



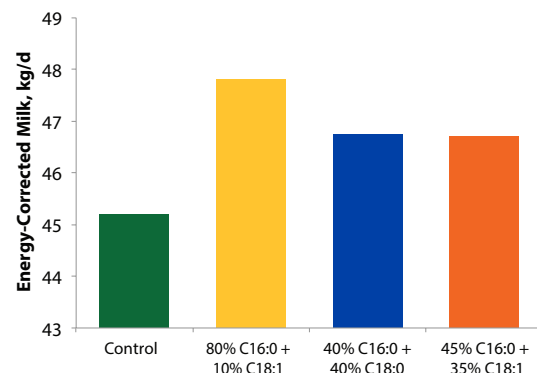
SPECTRUM Fusion is the next generation of fatty acid supplements for high producing dairy cattle. There are aspects of this fatty acid product beyond fatty acid profile that contribute to its potential to serve as a high impact feed ingredient in dairy diets.

Feeding Directions: Feed at 1.5% of dry matter intake to high producing dairy cattle, or according to the recommendations of an animal nutritionist. Do not exceed 3% of total dry matter intake.

Standard Analysis	% DM	
Dry Matter	98	

Fatty Acids	% DM	%TFA
Ether Extract	97	—
Total Fatty Acids	99	—
Calcium	1	—
C16:0	80.0	81.6
C18:0	5.0	5.1
C18:1 cis	10.0	10.2
Other	3.0	3.1

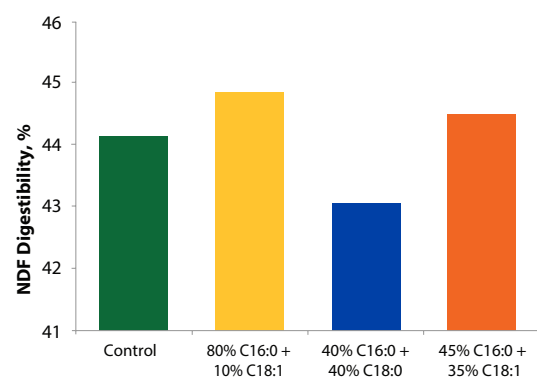
Figure 1



Fatty acid digestibility of palmitic acid (C16:0) supplements are greater than that of stearic acid (C18:0) supplements with increasing supplementation rate (Boerman et al., 2017, JDS 100:2729-2738; Rico et al., 2017, JAS 95:434-446). This study determined the ideal supplementation rate to be 1.5% DMI.

Providing the optimal fatty acid combination increases energy corrected milk (Figure 1). The effects of different dietary ratios of fatty acids in a supplemental fat blend fed at 1.5% diet DM on energy corrected milk yield (de Souza et al., 2016, JDS 99:E620). **Supplementation of C16:0 increases milk production while C18:1 allocates energy towards body weight** (de Souza et al., 2016, JDS 99:E620). These two in combination should maximize energy allocation to milk production and help stabilize energy balance in the post-fresh cow.

Figure 2



The latest research highlights the benefit of specific fatty acid combinations that increase NDF digestibility allowing for more energy corrected milk production (Figure 2). A recent meta-analysis of C16:0 shows C16:0 increases NDF digestibility by 3 percentage units. (Lock and de Souza, 2017, TriState Dairy Nutrition Conference Proceedings, pg. 87-98) Instead of using raw fatty acid distillates or nonspecific fatty acid streams, **SPECTRUM Fusion** is formulated using enriched fatty acid streams with known fatty acid profiles.



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The fusion of quality assurance, fatty acid nutrition, and rumen protection

A scientifically formulated fatty acid blend that maximizes energy corrected milk production



Science based. Research driven.

Fat in Dairy Diets

Adding fat to dairy diets has been an effective way to increase energy density while maintaining effective NDF levels. The term fat is often used synonymously with lipid, which is any compound that is soluble in solvent such as ether or acetone. Lipids include a large group of compounds including fatty acids, triglycerides, waxes, and phospholipids. It is imperative to understand the fatty acid composition of diets fed to dairy cows. Because the goal of adding fats to dairy diets is to increase fatty acids available for milk production, energy metabolism, and for replenishment of body reserves, it is imperative to understand fat digestion and absorption so as to maximize post-rumen availability. In order to promote optimal availability and digestibility of fatty acids we first have to understand how to deliver fat beyond the rumen while not inhibiting microbial fermentation and fiber digestibility. In the remainder of this article we will focus on triglycerides and their basic components, which are glycerol and fatty acids. Fatty acids are named and categorized according to the number of carbons they contain, and whether those carbons are saturated or contain double bonds, making them unsaturated. Common fatty acids that are in feed ingredients are:

- Palmitic acid (C16:0)
- Stearic acid (C18:0)
- Oleic acid (C18:1)
- Linoleic acid (C18:2)
- Linolenic acid (C18:3)

“In order to promote optimal availability and digestibility of fatty acids we first have to understand how to deliver fat beyond the rumen...”

