

FEEDING FOR MILK COMPONENTS



BASICS

OVERVIEW

- The recent change to multiple components pricing of milk has created interest in how to increase milk components (fat, protein, and other solids) and poses an attractive challenge to maximize nutritional management.
- The yield, or amount of components produced, and not the percentage, is the basis for the milk pricing system. Milk protein generally has a greater economic value than milk fat.
- Cow's milk is composed of 12.5% solids, of which protein ranges from 3.1 to 3.8%, fat from 3.5 to 4.9%, and lactose from 4.6 to 4.8%.
- The milk of water buffalo has 7 to 9 % fat and 5.0 to 5.5 % protein.
- A cow producing 60 pounds of milk with 3.1% protein yields 1.86 pounds of protein and returns the same dollar income from protein as a cow producing 55 pounds of milk with a 3.4% protein.
- With the emphasis on component yields, feeding programs that maximize milk yield while maintaining normal component percentages will be the most profitable. This chapter covers some feeding tips to enhance milk production while maintaining or hopefully slightly increasing milk fat and protein percentage.
- The other solids components, lactose, and minerals, are essentially unchangeable as a percentage in milk. The amount of other solids produced can only be increased by increasing milk production.
- The components in milk are fairly constant. In cow's milk in early lactation there is a lower % of fat than in late lactation. The reason for the fat variation is largely due to lower milk volume at the end of lactation. Protein % does not change very much during lactation. The relationship between fat % and protein % is positive in all the breeds of cattle. If the milk has higher % protein than fat then it is called protein fat inversion.
- Fat-protein inversion affects most dairies for a period of time. The inversion can remain for several weeks or months. Generally, herd monitoring (i.e., DHIA) will report the milk fat and protein and should be performed monthly. In the situation where fat % is less than protein %, generated income will be affected. It also affects the physiology of lactation, signaling possible chronic ruminal acidosis or significant ketosis.

GENETICS

In general, 55% of the variation in milk composition is due to heredity. Forty-five percent of the variation is due to environmental factors.

GEOGRAPHIC DISTRIBUTION

- The importance of milk components vary based on the method of compensation (i.e., milk components vs. liquid volume) which varies by location as well as market.

SIGNALMENT

- Dairy breeds have differing percentages of milk components. The Jersey and Guernsey breeds have a higher concentration of both milk protein and fat than Holsteins.

RISK FACTORS

Over-nutrition in growing heifers might compromise udder development. Fat infiltration in the heifer mammary gland may occur with negative impact on potential milk production and solid composition during subsequent lactations.

Protein-fat inversion can happen due to changes in fatty acid composition of milk. In early lactation cows can suffer clinical or subclinical ketosis which is exacerbated by poor body condition in the transition period, large changes in body condition, inadequate energy intake, and underlying disease in the fresh period.

Many factors other than nutrition can affect milk components such as stage of lactation, parity, and season.

NUTRITIONAL CONCEPTS

Optimizing rumen fermentation is the key to increasing the yield of milk components. Feeding a ration balanced correctly for protein, energy, and fiber along with good feeding management will increase both milk yield and component percentages.

For a general evaluation of the herd components, look at milk yields and the relationship between components. For example, a Holstein herd may have a fat test of 3.5% and their protein test of 3.1% with an average of 75 pounds of milk per day. In this example, milk production is good, components are slightly lower than breed average and the protein test is 88% of the fat test.

Protein:fat ratios between 0.8 and 0.9 (also reported as fat:protein ratio of 1.2-1.3) are considered normal. When ratios are outside of this range, rations should be evaluated for nutrient balance. Higher ratios may indicate a potential rumen health problem, whereas lower ratios indicate an opportunity to increase milk production.

Slight decreases in milk fat percentage to gain an increase in milk protein percentage and milk yield can be tolerated because fat has less economic value than protein. However, fat percentages should probably not be below 0.3% units of breed average because fat has economic value and rumen acidosis and cow health problems may be occurring.

