Fat Feeding Facts
2. What is fat?

Fat has typically been defined by the simple analytical method used to measure it: ether extract. But extracting a sample with the solvent ether may extract other compounds that are not fat; and all fat may not be extracted by ether—especially if it is physically or somewhat chemically bound. The cow's system is most attuned to fatty acid content and composition. The purpose of fat feeding for dairy cows is to increase their energy intake especially in early lactation when they are in negative energy balance. Since fat has 2.25 times more energy than protein or carbohydrates, and minerals have no energy content, fat could help increase energy intake in early lactation by making a more energy dense ration *if* that fat has no negative effect on dry matter intake (DMI) and has a high digestibility.

When fats are present as triglycerides, they have a glycerol molecule to which are attached 3 individual fatty acids. Hence the name tri-glyceride meaning there are 3 fatty acids attached to a glycerol. But as noted later, cows are not made to utilize triglycerides, but rather they primarily utilize "free" fatty acids--that is fatty acids not attached to glycerol. These individual fatty acids are named according to a protocol. The number of carbon (C) atoms are counted starting from the left of the fatty acid, and then designated as, for example, C18:0 indicating that the fatty acid below has 18 carbons with no double bonds. If a fatty acid has all of its bonds completely saturated with hydrogen (H) atoms, the number next to C18: is 0; or if the fatty acid is unsaturated, the number will indicate how many double or unsaturated bonds exist. The common name for the fatty acid illustrated below is stearic which is quite prevalent in ruminant fat depots and milk.

- *Saturated* **fatty acids**
  --no double bonds
  --maximum number of hydrogen atoms

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      O  H  H  H  H  H  H  H  H  H  H  H  H  H  H  H  H  H
      ||  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
HO —C —C —C —C —C —C —C —C —C —C —C —C —C —C —C —C —C —C —H
          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
          H  H  H  H  H  H  H  H  H  H  H  H  H  H  H  H  H
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Name: C18:0 or stearic fatty acid

Since the cow as a ruminant needs free fatty acids, bacteria in the rumen have the enzymes needed to break free the fatty acids attached to the glycerol in triglycerides coming in the ration. This process is called hydrolysis. Once the glycerol is freed from the triglyceride by the bacteria in the rumen, it can be fermented as an energy source and produce volatile fatty acids (VFA) which can be absorbed across the

rumen wall into the blood stream. The VFAs produced in the rumen are the major energy source for a dairy cow or ruminants in general.

If the fatty acids in triglycerides are fully saturated, the melting point of that triglyceride will be much greater than the temperature in the rumen. If that triglyceride does not melt in the rumen, it cannot be hydrolyzed very well. That will result in lower fat digestibility, as much as $\geq 50\%$ less than free fatty acid digestibility. But if saturated free fatty acids are fed, they are already hydrolyzed and in the form the cow needs, and so they now can flow out of the rumen simply temporarily attached to small feed particles. When they reach the small intestine, they can be absorbed into the cow's blood stream.

Triglycerides

- Glycerol with 3 attached fatty acids— which vary in chain length and degree of saturated and unsaturated

- Glycerol is a carbohydrate, not fat

- Triglycerides ~ 92% energy value of free fatty acids because of glycerol content

- Must be hydrolyzed or detached from glycerol in the rumen because cows utilize free fatty acids—not triglycerides
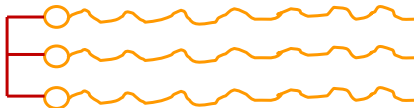
Glycerol with 3 attached fatty acids

Free Fatty Acids

- Detached from glycerol and thus are "free" fatty acids

- Fatty acids have 2.25 times energy value of carbohydrates or protein

- Can vary in chain length— usually 16 to 18 carbons long

- Can vary in whether saturated or unsaturated

- Do not need hydrolysis from glycerol in the rumen

- If unsaturated, rumen microbes need to saturate in the rumen

3 free fatty acids

As indicated in this comparison of free fatty acids vs triglycerides, triglycerides have about 92% of the energy value of free fatty acids. The presence of glycerol dilutes down the energy value of the triglyceride since glycerol is a carbohydrate which has a much lower energy value than fatty acids. The issue of saturated vs unsaturated fatty acids for dairy cows will be addressed in the next edition of Fat Feeding Facts.