Low Starch Diets for Lactating Dairy Cattle

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Higher corn prices over the past 2 years have sparked interest in lower starch rations (<20% of DM) that minimize the amount of supplemental corn grain. Dairy cattle have no starch requirement, and other carbohydrates can be fermented in the rumen and contribute to microbial protein production. Starch is most effective at promoting maximum microbial growth, whereas sucrose and pectin are slightly less effective, but still very acceptable energy sources. Neutral detergent fiber (NDF) is least effective, but high quality forages and non-forage fiber sources (NFFS) high in digestible NDF will support considerable microbial growth. A combination of rumen fermentable carbohydrates has the potential to result in microbial protein and milk production similar to a more conventional, higher starch diet.

Table 1. *Ingredient composition of low, medium and high starch diets fed to lactating Holstein cows.*

Ingredient %, DM Basis	Diet		
	17.7% Starch	21% Starch	24.6% Starch
Corn silage	30.2	30.2	30.4
Grass silage	18.5	18.5	18.6
Alfalfa hay, chopped	5.0	5.0	5.1
Corn meal	3.4	10.1	16.9
Soybean meal, 48% CP	7.1	7.9	8.4
Beet pulp	6.7	3.4	0
Wheat midds	13.4	10.1	6.8
Distillers grain w/solubles	9.7	8.7	7.8
Supplement	5.9	6.0	6.1

At Miner Institute, a study was recently conducted that evaluated the effect of 17.7, 21.0, or 24.6% dietary starch on performance of high-producing dairy cows. This range in starch content encompassed the practical range in dietary starch used routinely on most northeastern dairy farms. All diets contained similar amounts of corn silage, grass silage, and alfalfa hay (Table 1). As corn meal was removed from the diet, the amount of non-NFFS (beet pulp, wheat midds, distillers grains) was increased. The corn meal contained 68.6% starch with a relatively low 6-h digestibility of 57.3%. The grain mixes for each of the diets averaged ~12% starch with a high 6-h starch digestibility of 91%. Table 2 summarizes the nutrient composition of the 3 diets.

In the study, dietary starch content had no significant effect on feed intake, milk component production, solids-corrected milk yield, or efficiency of milk production (Table 3). Likewise, there was no effect of diet on chewing response or rumen fermentation. As a result of the similar ruminal conditions and DM intake, dietary starch content had no effect on microbial protein production.

To successfully feed a lower starch diet to high producing cows, availability of starch and its energy value to the cow needs to be understood. The three most important factors affecting starch availability in the rumen are particle size, moisture, and endosperm type. A key question is "can the effect of these factors on starch availability be measured and made use of during ration formulation?" Increasingly, nutritionists are tracking fecal starch (should be <5%) or corn silage processing scores to ensure starch is being efficiently used by the cow. These tools assume there is a reliable lab method for measuring starch content and digestibility, but really there is not. Last year, researchers at the U.S. Dairy Forage Research Center showed the important variation that can occur in starch analyses of corn silage and corn grain due to drying temperature and type of grinding mill. A cyclone mill (abrasion-type mill) resulted in higher starch values compared with a Wiley mill (cutting-type mill) for dry grain. Drying at 55ºC resulted in more precise values compared with 105ºC. Research like this will help forage labs adopt standardized methods for starch analysis that should make values more comparable among various labs.

Table 2. *Analyzed chemical composition of diets containing low, medium and high starch levels.*

Item	Diet		
	17.7% Starch	21% Starch	24.6% Starch
DM, %	48.2	48.7	48.2
Crude Protein (CP), % of DM	17.4	17.6	17.2
Soluble Protein, % of CP	39.7	40.9	43.0
NDF, % of DM	38.0	36.5	34.2
Starch, % of DM	17.7	21.0	24.6
In vitro starch digestbility, 6 h	82.5	77.3	73.6
Ethanol soluble carbohydrates (sugar), %	4.8	3.9	3.6
Ether extract, % of DM	4.6	4.6	4.3

For measuring starch fermentability in the rumen, there is currently no agreed upon method. In vitro systems incubate samples in flasks, tubes, or bags with rumen fluid and buffer; in situ methods involve incubating the sample in a bag directly in the rumen; enzymatic methods use amylase enzymes; and a new method proposes to measure zein protein that limits starch digestion in the rumen. The bottom line is that there is no standard method among labs.

What are the implications for nutritionists and dairy farmers who want to make use of starch analyses when feeding? Optimizing starch digestion and use of low-starch diets increase the need for accurate and precise starch analyses. Increasingly, there is a need to measure and adjust feeding management due to corn hybrid, field differences, harvest

date, processing, length of time in the silo, etc. Simply stated, nutritional and management needs are ahead of existing method development. But, low starch diets can be successfully fed to high producing cows with an understanding of starch fermentability.

What can be done rather than simply waiting for standardized methods to be developed for starch content/digestibility? Corn silage recommendations:

- Focus on DM, NDF, NDF digestibility, starch, and starch digestibility. Benchmark/track these over time to see if a specific value makes sense. This reduces potential for one bad value to throw off feeding program.
- Use one lab to avoid between-lab variability.
- Within-lab variability exists, track starch values and use common sense.

Table 3. *Performance data of lactating Holstein cows fed low, medium and high starch diets.*

	Diet			
	17.7% Starch	**21% Starch**	**24.6% Starch**	***P*-Value**
DMI, lb/d	58.2	59.3	58.0	0.51
DMI, % of BW/d	3.68	3.72	3.65	0.60
BW, lb	1583	1599	1592	0.27
BW Change, lb/21 d	13.2	24.2	15	0.66
Milk Yield				
Milk, lb/d	94.6	95.4	97.0	0.60
SCM, lb/d	88.9	89.9	90.9	0.73
Milk Composition				
Fat, %	3.57	3.57	3.48	0.45
True Protein, %	3.09	3.18	3.14	0.19
Efficiency, lb/lb				
Milk/DMI	1.64	1.62	1.68	0.32
SCM/DMI	1.53	1.52	1.57	0.41

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