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IN THIS ISSUE:

Advancements in Fine-Tuning Fiber
Consultant's Corner: Highly Digestible Fiber also can be Highly Valuable
From the Maternity Pen: Numerous Factors Contribute to Transition-cow Health
Beyond Bypass: Feeding Low-starch Diets: Insights
Quality Corner: Bypass Protein Sources for Low Starch Diets
Happenings: SoyPLUS and SoyChlor Production Facilities Receive HAACP Certification

Advancements in Fine-Tuning Fiber

Fiber is the “wildcard” of dairy rations, creating unique challenges with every go-around. As the slowest portion of the ration to be digested, it also is the most highly variable. When high-energy, low-fiber rations are fed, cows will regulate intake to meet their energy demands for production. When low-energy, high-fiber rations are fed, fill capacity becomes the intake-limitation factor. But is there a way to increase fiber (and thereby theoretically decrease ration cost) without sacrificing energy intake?

Rick Grant, PhD, president of the W.H. Miner Institute near Chazy, N.Y., has studied the intricacies of fiber extensively. He says the knowledge base of subtle characteristics of fiber that can change consumption and cow performance is growing.

“Historically, our nutrition models have treated fiber as a single factor, with differentiation only between digestible and non-digestible portions,” explains Grant. “Likewise, physical assessment of forages to date has mostly been limited to particle size measurement.” But that is changing.

One advancement has been the incorporation into nutrition models of physically effective neutral detergent fiber (peNDF), which is the fraction of NDF that stimulates chewing and contributes to the ruminal digesta mat. It is calculated by measuring both forage or feed particle size and NDF content, with the objective of accurately predicting chewing response. Additionally, Grant and his colleagues are examining fragility — measured as the rate of particle size reduction of feed when ball milled — as an additional factor in predicting fiber passage rate and digestibility. “We know that different NDF sources of similar particle size can elicit variable chewing responses,” says Grant. “Thus, fragility may be the variable factor that explains these differences.”

Because peNDF initially could be evaluated only in a laboratory setting via a dry-sieving method, researchers at the Miner Institute developed the “Z-Box” forage evaluation system. The Z-Box allows nutritionists to perform on-farm assessments of peNDF of forages and total mixed rations (TMR). They currently are modifying the Z-Box method to evaluate dry forages

and TMRs based mostly on dry forages. Additionally, they are adjusting the Z-Box sieves to measure forage and TMR particle distributions similar to the Penn State Particle Separator. They also are researching the merits of inserting a larger screen in place of the 1.18-mm screen of the Penn State system to more accurately assess forage physical effectiveness factors (pef).

Even with improved on-farm evaluation tools, Grant believes more information is needed to fully maximize fiber potential, and that's where fragility comes in. Fragility is defined as the relative rate at which forage is reduced in particle size during chewing or a laboratory simulation of chewing action. It may be related to lignin content and digestibility, as well as anatomical differences in plant species such as cell wall thickness. "Consequently, digestibility of the forage cell wall may be predictive of forage fragility," says Grant.

A team of Miner Institute researchers recently completed a study evaluating the relationship between fragility and digestible NDF (NDFD) in four lots of grass hay. They found that fragility ranged from 30 to 80%, and NDFD varied from 31 to 55%, with commensurate differences in chewing response. For example, high NDFD, high fragility sources stimulated less chewing per unit of NDF at a particle size similar to other forages. "In this case, one would need to feed more forage, formulate for higher peNDF, or supplement with a lower NDFD (and likely lower fragility) forage," advises Grant. Figure 1 shows the relationship between NDFD and fragility, based on results of the Miner study.

Charlie Sniffen, PhD, former Miner Institute president and researcher and now a consulting nutritionist with Fencrest Consulting LLC, Holderness, N.H., says he sees tremendous merit in incorporating pef values like fragility into popular nutrition models like the Cornell Net Carbohydrate Protein System (CNCPS). "Adding more definition to the fiber portion of the ration will allow us more flexibility with feed ingredients, based on costs and availability."

Grant believes NDFD still needs to be a primary consideration in ration formulation, and recommends its routine measurement, because of the known relationship between NDFD and forage energy content. Furthermore, his work has shown a stronger relationship between NDFD and chewing time compared to fragility and chewing time. "As forage NDFD increases, we would expect less chewing to be elicited per kilogram of NDF," he says. However, the apparent relationship between NDFD and fragility could provide an additional layer of precision in helping nutritionists maximize forage potential.

