Calf starters: A historical review

PREVIOUSLY, I have addressed the subject of calf rumen development and calf starters in American Dairy Science Assn. (ADSA) DISCOVER Conferences in 2008 and 2013 and for an ADSA Graduate Student Division Webinar on Jan. 15.

Each time, I have found it helpful to review the older literature to develop a historical perspective because, otherwise, we can get caught up with what is currently being practiced and not understand whether that is the best practice. A recent review was also done with that in mind (Kertz and Loften, 2013).

Studies atRalston Purina in the 1930s and 1940s addressed the effect of forage particle size on milk fat depression in cows as well as formulation of calf starters and calf rumen development. Some of these data were presented at ADSA annual meetings in 1939 and 1941.

More extensive rumen development studies were done in the 1950s to 1970s at Iowa State University by McGilliard, Jacobson, Sutton, Huber, Tamate and Morrill, at Cornell University by Warner, Flatt, Sanders and Harrison and at the U.K.’s National Institute for Research in Dairying by Stobo, Roy and Balch. Some of those studies used few calves per treatment, which still occurs (Kertz and Chester-Jones, 2004).

A key literature review by Warner et al. (1956) found that:

• The rumen had retarded development (Trautmann) but still grew in volume even on a milk diet;
• Roughage was not required for development of pillars, compartments and papillae of the rumen (Trautmann);
• Trautmann’s studies suggested that solid feed hastened the process of rumen, reticulum and omasum regeneration;
• Most rapid rumen change was between four and six weeks of age (Kesler et al.);

• Blaster reported that roughage fed in addition to milk developed larger rumen volume than when calves were fed only milk at the same growth rate and there was no increase in forestomach tissue weight, but roughage stretched tissues to increase forestomach capacity, and
• Flatt found, in early studies in Germany, that the ratio of reticulo-rumen to omasum-abomasum was 1:3 at birth, 4:1 at six months of age and 9:1 in adult cattle.

It was determined in several studies, such as the one by Flatt et al. (1958), that “these data confirm the view that end products of rumen fermentation, rather than the coarse nature of the feed, are the stimuli for the development of rumen papillae.”

In another study, infusing acetate, propionate, butyrate, glucose and sodium chloride at feeding time into rumen-fistulated calves (two per treatment) for 11 weeks until sacrificed at about 100 days of age (Sander et al., 1959) helped determine that volatile fatty acids (VFAs) stimulated rumen papillae development in the order of butyric, propionic and acetic acid.

After calves had been weaned early (Harrison et al., 1960) and fed a diet with either 90% concentrate or 90% hay, daily gains were 1.1 or 0.66 lb., respectively, with the latter calves described as being “thin, potbellied and unthrifty.”

This reduced daily gain and increased gut fill was demonstrated as well by Stobo et al. (1966) when they fed calves on various postweaning dietary treatments that had concentrate levels fixed at 1.9, 2.0, 3.0, 4.0 or 5.0 lb. per day with corresponding free-choice hay intakes of 61%, 31%, 25%, 16% and 4% of total dry matter intake.

Daily gain increased to about 1.3 lb., somewhat linearly along with corresponding rumen papillae development as concentrate intake increased. This daily gain occurred at 16% and 4% hay in total dry matter intake. However, results were confounded as gut contents increased with increasing hay intakes. Thus, the best daily gains and rumen papillae development and least gut fill occurred with the highest concentrate/lowest hay intakes.

Unfortunately, more recent studies with calf starters in which hay is or is not fed did not measure gut fill and implicitly assumed that there was no difference or that it was immaterial. That is not a safe assumption.

Physical form

In the early 1970s, John Porter, a graduate student of R.G. “Dick” Warner at Cornell, did a classic 2 x 2 study in which calf starters were formulated with two levels of fiber and two physical forms of meal versus mash (texturized). While there were some differences due to the fiber level, the greatest differences were due to the physical form of the starter.

I was well aware of this study since I was at Cornell at the same time and knew it was not published except for a short note in the 1973 Cornell Nutrition Conference proceedings. As I found a resurgence occurring of feeding not texturized but pelleted starters with or without feeding hay in the U.S. and in other countries, I contacted Porter to get these data published (Porter et al., 2007; Feedstuffs, Sept. 10, 2007).