Consider the following feeding strategies to increase production of milk components:

- 1) *Carbohydrate feeding.* Starch and sugars affect the yield of milk and the percentage of fat and protein in the milk. Non-fiber carbohydrates (NFC) or nonstructural carbohydrates are more digestible, but must be balanced adequately with the structural carbohydrate. Feeding increased NFC stimulates milk protein and milk yield and will increase milk protein percentage in later lactation. Milk fat percentage is inversely correlated. Inefficient NFC in diets, usually associated with high-fiber, increases milk fat percentage, but both milk yield and milk protein percentage decrease. Rations containing 35 to 40% NFC, dry matter basis, generally result in the best yield of milk components and milk. This is largely dependent, however, on the type of feed carbohydrate source and processing. Processing grains by cracking, rolling, grinding, or steam-flaking enhances digestion of starch in the rumen, improving milk protein percentage and milk yield. Caution is needed, however, because the amount of processed grain that can be fed before acidosis problems develop is less than with very coarse textured grains.
- 2) *Fat feeding.* The addition of fat in any form (cottonseed, soybeans, sunflowers, tallow, or rumen-inert fat) to the ration will lower the milk protein percentage. As a guideline, 1 pound

- of fat added to the ration will lower milk protein percentage by about 0.1% units. Milk fat percentage may increase, decrease, or not change when fat is added to rations. Animal and rumen inert or bypass fats tend to increase milk fat percentage, whereas vegetable fats such as soybeans and sunflowers, decrease the percentage. Feeding 1 pound of fat/day has the potential to increase milk production by 7 pounds/day. Thus, yields of milk protein and fat can increase, even though their percentages decrease with fat feeding. Because of the potential to increase component yields, fat additions to rations can be profitable.
- 3) *Fiber in rations.* Adequate amounts of quality fiber are needed in rations to maintain good rumen health. Rations should be 8 to 20% ADF and about 28% NDF and have about 21% NDF from forages (hay crops, corn silage, and/or cottonseed). For quality of fiber, more than 10% of the total ration or 20% of the hay crop forage fed should have a particle length of 1.5 inches or longer. Feeds with fiber that is highly digestible in the rumen are advantageous in stimulating rumen and fermentation and microbial growth in the rumen. Cottonseed, soy hulls, wheat midds, and corn gluten feed are good digestible fiber sources, which can help maintain fat percentage, while increasing milk production. Feeding above ration fiber guidelines with fiber from hay crop forages will probably increase milk fat percentage, but decrease milk yield. Corn silage, because of its green content (NFC), may increase milk protein percentage. Fine chopping or grinding of forages will change the digestion pattern of forages in the rumen to look more like grain, thus lowering milk fat percentage, but possibly increasing milk and milk protein yield.
 - 4) *Rumen-degradable protein.* Generally, for every 1% decrease in crude protein in the ration from 17 to 9%, there is a 0.02% unit decrease in milk protein percentage. Thus, feeding a 13% protein ration instead of an 18% ration will decrease milk protein percentage by 0.1%. Shortening protein in the ration will have a much greater effect on milk yield than milk components. Rumen-degradable protein should be about 65% of the total or crude protein in the ration. Feeding rumen-degradable protein at less than 60% of the total protein in the ration will decrease rumen fermentation of feeds, reducing the fermentation and products needed for milk yield and milk component production. Rations must have adequate readable protein from sources such as soybean meal, alfalfa, and urea to support good rumen fermentation.
 - 5) *Bypass protein and/or rumen-protected amino acids.* The amino acids methionine and lysine have been shown to increase milk protein percentage. Rumen-protected methionine and lysine research studies indicate that as much as a 0.2% unit increase in milk protein percentage, but little or no change in milk production. Feeding a high-quality bypass protein supplement or rumen-protected amino acids may increase milk protein yield. However, the cost benefit of feeding these higher-priced protein sources must be considered. An increase in the bulk tank milk protein percentage and/or milk shipped should occur within two weeks of changing protein feeding to increase lysine and/or methionine. The percentage of fat and other solids and milk generally doesn't change when both rumen-protected lysine and methionine are fed. Feeding protected methionine alone has been shown in some studies to increase milk fat percentage, especially in early lactation. In a review of 60 studies looking at substituting soybean meal with rumen undegradable protein, neither milk yield nor milk protein percentage were consistently improved. Milk yield increased in only 19% of the studies (16 out of 84) and milk protein percentage increased in only 6% of the studies (5 out of 81).
 - 6) *Feed additives.* The use of rumen buffers to increase milk percentage and possibly milk production when low-fiber, high-green rations are fed is well substantiated. Sodium bicarbonate, with or without magnesium oxide should be fed when cows are consuming more than 30 pounds of wet corn silage, finely ground grain sources, or high levels of rumen-fermentable fiber from byproduct feeds. This type of high-carbohydrate, highly fermentable ration is favored under the component pricing system. Feeding buffers will not only help milk

fat percentage with these rations, they will also help maintain a healthy rumen environment. Rations in which all of the forage comes from alfalfa generally provide enough buffering action in the rumen and do not benefit from the addition of buffers. Niacin is another feed additive receiving attention with component pricing. Some studies have shown that niacin alleviates the milk protein percentage decrease with fat feeding. However, some studies also show a slight decline in milk production and milk fat percentage with niacin feeding. Niacin is beneficial in helping prevent ketosis in early lactation, especially with over-conditioned cows. Feeding niacin to thin cows with a body condition score of less than 3 (on a 5-point scale) at freshening has been shown to reduce milk production and is not recommended. Evaluate the herd's body condition scores and ketosis problems before feeding niacin to potentially increase milk protein percentage.

