Dairy Technical Bulletin

Interaction Between Energy and Protein and the Impact on Milk Yield Components

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Definitions for key words:

Metabolizable energy (ME) – The energy available for milk production and microbial growth in the rumen. ME comes from the digestion of carbohydrates and fats but not from NPN or minerals.

Metabolizable protein (MP) – The protein (amino acids, peptides, true protein and NPN) available for microbial growth in the rumen and milk production. MP comes from the digestion of proteins and utilization of NPN for the synthesis of microbial protein.

Details of the scientific studies cited in this analysis.

Source Papers: Study 1: J. Dairy Science. 2012. 95:6171-6183; Study 2: J. Dairy Science. 2010. 93:4128 – 4143

Study 1: Involved 3, 554 cows and data was collected for 3 years. This group of cows served as the treatment group. This was a massive study with data collected from 27 farms. **Key point** from the study is that three nutrients, starch, NDF and crude protein (CP) interact to determine peak milk yield, and milk component yield. The impact of CP and NDF is influenced by starch content of the diet.

Study 2: Involved 24 mature cows and 24 1st lactation cows in mid-lactation. Cows were assigned to treatment groups based on parity and milk yield. The experiment was designed to measure milk yield and milk components as the energy and protein content of the diet were altered. **Key point** from the study is that the impact of energy supply on milk yield is greatest when the metabolizable protein supply exceeds the animal's requirement. If the metabolizable protein needs of the cow are not met, it will limit the response to energy and reduce milk and milk component yields.

How Does the Starch Content of the Diet Impact Milk Yield?

Study 1: Increasing the starch content of the diet had twice the influence on milk volume compared with increasing crude protein. Starch is an indirect measure of the fermentable carbohydrate content of the diet. So, increasing the fermentable carbohydrate content of the diet had twice the influence on milk volume compared with crude protein.

Study 2: Milk yield increased more rapidly with the increase in energy supply when the metabolizable protein (MP) supply exceeded the animal's requirement. High energy diets required more metabolizable protein (MP) for maximum production. The milk response to increased MP in the diet was 3.5 pounds of milk. **Application for QLF**: Feeding QLF liquid feeds at 3 – 6 pounds, increases the fermentable carbohydrate content of the diet. Diets with a positive ME balance require a positive MP balance to optimize milk and milk component yields. In diets formulated with QLF liquid feeds the MP balance must be positive for optimum response to additional ME.

Does the metabolizable protein content of the diet influence peak milk yield?

Study 1. For the optimal production response to CP, the starch must be high and NDF low in the diet. In this study, high starch was 27.7% of diet DM and low NDF was 31%. This illustrates the concept that cows make milk from rumen fermentable carbohydrates. Diets that met or exceeded the animals' requirement for metabolizable protein (MP) produced less milk when the metabolizable energy (ME) requirement was not met. Peak milk was maximized when the diet contained 19% CP and 27.7% starch compared to a diet containing 15.5% CP. One take home message is that low crude protein diets in the first 115 DIM reduce the yield of milk, milk fat and milk protein.

Study 2. Response to the metabolizable protein (MP) content of the diet was influenced by the metabolizable energy (ME) content of the diet. Increasing the MP content of the diet had little impact on milk or milk protein yield when the ME balance of the diet was negative or zero. To maximize the yield of milk fat, both ME and MP had to exceed the animals requirement. One take home message from this study is that you must formulate diets that have a positive ME and MP balance if you want to maximize milk and milk component yields. **Application for QLF:** To optimize the response to QLF liquid supplements, it is necessary that dairy diets be formulated to a positive energy and protein balance. During the first 115 DIM, the protein content of the diet can limit response to QLF supplements if it is too low. These studies suggest that a two group system for feeding cows, higher protein and energy for fresh cows and high cows and lower protein for mid-lactation cows will optimize milk and milk component yields.

What is the practical implication and economic outcome?

Feeding a higher crude protein diet to fresh cows and high group cows will generate $186 more income per cow for a 305 day lactation (Table 1.) Feeding a higher starch diet to early lactation cows (Table 2.) will generate $353 more income per cow for a 305 d lactation. **Application for QLF**: Response to QLF liquid supplements can be reduced if early lactation cows are not fed enough starch and protein. To maximize peak milk yield, the diet should contain 5.5 – 7% sugar and 27% starch. After early lactation the starch and protein content of the diet should be reduced.

Table 1. Change in Peak Milk Yield (lb/d) as Diet Protein Content was Changed

Crude Protein Content of Diet	Change in Peak Milk Yield (lb/d)	Estimated Change in 305 d Lactation Milk Yield, lbs./cow	Value ($) of Extra Milk per Cow at $19/Cwt Milk Price
11.6	0	0	0
15.5	2.2	440	$83.60
19.4	4.9	980	$186

Diets contained 27.7% starch and 31% NDF. Peak Milk Yield Change of 1 Pound = 200 Pounds of Milk

Table 2. Impact of Dietary Starch Percent on Peak Milk Yield (lb/d) as Protein Content Changed

Dietary Starch %	Dietary Protein %	Change in Peak Milk Yield (lb./d)	Estimated Change in 305 d Lactation Milk Yield, lb/cow	Value ($) of Extra Milk per Cow at $19/Cwt Milk Price
12.8	15.5	0	0	0
20.3	15.5	2.73	546	$103.74
27.7	15.5	5.66	1132	$215
12.8	19.4	0	0	0
20.3	19.4	4.5	900	$171
27.7	19.4	9.3	1860	$353.40

Peak Milk Yield Change of 1 Pound = 200 Pounds of Milk

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