Ruminal Fat Digestion

Typical ruminant diets do not contain a large percentage of fat (generally less than 5%) so adding fat to the diet can cause negative effects depending on the type of fat added. It is well known that unsaturated fatty acids are toxic to rumen microbes and are biohydrogenated. Biohydrogenation is the process of adding hydrogen to the carbon chain of unsaturated fatty acids by removing the reactive double bond between two adjacent carbons. This is what occurs when oleic acid (C18:1) or linoleic acid (C18:2) are converted to stearic acid (C18:0). Moreover, specific intermediates produced during biohydrogenation cause milk fat depression and can lower feed efficiency. To minimize the negative effects of incomplete biohydrogenation, saturated fats are used in dairy rations.

Bypassing the Rumen

In order to minimize negative effects of unsaturated fatty acids on rumen microbes, technology was developed to limit microbial fatty acid availability for microbial degradation. The first method was reacting fatty acid distillates with calcium to form soaps helping to limit microbial toxicity by slowing down the amount of unsaturated fatty acids available for biohydrogenation. Palm fatty acid distillate is extensively used in this process. Raw palm fatty acid distillate contains a mixture of fatty acids and impurities distilled out during the refining process. During their refining, the free fatty acid streams are removed and used in the production of most fat supplements in dairy (see **Figure 1**.)

Although forming calcium soaps is an effective way to reduce the negative effects of free fatty acids (especially unsaturated fatty acids) on rumen fermentation, the resulting products are often associated with reduced DMI. The reaction to create a soap is a nonspecific process and the end products can vary in particle size and fatty acid composition. While the conversion of free fatty acids to calcium soaps reduces their negative effects on microbes (especially the fiber digesters), the binding strength is less for unsaturated fatty acids and thus allows for a more rapid and extensive dissociation in lower rumen pH, freeing a significant proportion of fatty acids for microbial biohydrogenation. Large variations in unpurified distillates allow unsaturated fatty acids to make up a large proportion of the resulting products. Hence, the greater calcium dissociation leads to increased biohydrogenation, resulting in increased risk of milk fat depression.

Another concern with some fat supplements based on the Ca soap technology is particle size consistency. Uniformity of product form is extremely important when incorporating these products into actual diets and base mixes. The key of any feed additive is to be incorporated into the mix so that the final diet is as homogenous as possible so that every bite delivers nutrients as close to the recipe

formulated on paper. In order to achieve this particle uniformity is one of the keys to a proper mix.

Other methods used in manufacturing rumen-protected fats are to make flakes or dry fat prills, using inconsistent fatty acid streams and spray-drying the resulting fatty acids mixture. This approach increases the melting temperature and decreases the ruminal solubility of the fatty acids mixture, hence reducing negative effects on rumen fermentation. Although these products can be more uniform in particle size and have generally fewer palatability issues than calcium soaps, they can be quite variable in fatty acid composition. Since most of these supplements are made from refinery waste and by-product streams the fatty acid composition and impurities vary from batch to batch and from refinery to refinery.

Fatty Acid Research in Dairy Diets

Much of the recent research in fat nutrition has focused on how fatty acids are digested and utilized by dairy cattle. It has been shown that as more stearic acid is added to the dairy cow diet, the digestibility of fatty acids decreases (see **Figure 2**). This makes sense because stearic acid is the predominant fatty acid delivered to the cow's intestine. Ruminant biohydrogenation transforms nearly all 18 carbon unsaturated fatty acids to stearic acid. Hence, the pattern of fatty acids delivered to the small intestine

Recent fatty acid research confirmed that switching from stearic acid to palmitic acid increased fatty acid digestibility (see **Figure 2**). It has also been shown that blends of palmitic and oleic fatty acids increase NDF digestibility and allow for increased milk production. Fatty acid nutrition in dairy cattle is complex and our understanding in this area is still incomplete. **Perdue AgriBusiness** is committed to funding research to increase our understanding of fat digestion and utilization. Our research so far has allowed us to put together a product that was designed specifically for dairy cows and not simply a byproduct of another industry. The resulting product is named **Spectrum Fusion**

Putting Together All the Components

Perdue is proud to deliver the highest quality and most consistent performing products on the market. **Spectrum Fusion** is a scientifically formulated blend of fatty acids. The blend of fatty acids is based on the latest research to maximize fatty acid availability and NDF digestibility to support increased milk production. Our process ensures that product quality is not influenced by variations in raw materials. We start with palmitic acid and add a combination of 18 carbon unsaturated calcium salts to produce a targeted blend. The product is manufactured to **Perdue AgriBusiness'** strict quality standards to ensure high fatty acid digestibility while increasing

“Spectrum Fusion is the first fat supplement formulated to increase milk production based on specific fatty acid concentrations, and is supported by our commitment to a science-based, research-driven approach.”