Milk Fat Depression

Diet-induced milk fat depression has perplexed dairy producers and scientists for over a century. Following the recognition that the basis involved an interaction between microbial fermentation in the rumen and post-absorptive effects on tissue metabolism, many theories were proposed. A portion was based on the concept that the reduction in milk fat synthesis was due to a shortage in the supply of lipogenic precursors, but research over the last decade has offered little support for these theories. The demonstration that all types of diet-induced milk fat depression resulted in alterations in rumen biohydrogenation and the identification of trans-10, cis-12 CLA as a potent inhibitor of milk fat synthesis were particularly important developments. These result in the "biohydrogenation theory", which proposes that diet-induced MFD is the result of a direct inhibition of milk fat synthesis at the mammary gland by unique fatty acid intermediates formed during rumen biohydrogenation of PUFA. Trans-10, cis-12 CLA is the first such intermediate identified, but is apparent that others must be formed in the rumen under conditions of diet-induced MFD. Thus, further research is needed to identify additional inhibitors of fat synthesis that are produced during rumen biohydrogenation and delineate their cellular mechanisms; we anticipate this will have a broader application in understanding the regulation of lipid metabolism.

In general, no single dietary factor is responsible for MFD, and highlighted throughout this chapter are the interactions between various dietary components that can increase the rumen outflow of BH intermediates associated with MFD. Dietary components can increase the risk of MFD by increasing substrate supply, altering rumen BH pathways, and altering rates of BH. With the latter, it is important to consider factors that alter rates of BH (i.e., altered ruminal BH pathways) to accentuate the effects on milk fat.

MONITORING

Instead of monitoring the individual cows, the herd suffering from protein-fat inversion or early lactation subclinical ketosis need to be monitored on a weekly basis. The fatty acid analysis of milk is a good diagnostic tool to identify fat depression. Monitoring energy intake, % of soluble and non-soluble proteins along with the energy supply will help to resolve the protein-fat inversion.

The herds on monthly DHIA testing can monitor monthly milk components if the herd is not on DHIA. The only way to monitor is having electronic monitoring or sending monthly samples for the analysis.

PREVENTION

It is important to note that a protein-fat inversion can be corrected easily; however, it can be prevented by observing nutritional formulation, mixing and fiber length and intakes. Dairies should ideally use a feed monitoring system (i.e., Feed Watch or EZ Feed®) for calculating and correcting the intakes on a continual basis. Feeders must be appropriately trained to understand the importance of feed mixing, delivery, timeliness, cleanliness, etc.



MISCELLANEOUS

PRODUCTION MANAGEMENT

- It is important for the herd veterinarian to know that the nutrition and feeding is the biggest cost on the dairy and therefore be actively involved in this aspect of the herd.
- Generally, the herd nutritionist is not a veterinarian and therefore knows how to formulate the ration but must work together with the veterinarian on issues of cow health and their interface.
- It is important to monitor blood metabolites (BHBA, NEFA, calcium) around the transition period as well as milk components monthly.
- It is essential that the dairy manager, veterinarian and nutritionist have routine meetings to discuss cow health and herd management.
- As dairy practice is changing constantly, dairy veterinarians need to get acquainted with these issues.

SEE ALSO

- Dairy Nutrition: Ration Guidelines for Milking and Dry Cows (www.fiveminutevet.com/ruminant)
- Fatty Liver
- Ketosis: Dairy Cattle
- Low-Fat Milk Syndrome
- Milk cow Nutrition Monitoring (www.fiveminutevet.com/ruminant)
- Nutrition and Metabolic Diseases: Dairy

ABBREVIATIONS

- BHBA- betahydroxybutyric acid
- BUN- blood urea nitrogen
- CLA- conjugated linoleic acid
- DHIA- dairy herd improvement association
- MFD- milk fat depression
- NEFA- non-esterified fatty acids
- PUFA- polyunsaturated fatty acid

Suggested Reading

AABP Seminar 22. Understanding Milk Components and Trouble Shooting Herd Problems (2009)

Bailey, K. E., C. M. Jones, and A. J. Heinrichs. 2005. Economic returns to Holstein and Jersey herds under multiple component pricing. J. Dairy Sci. 88:2269-2280

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