Research Focus

By Sarah Williams and Thomas Overton

Starch and fiber in fresh cow rations

The fresh period of lactation is incredibly important as the cow must overcome the inevitable negative energy balance of this period, while remaining healthy and productive, to have a successful lactation. One strategy to help cows achieve a more positive energy balance earlier in this fresh period is to increase the energy density of the diet (i.e. increased starch), to provide more glucose precursors to the cow. Although some data supports that higher starch diets help increase energy balance, decrease body tissue mobilization, and increase intake, other data suggests that higher starch fresh diets can be detrimental to cows in the fresh period, resulting in decreased intake and higher levels of body tissue mobilization.

Keeping energy density and rumen health in mind is key to a successful fresh period.

This inconsistency in study results may be because feeding high starch diets can increase susceptibility of subacute ruminal acidosis (SARA) in cows in the fresh period. Risk of SARA increases any time there is a large change in diet composition, specifically when the diet composition becomes more fermentable, making the fresh period a prime target. SARA has been linked to decreased intake, decreased milk production, and an increased inflammatory response. As the fresh cow is not eating to her gut capacity shortly after parturition, one possible way to help mitigate the risk and/or effects of SARA in this period is to add more fiber to the diet to help foster a healthy rumen environment.

Recent work at Cornell and Miner Institute suggest that the undigested fiber after 240 hours of in vitro fermentation ($uNDF_{240}$) is a possible measure to use to evaluate diets in terms of intake and rumen health. If $uNDF_{240}$ is too high in a diet it will limit intake due to gut fill, while if $uNDF_{240}$ is too low in a diet it can lead to an unstable rumen environment and potential digestive upset. This concept, however, is still being explored to understand further the levels to strive for in dairy rations, especially for different stages of lactation.

Based on a case study from our lab we found that high levels of starch in the fresh period may not be tolerated at low levels of $uNDF_{240}$ (8.3%), resulting in digestive upset and clinical disease. However, cows fed higher starch levels in conjunction with higher levels of $uNDF_{240}$ (10.7%) had high dry matter intakes and better overall energy status postcalving. To further investigate the interaction of starch and fiber in the fresh period, we conducted a study using 57 multiparous Holstein cows at the Cornell University Research Center. Cows were moved to individual tie-stalls 28 days from expected parturition and fed a common close up diet. At calving cows were randomly assigned to one of two fresh diets. Diets were formulated using version 6.5 of CNCPS. Both fresh diets contained a higher level of starch (26%), but differed in levels of fiber. The low fiber (LF) diet contained 32.8% aNDFom, 9.5% $uNDF_{240}$, and 21% peNDF. The high fiber (HF) diet contained 35.3% aNDFom, 12% $uNDF_{240}$, and 25% peNDF with the difference being achieved through the addition of chopped straw in place of non-forage fiber sources. The assigned treatment diets were fed through 28 DIM. At 29 DIM all cows were fed the LF diet through 42 DIM.

Cows fed the HF diet became limited by gut fill earlier than expected. Intake as a percent of bodyweight was lower in weeks three and four postpartum for cows fed HF than those fed LF. This same response was seen in milk production as a tendency for HF cows to have lower production in week three and significantly lower production in week four. $uNDF_{240}$ intake as a percent of bodyweight was different between the groups, with HF cows eating 0.34% BW and LF cows eating 0.29% BW. Interestingly, rumination was not different between groups. After the diet switch at 29 DIM intake, milk production levels of the HF group quickly increased to match that of the LF group, and no significant differences were seen in weeks five and six postpartum.

Plasma metabolites NEFA and beta-hydroxybutyrate (BHBA), which elevated levels are indicative of body tissue mobilization, reflect the limited intake and therefore more pronounced negative energy balance of the HF group. NEFA concentrations were higher in weeks three and four, and BHBA levels were higher in weeks two through four postpartum for HF cows compared to LF cows. Levels of NEFA and BHBA were similar for both groups in weeks five and six postpartum.

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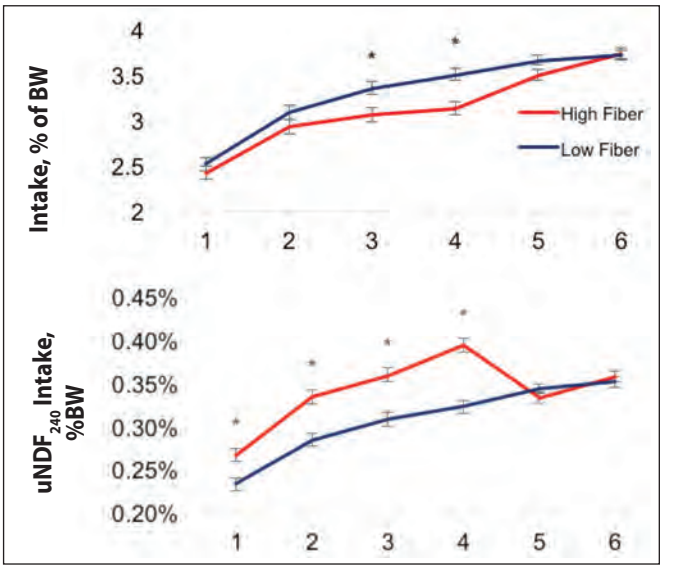

Dietary mineral sources and feeding rates in the transition period
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Consistent with higher intake, cows fed MIN-AD had lower blood non-esterified fatty acid (NEFA) concentrations prepartum and tended to have lower NEFA concentrations postpartum.