Figure 1: Fat and Oil Refining Process

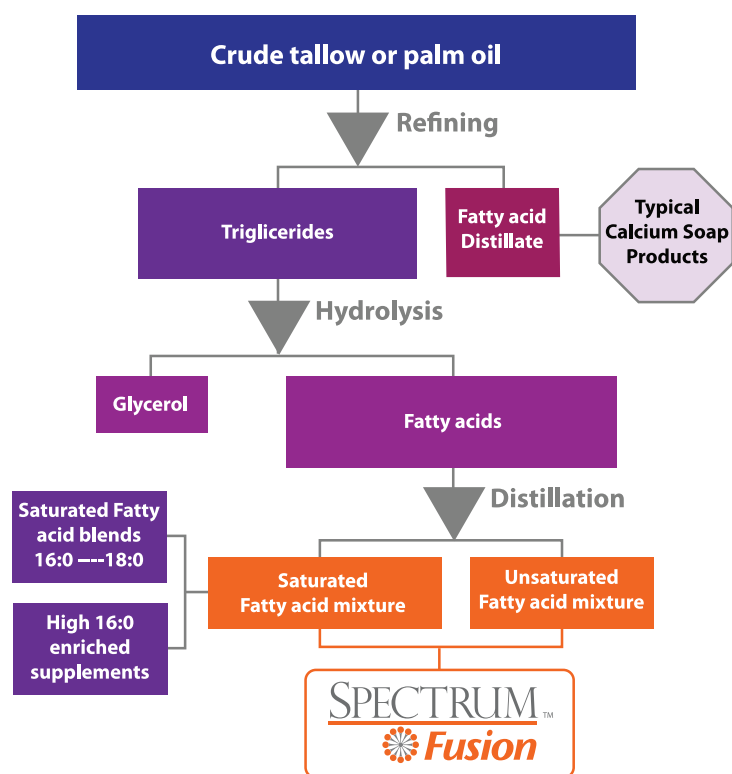
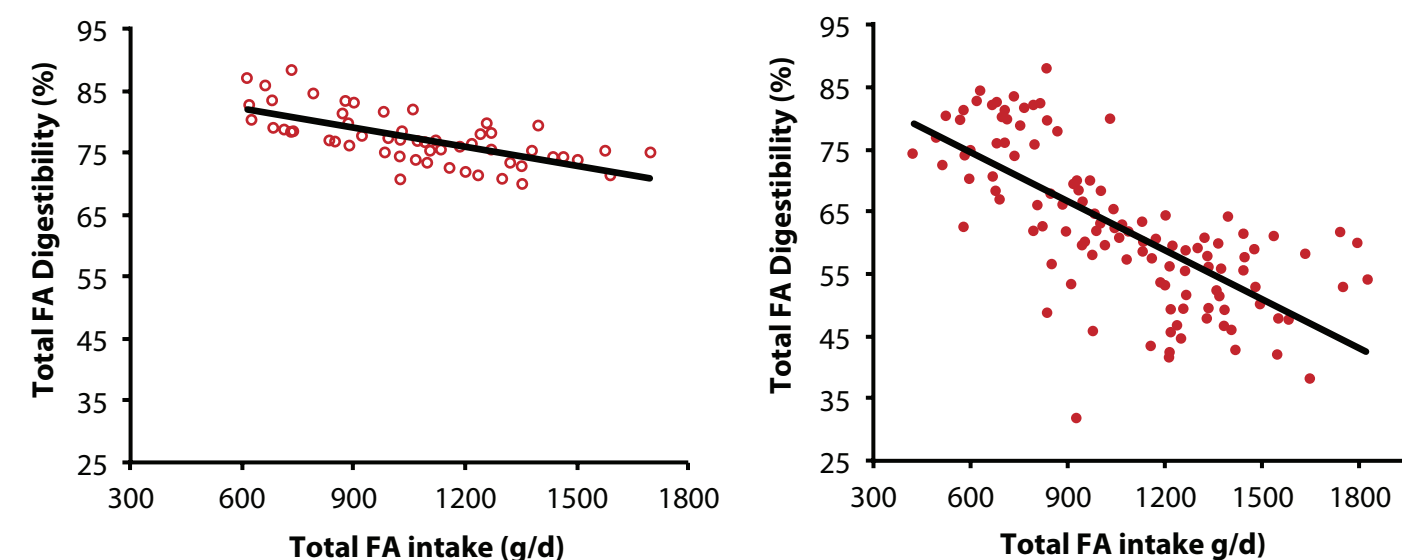


Figure 2: Relationship between total fatty acid intake and apparent total-tract fatty acid digestibility of dairy cows supplemented (from 0 to 2.3% DM) with either a C16:0-enriched supplement (left) or a C18:0-enriched supplement (right). Adapted from Rico et al. J. Anim. Sci. 95:436–446 and Boerman et al. J. Dairy Sci. 100:2729–2738.



is very different from what is being fed, with stearic acid occupying the lion's share of the fatty acids appearing in the intestine. The constant supply of stearic acid to the intestine is why fat supplements containing stearic acid are less digestible than palmitic based supplements.

NDF digestibility. **Spectrum Fusion** is the first fat supplement formulated to increase milk production based on specific fatty acid concentrations, and is supported by our commitment to a science-based, research-driven approach.