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Balancing protein nutrition for high-yielding dairy cows

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This issue examines why protein nutrition has moved beyond crude protein percentages and argues that profitable dairy production depends on maximizing metabolizable protein and amino acid supply rather than simply feeding more protein.

Modern dairy cows produce far more milk than those of only a few decades ago. A cow producing 50 kg of milk per day exports approximately 1.6 kg of true milk protein daily, requiring a continuous supply of absorbable amino acids. Yet, despite these greater demands, feeding more crude protein is no longer considered the best solution. High-protein diets are expensive, reduce nitrogen-use efficiency, increase nitrogen excretion, and often provide little additional milk production. Today, protein nutrition is less about feeding protein and more about feeding protein efficiently.

Crude protein is the starting point

Crude protein simply estimates nitrogen content by multiplying total nitrogen by 6.25. Two feeds may each contain 20% crude protein while supplying very different amounts of digestible amino acids. Likewise, increasing dietary crude protein from 16% to 18% rarely produces proportional increases in milk yield if amino acid requirements have already been met. Instead, excess nitrogen is converted to urea, requiring energy for detoxification before being excreted in urine. In practice, many high-producing Holstein diets contain 16.0 to 17% crude protein on a dry matter basis, depending on milk yield, forage quality, stage of lactation, and feed prices.

The rumen is the main protein factory

Dairy cows obtain much of their absorbable protein from rumen microbes rather than directly from dietary ingredients. These microorganisms use rumen-degradable protein (RDP) together with fermentable carbohydrates to synthesize microbial protein, which later passes into the small intestine where it is digested by the cow. Under well-balanced feeding conditions, microbial protein supplies approximately 55 to 65% of the metabolizable protein reaching the cow. Modern high-producing rations commonly contain 9 to 11% RDP and 5.5 to 7.0% rumen-undegradable protein (RUP) on a dry matter basis.

Metabolizable protein feeds the cow

The cow produces milk from metabolizable protein, which consists primarily of microbial protein plus digestible dietary protein that escapes rumen degradation. Modern feeding systems formulate diets around metabolizable protein rather than crude protein alone. A cow producing 45 to 50 kg of milk per day may require approximately 2.7 to 3.2 kg of metabolizable protein daily, depending on body weight, milk composition, stage of lactation, and pregnancy status.

Amino acids vs protein percentage

Supplying sufficient metabolizable protein is only part of the challenge. The amino acid profile of that protein ultimately determines productive performance. Lysine and methionine are usually the first limiting amino acids. When one essential amino acid becomes limiting, the remaining amino acids cannot be utilized efficiently for milk protein synthesis regardless of their abundance. As practical formulation targets, metabolizable lysine often represents **6.6 to 7.2% of metabolizable protein**, whereas metabolizable methionine commonly represents **2.2 to 2.4%**, producing a lysine-to-methionine ratio close to **3:1**. These values are guides rather than universal rules.

Protein efficiency and profitability

Protein is usually among the most expensive components of a dairy ration, making efficient utilization economically important. Milk nitrogen efficiency typically ranges from **25 to 35%**, meaning that most dietary nitrogen never reaches the milk tank. Instead, it is excreted through urine and manure, increasing feed costs and environmental losses. Milk urea nitrogen (MUN) provides another useful monitoring tool. Values around **10 to 14 mg/dL** indicate satisfactory protein utilization, whereas higher values may suggest excessive dietary nitrogen or poor synchronization between energy and protein fermentation.

Precision dairy nutrition

Protein nutrition continues to evolve from fixed recommendations toward dynamic management. Modern nutritional models incorporate metabolizable protein supply, amino acid balance, forage digestibility, stage of lactation, milk production, and environmental conditions when predicting protein and amino acid requirements. At the farm level, nutritionists increasingly evaluate milk urea nitrogen, milk components, feed efficiency, and production response to determine whether protein is being used effectively.

In brief,

Modern dairy protein nutrition is no longer defined by crude protein percentage alone. High-producing cows depend on efficient rumen fermentation, abundant microbial protein synthesis, adequate metabolizable protein supply, and balanced amino acid nutrition. Feeding more protein rarely improves profitability once requirements have been met. Instead, the objective is to convert a greater proportion of dietary nitrogen into milk protein while reducing unnecessary feed costs and nitrogen losses. In modern dairy systems, the best protein program is not the one that feeds the most protein—it is the one that uses protein most efficiently.

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