FAT FEEDING FACTS 11

Fatty Acid Follies

In an apparent effort to find new marketing angles for fat supplements for dairy cows, claims related to oleic (C18:1), linoleic (C18:2), palmitic (C16:0), and calcium salts of fatty acids (CSFA) have surfaced. Previously, ruminal biohydrogenation has been explained (Fat Feeding Facts 3. Unsaturated vs. Saturated Fatty Acids) and the role this process plays in dry matter intake (Fat Feeding Facts 4. Dry Matter Intake (DMI)) and milk fat depression (Fat Feeding Facts 5. Milk Fat Depression).

In a review of 25 published studies (Jenkins and Bridges. Eur. J. Lipid Sci. Technol. 109 (2007) 778–789), unprotected oleic, linoleic, and linolenic FAs were ruminally biohydrogenated to the extent of about 82-86%. There was little difference in the extent of ruminal biohydrogenation when these FAs were in the form of CSFAs. An extensive study of ruminal biohydrogenation in vivo was done using early lactation high-producing cows fed non-fat to increasingly unsaturated FA dietary supplementation (Harvatine and Allen. J. Nutr. 136: 677–685, 2006.) This is a very complex situation because dietary unsaturated FA supplementation of oleic and flow to the small intestine is subject to ruminal biohydrogenation to stearic, absorption, oxidation, and an increase due to incomplete biohydrogenation of linoleic or linolenic FAs. From this study, it was modeled and estimated that ruminal biohydrogenation was about 62-73% for oleic, and about 80 to 87% for linoleic and linolenic. It could require feeding about a lb of linoleic to provide an increase in milk linoleic since the transfer efficiency of linoleic is typically less than 10% (range of 4 to 15%). That feeding level of linoleic typically results in some DMI decrease along with lower milk fat %.

Of the lipids leaving the rumen, 85 to 90% are in the form of free FAs of which 2/3 are stearic, 1/3 are palmitic, and 10 to 15% are phospholipids from microbial cell walls (Drackley, J. K. 2004. Overview of Fat Digestion and Metabolism in Dairy Cows.) The lipids in milk are comprised of 65% saturated FA (40% palmitic, stearic, and myristic); and 35% unsaturated (2/3 oleic, linoleic and linolenic) based on an extensive survey by O'Donnell-Migaro et al. (2011. J. Dairy Sci. 94:59-65). So where does all of the oleic in milk come from since intake is low and ruminal biohydrogenation high? The cow has an enzyme process which desaturates the major FA stearic flowing into the duodenum to oleic.

Assertions that oleic, linoleic, and palmitic positively impact FA absorption, NDF digestibility, body condition, and overall performance are not supported by refereed journal publications.

With the advent of high palmitic FA supplements (about 85% palmitic), scientific trials and field results have illuminated several characteristics of palmitic and stearic FAs. High palmitic supplementation tends to increase milk fat % by 0.1 to 0.3%, but not consistently. And it often results in decreased DMI and mobilization of body condition evidenced by increased blood NEFAs even in mid to late lactation cows. These studies have almost exclusively been done with short trials (about 3 week periods), mid to late lactation cows, and by one research laboratory. The major beneficial period for dietary fat supplementation is in early lactation when cows are in negative energy balance. An extensive review (Loften et al., 2014. J. Dairy Sci. 97:4661-4674) of key characteristics of palmitic and stearic FA studies found:

Palmitic

- Very poorly absorbed into adipose (fat) tissues
- Highest level of FA in blood NEFAs (non-esterified FA)
- Can accumulate in liver and impair glucose synthesis—which is necessary for milk lactose and milk volume production
- Can be oxidized to produce energy for the cow, but liver accumulation and oxidation can decrease DMI
- Helps increase milk fat % but this is partially offset by decreased synthesis of shorter chain FA than palmitic in milk

Stearic

- Located throughout many tissues and oxidized to provide for the cow's many energy needs—especially critical in early lactation
- Does not accumulate in the liver, nor contribute to DMI decrease
- The most prevalent unsaturated FA in cow tissue and in milk is oleic (C18:1) which the cow creates by converting from stearic (C18:0)
- Tends to increase milk fat%, but does not decrease shorter chain FA
- Facilitating glucose synthesis aids in milk volume increase and possibly milk protein synthesis too

Together, these two FAs appear to complement each other and overall responses. To avoid getting caught up in what fat supplements are hyped as the latest, "show me the data." Especially, data that utilize early lactation cows—the most critical stage, considers body condition changes, are published in refereed scientific journals, and do not primarily or exclusively originate from one research laboratory.