Figure1. Relationship of the 24-hour in-vitro NDF digestibility (NDFd24) of various forages with the fragility of the forages as measured by change in physical effectiveness factor following ball milling.

CONSULTANT'S CORNER

Highly Digestible Fiber also can be Highly Valuable

By Charlie Sniffen, PhD, Nutrition Consultant, Fencrest LLC, Holderness, N.H.

Advances in our ability to assess the unique characteristics of fiber fractions have created new opportunities to utilize fiber as an affordable energy source. I like to define the digestible portion in two categories — "slow" and "fast" digestible fiber, with fast fiber being the more fragile, rapidly digestible portion. We have found that fast fiber can replace a significant portion of higher-priced starch in the ration (typically corn) without sacrificing health or milk production. However, the content and quality of this fiber source is highly variable. Factors to consider when seeking fast fiber are:

- **Plant varieties and hybrids** — Brown midrib (BMR) corn is low-lignin and high in fast fiber. So high, in fact, that it can pass too rapidly through the rumen, upsetting rumen microbes and disturbing rumen mat formation. This is fairly easily remedied by adding 2 to 3 pounds of straw to the ration or using some higher fiber grass. Alfalfa also contains a large amount of fast fiber, and straight alfalfa also may require a rumen-stabilizing balancer like grass or straw. Fiber digestibility can vary greatly among hybrids, and may not be consistent among the same hybrids from year to year, especially in conventional hybrids.

- **Growing conditions** — Drought negatively affects yield, but on the upside, it typically increases fiber digestibility, because drought-stressed plants are less capable of producing lignin. Wet years — and heavily irrigated crops — tend to produce plants with undesirably high proportions of lignin and slow digestible fiber.

- **Plant maturity** — Of greatest concern on the haycrop side, plant maturity is most sensitive in grasses. Over-maturity causes overall NDF — and the percentage of lignin and slow digestible fiber — o go up. Alfalfa is more forgiving, and the higher the percentage of alfalfa in mixed haycrops, the more flexibility there is in plant maturity at harvest.

- **Storage conditions** — The silage that goes into the bunker or bag in the fall is not the same product that comes out in the spring. At harvest time, 30 to 35% dry matter for BMR corn is common, but the starch availability in it is low. Ideally, this can be managed by keeping an inventory of four to five months' worth of silage on hand to allow for complete fermentation. The alternative is feeding more fermentable carbohydrates in the fall. There are expenses to both propositions.

Correctly packing, sealing and collecting silage also are so critically important. It is possible to take a near-perfect crop and virtually destroy it with poor packing and sealing methods. Likewise, collecting with facers — as is widely performed in Europe — is highly preferable to scooping from the silage face with a payloader. Facers create minimum air exposure to the silage supply, and do not compromise silage stability.

FROM THE MATERNITY PEN

Numerous Factors Contribute to Transition-cow

Health

It has been well-documented that health disorders in transition cows are highly correlated. Infectious fresh-cow diseases — mainly mastitis and metritis — frequently precede or follow metabolic disorders such as ketosis, milk fever, and displaced abomasum.

Mathew Waldron, PhD, researcher in the Division of Animal Sciences at the University of Missouri, Columbia, Mo., has studied the cause and effect of immune system changes that potentially contribute to this disease cascade. Among his findings:

- Glucocorticoids (cortisol), which are known endocrine immunosuppressants, are elevated around the time of calving, and are believed to contribute to immunosuppression in early lactation. Changes in estradiol and progesterone just prior to calving also may be contributing factors.
- Rapid energy metabolism in the post-fresh period results in low concentrations of glucose and high concentrations of ketone bodies and nonesterified fatty acids (NEFA), significantly impairing immune function.
- High levels of circulating NEFA and calcium metabolism also may contribute to early lactation immunosuppression.
- Oxidative stress is a common denominator between active metabolism and inflammation. Unstable oxidizing molecules react with tissue lipids, proteins and DNA. If adequate levels of antioxidants are not present to counter the effects of this stress, extensive and permanent tissue damage can result.

