Understand Fiber Digestibility in the Entire Ration Context

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Cows were designed to use forages. Forage is the base dairy rations build on to have productive, healthy, efficient, profitable herd performance. Forage composition, digestibility, and physical form set limits on how well cows can perform. It dictates how much forage you can include, and how many other feedstuffs need to be supplemented.

But, "quality" is not something that exists by itself; it has to be judged in the context of the ration in which it is included and how well it supports animal performance. Here, our focus is on how we measure and consider digestibility, and how the various aspects of quality affect how we need to work with forages in dairy rations.

Fiber Digestibility

Fiber digestibility gives us a way to estimate the potential for fiber to be converted into nutrients the cow can use. The value we use, Neutral Detergent Fiber (NDF) Digestibility (NDFD), is determined in the laboratory by fermenting a ground feed sample with rumen microbes and measuring how much NDF remains after a certain number of hours of fermentation.

Fiber digestibility is useful for comparing relative energy values of forages, but it is not a very precise number. All feed analysis methods have some variability, so you do not get precisely the same number with each analysis. The NDFD assay combines multiple steps making the assay more variable than chemical analyses like crude protein. If NDFD values are closer than 5% NDFD, they may not really be different. For best consistency, stick with one lab for NDFD; and pay attention to how feeds rank or change relative to one another as that can reflect differences in energy content.

Starch Digestibility

Nonfiber carbohydrates are estimated to be 98% digestible (NRC, 2001). That may be largely true of the water-soluble carbohydrates (sugars, oligosaccharides, fructans), but not necessarily for starch. How finely ground, fermented, or dry a feed is, or how bound the starch is in a protein matrix, will affect starch digestion. Present starch digestibility assays include a seven-hour in vitro fermentation of coarsely ground samples.

Cows perform well when rations are digestible enough to provide needed nutrients, there is enough effective fiber to maintain rumen function and protect against ruminal acidosis, and there are some indigestible fractions to pass and carry liquid and solids from the rumen for digestion further down the tract. We also need to provide forage within limitations set by physical fill (undigested bulk taking rumen space) to avoid limiting intake but providing enough fiber to maintain rumen function and animal health.

Fiber and Starch

The amount of forage or fiber needed to maintain good productivity in herds also varies with the type of nonfiber carbohydrates fed. The relationship between starch and forage shows, as NDF from forage increases, more starch can be safely included in the ration. If conditions are such that animals consume large meals of grain, sort their feed for grain, slug feed, suffer from heat stress, consume starch sources with very rapid rates of fermentation (high moisture shell corn, finely ground barley or wheat), it might be a good idea to include more NDF and less nonfiber carbohydrates as a matter of "risk management" to prevent digestive problems.

The recommended amount of forage NDF is a proxy for making sure cows get sufficient physically effective fiber to maintain rumen function and rumination. However, fiber digestibility can affect the amount of effective fiber needed. If fiber is fermented rapidly and extensively, it will reduce in size more quickly, pass from the rumen, and not enhance rumination. Conversely, if forage fiber is very slowly fermented, it can stay in the rumen longer to enhance rumination (think "chopped straw"). On top of this, the physical form of the fiber (chopped corn silage vs. alfalfa silage vs. grass forage vs. wheat straw) alters how effective fiber is at increasing rumination (straw and grass more than alfalfa and corn silage).

The more slowly fermenting, bulky material can limit intake through rumen fill. We've known for years undigested fiber can fill the rumen and reduce dry matter intake. Now work is underway to evaluate how well intake can be predicted based on undigested NDF (uNDF). There is agreement that even with uNDF, the fineness of the forage chop will affect how it relates to intake – finer material will pass more quickly and have less impact on fill. However, feeding too much of a slowly fermented forage fiber source with a low extent of digestion will limit intake.

So, how does this translate into getting cows enough effective fiber to keep rumens working well and maintain desired intakes? A forage fiber that ferments rapidly and extensively may not induce as much rumination, so you need to feed more of it to provide enough effective fiber to support rumen function, or supplement an adequately sized, slowly fermenting fiber. If you feed forage fiber that ferments slowly and less extensively (think "straw"), there could be issues with the fiber filling the rumen and reducing intake, and you would need to feed less to meet effective fiber needs.

Presently, there is no absolute way to know in advance whether the combinations of forage NDF, particle size, and digestibility will allow for excessive, adequate, or insufficient effective fiber. You still will need to go look at the cows. Sufficient effective fiber will have at least 50% of the cows ruminating if they are not sleeping, eating, drinking, or in heat. Only ~5% of the cows may have manure that does not look normal (assuming no disease issues and no sorting of feed), and typically there will be limited amounts of loose manure or long fiber (>2 cm long) in the manure.