TECHNICAL BULLETIN
DAIRY

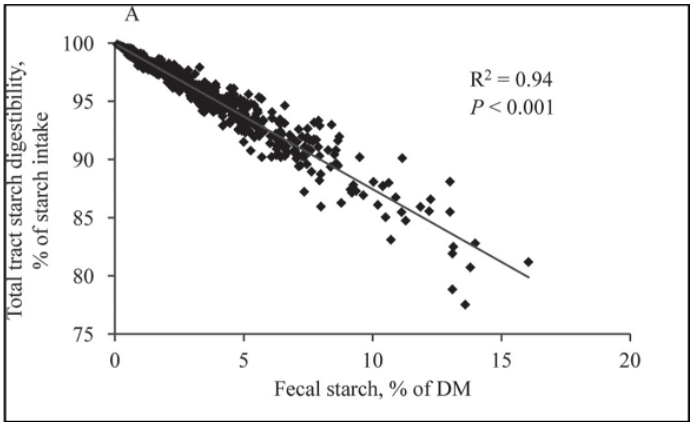
QLF QUALITY LIQUID FEEDS

HOW MUCH DOES UNDIGESTED STARCH COST?

Starch is one of the key components of dairy ration, oftentimes accounting for 25 to 30% of the daily dry matter intake. The digestibility and fermentability of starch play important roles in feed economics and dairy cow performance. This article will discuss costs of undigested starch and strategies to cope with undesirable starch digestibility.

Total-tract digestibility, fecal starch, and economics

Once consumed by the cow, starch will be digested in the rumen, small intestine, and hindgut. Total-tract starch digestibility (TTSD) estimates starch digested in both rumen and post-ruminal tracts. Optimizing ruminal starch digestion helps maximize VFA, nitrogen utilization, and microbial protein in the rumen to enhance milk and component production. Some starch will escape ruminal and post-ruminal degradation and end up in the manure, which can be quantified through fecal starch analyses. Research shows strong correlations between total-tract digestibility and fecal starch. A 5% fecal starch is roughly correlated with 95% total-tract digestibility, and 7% fecal starch is roughly correlated with 90% total-tract digestibility.



Fredin et al., JDS 97:1862-1871

Increased fecal starch % indicates reduced total tract starch utilization and lost production. For instance, every 1% increase in fecal starch over 3% may reduce milk yield by 0.7 lb/cow (Ferguson, 2003). At $16.50/cwt, this is a milk income loss of $0.11/cow/day per unit of fecal starch over 3%. While 3% may not be achievable in all settings due variations in growing season, harvest conditions, and feeding management, keeping a practical goal of 3-5% helps optimize milk production and reduce waste. Based on over 1000 fecal samples submitted to Dairyland Laboratories for the 2019 crop year, about 50% of samples were >3%, and about 30% of the samples showed > 5% fecal starch. Although the data do not represent entire farm demographics, there are certainly opportunities for some dairy farms to reduce fecal starch loss. University of Wisconsin interpretation guidelines for fecal starch analyses (Akins et al. 2019) are as follows:

<3% (>96% TTSD)	Good starch digestion. Continue periodic monitoring of fecal starch & starch sources.
>3% (<96% TTSD)	Opportunity to improve starch digestion. Evaluate corn grain particle size, corn silage kernel processing, moisture level & storage time of corn silage & high moisture corn.