Waldron concludes that, while energy balance appears to not be a key culprit in transition-cow health challenges, other nutritional factors play a critical role. “Many micronutrients serve to protect tissue as antioxidants,” he says. “Limiting environmental stress, coupled with careful nutritional management to provide highly bioavailable nutritional profiles and promote metabolic health, currently are our best strategies to maximize immune function and prevent transition-cow diseases.”

BEYOND BYPASS

Feeding Low-starch Diets: Insights

High corn costs are compelling many nutritionists and their clients to search for lower-cost ration options that will not sacrifice cow health and milk production. Heather Dann, PhD, researcher at the Miner Institute near Chazy, N.Y., says common recommendations for dietary starch on a DM basis range from about 23 to 30 percent. But surveys of high-producing dairy herds (>27,940 pounds of milk per cow per year), reveal that some of these herds feed starch levels as low as 15 percent, indicating that successful low-starch feeding is possible.

Dann shares these strategies for lowering starch content:

- Use non-forage fiber sources (NFFS) such as wheat middlings, dried brewer’s grain, beet pulp and soy hulls to replace some of the starch in the ration. Dann says these feedstuffs are excellent sources of highly digestible NDF, and cites several studies in which such substitutions had little to no significant effect on milk yield.
- Replace corn starch with sugar sources in high-forage diets containing alfalfa and/or corn silage. Options include dried molasses and sucrose, which have been shown to maintain milk yield and increase dry-matter intake (DMI).

- Replace corn with high-quality forages. While this strategy has been shown to decrease DMI and milk yield, Dann says it may still be profitable to rely more heavily on forages if net income-over-feed-costs improves. She advises against reducing the dietary starch content to less than 20.7 percent when substituting alfalfa silage for corn starch.

Dann says most research on low-starch diets has been performed on mid-lactation cows that already were off to a healthy start. If a whole-herd, low-starch strategy is employed, she advises working with a nutritionist to watch for signs that starch levels are too low. Those signs include decreased milk production; decreased milk protein content; weight loss and decreased body condition; increased milk urea nitrogen (MUN); and stiffer manure. Ration ingredients also should regularly be monitored for changes in NDF and starch digestibility.

QUALITY CORNER

Bypass Protein Sources for Low Starch Diets

In addition to the many important points emphasized by Dr. Heather Dann in her “Beyond Bypass” article, two additional nutrition variables should be considered when attempting to feed low starch diets to lactating dairy cows. One of these variables is the non-starch carbohydrate contained in some plant protein sources, and the other is the importance of protein quality in supplemental bypass protein sources.

As fermentable starch in the diet is reduced, there is potential for reduced microbial protein yield. Dann addresses this by recommending the feeding of more fermentable fiber and sugars. Plant protein sources such as SoyPLUS® can supply significant amounts of each of these. Much of the fiber in SoyPLUS® is from the soybean hull, which Dann mentions as an ideal source of fermentable fiber. SoyPLUS® also contains over 12 percent sugar, which will also contribute to the non-starch fermentable carbohydrate supply. The combination of these two carbohydrate sources will help boost the supply of metabolizable protein (MP) from rumen microbial synthesis.

When you consider that microbial MP is some of the highest quality MP available to the cow, the quality of bypass protein sources becomes more important as microbial MP supply declines. This is another area where SoyPLUS®steps up to the plate. The consistency of crude protein and bypass protein content, coupled with a desirable content of digestible amino acids in that bypass protein, make SoyPLUS® a natural fit in low starch diets. We should always consider the contributions of all nutrients in the feed ingredients that we use, so don’t forget to examine your bypass protein sources for their contribution of non-starch fermentable carbohydrates.

HAPPENINGS

SoyPLUS and SoyChlor Production Facilities Receive HAACP Certification

Earlier this year, West Central received HAACP certification of its SoyPLUS and SoyChlor production processes. The HAACP certification compliments the ISO certification each of these processes received earlier in 2009.

Hazard Analysis and Critical Control Points (HACCP) is a systematic preventative approach to food safety that addresses physical, chemical, and biological hazards as a means of prevention rather than finished product inspection. Food safety concerns and government and industry regulations of the food chain are getting more and more attention. The idea of being able to look at the entire food chain from start to finish starts in the farm field and has ripple effects throughout agriculture. West Central intends to stay on the leading edge of this trend, and is preparing now for future regulations.

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