What is a properly texturized starter? The Porter et al. paper contains particle size data for reference. Hill et al. (2008) also did a study with particle size measurements and found negative effects for calves when including hay in a well-texturized starter.

In another study, Bateman et al. (2009)

<table>
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<th>Effect of hay intake along with starter on gut fill</th>
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<td><strong>Starter</strong></td>
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<tr>
<td>Rumen-reticulum plus digesta, lb.</td>
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<tr>
<td>Rumen-reticulum minus digesta, lb.</td>
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Source: Khan et al., 2011.

found negative effects of fines/small particles on starter intake and daily gain. There are also extensive data on calf starter particle size distributions as well as ingredient and nutrient composition in this report of five calf trials.

Earlier in this column, I noted that in the review by Warner et al. (1956), Trautmann reported that roughage was not required for development of the rumen pillars, compartments and papillae. So, how does having a texturized starter without any hay work?

Fermentation is required in the calf rumen to initiate rumen papillae development. These papillae, in turn, absorb VFAs as the calf’s primary energy source, which they also are for all ruminants. The key is to have a fermentation that enhances butyrate production and, secondarily, propionate because both of these VFAs are most stimulatory for rumen papillae development. However, we do not want ruminal acidosis because that limits intake and reduces digestibility, as shown by Porter et al. (2007).

That is where texture comes in because it leads to calves ruminating more. This facilitates salivation, which helps buffer the rumen from becoming too acidic. Pelleted starters do not have the particle size to aid this process. Hay or roughage would need to be fed to avoid that acidosis (Terre et al., 2013; Feedstuffs, Sept. 9, 2013), but then this does not help produce the optimal pattern of butyrate and propionate in rumen fermentation.

That type of fermentation does not facilitate rumen papillae development. The best illustration of this is a series of slides available on the Pennsylvania State University website at http://extension.psu.edu/animals/dairy/health/nutrition/calves/cal-rumen-images. At times, calves on a pelleted starter can be seen (and heard) trying to compensate for this problem by chewing loudly on wood. This facilitates salivation, which helps buffer the too-acidotic rumen.

Earlier this year, on a large dairy where a pelleted starter was fed with no hay, I observed 50 calves nearing weaning and found that only three were ruminating. Then, I counted 34 fully weaned calves on the same starter and found none that were ruminating.

A study by Khan et al. (2011) illustrates several of the dimensions discussed. Calves were fed a “texturized” starter alone or with hay. The starter had 14% flatted barley, 13% flatted oats and 10% steamed corn, which summed to 37% processed grains. Except for barley, it is not usually necessary to process grains for a texturized starter. However, the low rumen pH of 5.06 clearly shows that the starter-alone treatment was not adequately texturized.

Since bodyweights were not different between the two treatments, true bodyweight was distorted by 10.4 lb. more gut fill (0.7 lb of that could have been from the increased tissue weight too) for calves on the starter/hay treatment (Table). This gut fill may not likely be visually evident. Thus, calf trials in which hay is or is not fed, such as in the Khan et al. trial, should have gut fill measurements so they don’t wind up with confounded growth data.

When I visited with two of this study’s authors at the 2012 Western Canadian Dairy Seminar and pointed out that the “texturized” starter was not adequately texturized, the response was that I should tell the industry about this situation, which is a major reason for writing this column on the topic.

The Bottom Line

Calf rumen development is dependent on VFAs produced during rumen fermentation in the effectiveness order of butyric acid first, propionic acid second and acetic acid third. However, ruminal acidosis also needs to be minimized.

If hay is fed, then gut fill will likely occur and confound true bodyweight gain. Also, hay/straw/roughage does not facilitate rumen papillae development in its fermentation pattern.

Furthermore, sourcing and processing a consistent roughage supply for calves is not easy to do very well on dairy or calf operations.

A well-texturized calf starter will provide a more optimal rumen pH by facilitating rumination, a more optimal VFA pattern for rumen papillae development and intake, daily gain and digestibility. Feeding a pelleted starter has been shown to lower rumen pH unless hay/straw/roughage is also fed, and then gut fill confounds true body growth.

References


