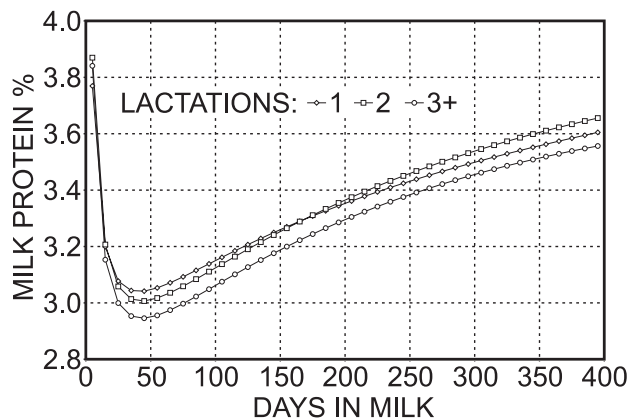


Figure 1 : Normal lactation cycle variation in milk protein % for Alberta Holsteins on DHI.

Overfeeding of undegradable protein (UIP) may decrease true milk protein because high levels of UIP do not allow enough protein for optimum growth of rumen microbes (see article [1A3](#)). Rumen microbes supply a large proportion of the amino acids that are absorbed and utilized for milk protein synthesis.

Non-structural carbohydrates (NSC or NFC: non-fibre carbohydrates) which are fermented to provide energy for rumen microbes should be at least 35% of the ration dry matter. Levels above 40% of the ration dry matter may cause acidosis and digestibility of the entire diet may be reduced.

In addition to energy, rumen microbes require a nitrogen source. This is provided by rumen degradable protein and soluble protein. Soluble protein should be approximately 50% of degradable protein. Fermented feeds are high in soluble protein, especially when treated with ammonia or urea. However, dry forage rations may require that soluble protein be added to the grain mix in the form of urea to supply adequate nitrogen levels to the rumen microbes.

Maximizing rumen function is the most important aspect of balancing a ration for optimum milk and protein production.

### Limiting amino acids

Research has shown that lysine and methionine are usually the amino acids which are most limiting for milk protein production. One Canadian study showed that high-producing cows fed at NRC requirements for total protein responded to additional lysine and methionine, which were protected from rumen degradation. The result was higher milk production as well as increased protein and fat content. Recent research suggests that other amino acids may also limit milk protein production. For example, glutamine was shown to be potentially limiting when free amino acid levels were monitored in plasma and muscle.

Fish meal, in particular, is high in both lysine and methionine as well as other limiting amino acids and can increase milk protein. Fish oils can also decrease milk fat content, possibly by altering glucose and fat availability to the mammary gland. Menhaden fish meal and blood meal have amino acid profiles that are higher in the most limiting amino acids for milk production and milk protein content.

## Maximize Milk Protein

- ✓ Use bulls with high genetic merit for milk protein.
- ✓ Keep SCC low (see article [6L2](#)).
- ✓ Maximize feed intake (see article [111](#)).
- ✓ Feed a ration that provides fermentable carbohydrate (35% to 40% NFC) and degradable protein (62 to 65% of crude protein) to maximize rumen microbial protein production.
- ✓ Provide undegradable protein sources with the correct amino acid balance to provide limiting amino acids for milk protein production.
- ✓ Provide rumen protected amino acids (see article [1A3](#)).
- ✓ Determine the benefit of fat supplements for milk yield versus their effect on milk protein as dictated by milk pricing structure.

Fish meal and blood meal have better amino acid profiles than feather meal. Distillers grains have low lysine but can be balanced with blood and fish meal. In more progressive herds, amino acids are balanced for optimum milk protein production. As amino acid profiles of ingredients become more standard, more rations will be balanced on amino acid levels.

### Effect of fat supplementation on milk protein concentration

Supplemental fats are known to depress milk protein. When milk protein is depressed by supplemental fat, the addition of ruminally protected lysine and methionine have not alleviated the protein depression caused by fat. The benefits of increasing milk production with fat supplements should be weighed against the adverse effects on milk protein. Greater than 5% fat of the total ration dry matter can cause milk protein depression.

The exact mechanism for milk protein depression that fat supplements cause is not fully understood. In some studies, niacin has been shown to alleviate milk protein depression caused by fats. A water soluble B vitamin, niacin is involved in glucose and fat metabolism and may not be synthesized in sufficient amounts by rumen microbes, especially in high-producing cows.

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