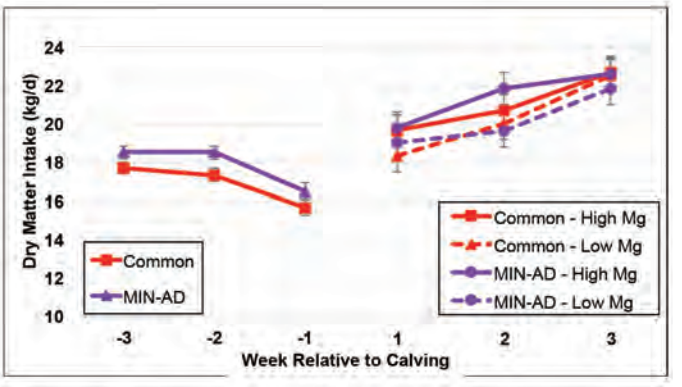
Aside from inclusion in diets as a mineral source, MIN-AD is also incorporated into diets as a buffer. Postpartum, this additional buffer could be aiding in rumen health as cows transition onto higher starch fresh cow diets. While rumen pH fluxuations aren't typically thought of as an issue in the prepartum period in high forage, low starch diets, there may be some unknown benefits of supplementary buffers in the prefresh diet. Additionally, dolomite minerals, the chemical structure of the calcium and magnesium complexed with carbonate in MIN-AD, have previously been shown to increase passage rate, which could influence intake in the transition period.

The take home message. While varying dietary source of calcium and magnesium, and level of magnesium postpartum, did not influence plasma calcium status in this trial, the exceptionally healthy study population may have masked potential effects of the treatment diets. Some important take home points from this trial include:

• Lower blood magnesium in this trial did not impair calcium status, intake or performance suggesting that blood magnesium concentrations in fresh cows should be interpreted cautiously.

• Feeding MIN-AD improved dry matter intake and blood NEFA concentrations, warranting further investigation into strategic use of specific dietary mineral sources in transition cow diets. ❐

Figure 3. Dry matter intake in the prepartum period was higher for cows fed Ca and Mg primarily from MIN-AD as opposed to common sources.



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Genomic research and selection improve cow health
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parity > 1. Previously, it was noted that the digital cushion of primiparous cows are different than those of multiparous cows. Additionally, the digital cushion thickness of primiparous cows seem to follow a more distinct change in digital cushion across time. On the other hand, multiparous cows show more variation with their digital cushion thickness (Fig. 5). This could be due to differing fatty acid composition between heifers and cows.

Once both phases are completed, the final step is to compare the trait data, primarily digital cushion thickness, to over 777K genetic variants spanning the genome. By looking at the whole genome we hope to determine possible genetic markers associated with digital cushion thickness. Characterizing the digital cushion in Holsteins and Jerseys allows us to compare genetic variants within and across breeds. Once these are determined, results will be proposed to breed associations, industry, and the Council for Dairy Cattle Breeding, to potentially incorporate into genetic evaluations. Characterizations of legs and hooves are not well represented in genetic evaluations and thus far have shown little impact towards decreasing lameness. Lameness research needs growth and attention to improve animal well-being and to reduce economic loss to farmers. ❐

Table 1. Traits recorded per sample event

	Sample Event 1 245-266 DCC	Sample Event 2 1-30 DIM	Sample Event 3 91-120 DIM	Sample Event 4 >270 DIM
Blood	X			
BCS	X	X	X	X
Lesion	X	X	X	X
Locomotion	X	X	X	X
Ultrasound	X	X	X	X
Height	X			X

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From this project we determined that our LF diet likely had adequate amounts of fiber to foster a healthy rumen environment at the level of starch we achieved. Our HF diet, however, limited cows via gut fill and therefore showed negative responses in intake, milk production, and blood metabolites, mainly in weeks three and four postpartum. It is important to note that the HF cows responded quickly to a diet change, meeting the LF cows level of intake, production, and blood metabolites within a week after the diet switch.

In this study we found that it is possible to limit fresh cows via gut fill in the few weeks after calving, however, the limitation is not permanent and can be relieved quickly by feeding a more digestible diet. Although the fiber level in our low fiber diet was not low enough to show any detrimental effects, it is important to note that this is just for the level of starch we achieved. Formulation of fresh rations should occur being mindful of both the starch and fiber levels, specifically $uNDF_{240}$, to maximize both energy density of the diet and rumen health. ❐

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