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The high cost of undigested starch

How much does undigested starch cost? Let's use 87.5% total tract starch digestibility as an example to calculate the costs of undigested starch. For a typical cow with dry matter intake at 60 lb/d and dietary starch at 28% DM, the daily intake of starch is 60 x 28% = 16.8 lb/d

- Corn grain has 70% starch, if a cow has 87.5% total tract starch digestibility, then for 1 lb of DM corn, the digested starch is: 1 lb DM corn x 70% starch x 87.5% digestibility = 0.61 lb of digestible starch
- Also, daily loss of starch is 16.8 lb/d x (100 - 87.5)% = 2.1 lb/d starch

We can then calculate that corn loss per day is: 2.1 lb/d divided by 0.61 = 3.44 lb of DM corn

- If corn has a dry matter of 88%, then 3.44 lbs of DM corn is equivalent to: 3.44 divided by 88% = 3.9 lb of as-fed corn
- If corn grain price is $170/ton (or $0.085/lb), then 3.9 lbs of corn is worth $0.33 loss per cow per day.
- For a 1000-cow herd, that is $120,450 per year.

Similarly, we can calculate that for 93.75% total tract starch digestibility, the costs of undigested starch is around $0.15 per cow/d, or $54,750 per year for a 1000-cow herd. The calculation is summarized in Table 1.

Table 1: Costs of undigested starch

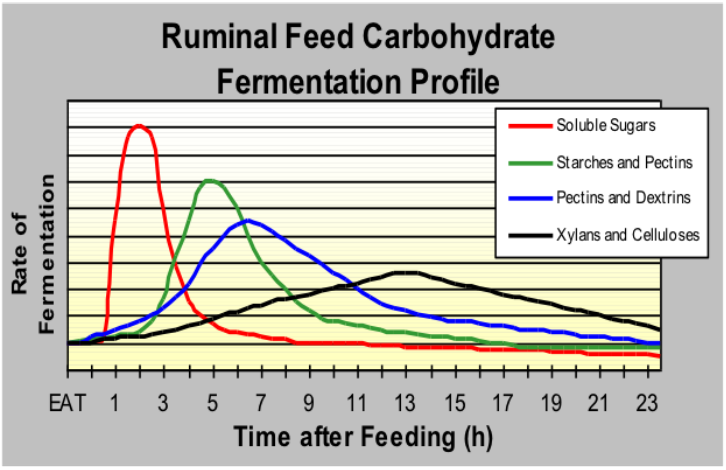
Dry matter intake, lb/d	60	60
Starch intake at 28% starch, lb/d	16.8	16.8
Total tract starch digestibility, %	87.5	93.75
Starch loss, lb/d	2.1	1.05
Corn loss as-fed, lb/d	3.9	1.81
Corn loss at $170/ton, $/d	0.33	0.15
Annual loss for a 1000-cow herd	$120,450	$54,750

Calculation adapted from Dr. Luiz Ferraretto 2019 Penn State Nutrition Conference presentation

How to cope with undigested starch

A key to a successful nutrition program is to have high quality feed ingredients available, such as highly digestible corn silage. Among other factors, one of the most important starch digestibility indicators is corn silage kernel processing score, which estimates percent of starch passing through 4.75 mm sieve. Corn silage with over 70% of the starch passing through the sieve is considered as optimally processed. Excellent kernel processing is critical to maximize the potential of starch digestion. On the other hand, feeding over-processed corn or corn silage, or too much "hot" high-moisture corn can easily depress milk fat and result in acidosis.

If a farm is facing the issue of undigested starch, consider using alternative carbohydrate sources such as sugar (QLF molasses-based products) or soluble fiber (soy hulls) to replace some starch. Sugar and soluble fiber are highly digestible and are more rumen friendly compared with starch. Sugars are digested and used by the rumen microbes very rapidly and can help to provide the energy needed at the right time in relation to the fermentation of other carbohydrates in the ration, as shown in the chart at left. Sugars help the rumen microbes capture and use nitrogen sources in the diet, especially rapidly digestible nitrogen sources such as the soluble protein. Recent research recommended feeding rations containing around 7% sugar for maximal milk component yields. Fiber digestion, microbial protein synthesis, and energy absorption from the rumen can increase with additional dietary sugars.



Adapted from Johnson, R.R., 1976

In short, using QLF to partially replace starch, especially when starch digestibility has concerns, can reduce wasted costs of undigested starch and enhance profitability though improved milk performance.