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Manipulating Milk Protein Percentage and Production in Lactating Dairy Cows
1. Difficult to Manipulate Factors

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The protein content of milk has become a much more important component of milk in recent years. This reflects the rise in production of cheese, as well as the perception of consumers that milk fat, and fats in general, are unhealthful while milk protein is healthful. Regardless of the reasons, dairy producers are paying more attention to the protein production of their dairy cows, both in pounds per day and as a proportion of milk, as both now influence the total value of the milk.

There are a number of factors that affect the production of milk protein by dairy cows. These reflect characteristics of the cows, the feeds that they are fed, and the environmental conditions under which they are housed. However, few of the factors can be easily manipulated on the dairy, although considered together, they will determine both milk protein yield, and the percent in the milk, on a particular string of cows.

The purpose of this article is to highlight most of the commonly accepted factors that impact milk protein production as well as milk protein percentage, but are rather difficult to manipulate on commercial dairies over the short term.

Factors that Reflect the Cows

A number of characteristics of the cows in the string being assessed influence the expectation of the milk protein percent and/or yield.

Breed of the Cows

Holsteins tend to have the lowest milk protein percentage, at between 3.15 and 3.25% protein, of all the traditional European breeds of economic importance. In contrast, Jersey's, at between 3.80 and 3.90% tend to be the highest. Ayrshires (3.25 to 3.35%) and Guernseys (3.55 to 3.65%) are intermediate. Keep in mind that since these values are full lactation averages for cows weighted over a normal distribution of lactations within a

herd, individual herd values may deviate. In addition, the absolute production of protein will not follow the same pattern. For example, using the averages of the milk protein ranges listed above, a Holstein herd producing 25,000 lbs of milk will produce the same amount of protein as an Ayrshire herd at 24,250, a Guernsey herd at 22,200, or a Jersey herd at 20,800 lbs.

Genetic Merit of Individual Cows

Within all breeds, there is a range of milk protein production potential within cows that tends to cluster most of the cows around the herd average value. However, there are generally herd average outliers, both high and low. For example, in a group of 25 multilactation Holstein cows between weeks 6 and 12 of lactation all fed the same diet, an average milk protein percent of 2.85% was recorded with a range of between 2.55% and 3.30%. These outliers are expressing their genetic predisposition to produce milk protein at either a high, or low, ratio to total milk. Selection of semen from bulls with high milk test daughters is a means to increase milk protein percentage on the long term, if there is confidence in the continued value of milk protein in the future.

Parity of the Cows

Milk protein percentages tend to decline from first lactation to stabilize by the fourth or fifth lactation. However these differences are relatively small after second lactation and less than the increase in protein yield that occurs over the same range of parities.

Stage of Lactation of the Cows

A normally fed group of Holstein cows can be expected to show a substantial difference in milk protein percentage with stage of lactation. Typically, a milk protein percentage of about 4.0% in the first week of lactation will decline to 2.7 to 3.0% by week 5 to 6 of lactation and then show a slow increase to as high as 3.6 to 3.8% by the end of the lactation. The sharp decline in milk protein percentage in early lactation is partly due to the residual impact of colostrum production, whereas the slow increase in later lactation reflects the relatively slower reduction in production of milk protein relative to milk lactose, which is the main determinant of milk volume. Examining the relationship between days in milk and milk protein percentage, within parities, is an effective method to determine whether the milk protein percentages in a particular herd are relatively high, low or normal for the different stages of lactation.

Factors that Reflect the Conditions of Feeding and the Rations

A number of characteristics of the conditions of feeding and the rations fed to the cows in the string to be assessed influence the expectation of the milk protein percent and/or yield.

Season of the Year

Dairy herds in California show seasonal patterns in milk protein percentage with the lowest values during the summer and the highest values during the winter. This difference has been shown to be in the range of 0.2 to 0.3 milk percentage units between the summer low values and winter high values. It is not clear whether seasonal effects are simply related to high temperatures, or whether daylength is a contributing factor.

Dietary Fat Level

While the level of fat in the diet can be manipulated relatively easily on commercial dairies, decisions to increase or decrease fat levels in the diet are generally made relative to the energy needs of the cows, rather than the protein level of the milk. Nevertheless, it is clear from research completed at numerous sites that dietary addition of either ruminally unprotected or protected fats is associated with reductions in the milk protein percentage by as much as 0.3 milk percentage units. In contrast, milk protein yield is generally unchanged or slightly increased, reflecting the biology of the cow which predisposes supplemental fat to have a greater impact on production of milk fat and lactose, which is the major regulator of milk volume, than on milk protein production.

The study reported from UC Davis in 1990 demonstrates that the impact may differ with the form of the added fat.

Milk Yield and Composition as Influenced by Diet Fat Level

	No Fish Meal		With Fish Meal	
	-RPFat	+RPFat	-RPFat	+RPFat
Yield (lb/d)				
Milk	80.5	82.9	83.3	80.4
Fat	2.50	2.40	2.32	2.49
Protein	2.58	2.50	2.72	2.53
Milk Composition				
Fat	3.10	2.90	2.90	3.10
Protein	3.21	3.02	3.27	3.15

DePeters and Palmquist (1990)
RP = ruminally protected

Diet Forage to Concentrate Ratio

It is clear that both milk protein yield and percentage can be increased by increasing the proportion of concentrates in the ration fed to the cow. This may be due to the associated changes in ruminal fermentation, the increased delivery of digestible nutrients at the intestinal absorptive site, or the increased flow of bacterial protein from the rumen to the intestine. However recently reported research also indicates that very high levels of concentrate in the diet may also suppress milk protein yield and percent. This may be the result of suppressed rumen bacterial growth associated with the acidotic rumen fermentation conditions that are typical of situations where high levels of concentrates are fed in the ration.

However whatever the cause, it is not likely that commercial dairies will want to make shifts in the forage to concentrate ratio of the diet as a tool to manipulate milk protein yield or percentage.

Milk Yield and Composition as Influenced by Diet Forage to Concentate Ratio

	Forage/Concentrate Ratio (DM basis)		
	77/23	55/45	42/58
Yield (lb/d)			
Milk	68.3	76.8	79.4
Fat	2.73	3.00	2.73
Protein	2.18	2.64	2.46
Milk Composition			
Fat	4.02	3.93	3.52
Protein	3.23	3.44	3.12

Robinson and McQueen (1997)

Summary

An unfortunately high number of the factors that impact milk protein production cannot be easily manipulated on the dairy on the short term. However, they are all important in allowing a rational decision to be made as to whether milk protein values, under any particular commercial situation, are high, low or normal.

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