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Dairy Update

FAT QUALITY CONTROL FOR DAIRY RATIONS

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The addition of fat to feed rations has gained acceptance as a formulation practice. Fats have physical, chemical and physiological properties which make them important in feed manufacturing and animal nutrition. One important feature of fat is its high energy value. Fat contains about three times more net energy for lactation than an equivalent amount of corn. Therefore, when energy becomes a limiting nutrient in a ration and the upper limit of grain supplementation has been reached, fat addition can be of significant energy benefit to high producing cows. Fat supplementation in this instance will provide necessary energy density in the diet to provide flexibility for fiber and protein balancing.

Improved lactation performance, body condition and reproductive performance are often cited as potential benefits of feeding supplemental fat. Fat addition also has several other unique benefits such as helping reduce dust of a ground feed mixture.

Concentrated fat sources are typically found in 2 forms: dry and liquid. Dry fats have the distinction of being easy to handle, can be purchased in small quantities, but are usually more expensive than liquid fats. Liquid fats are typically more economical to use, but can take specialized equipment to incorporate into a feed mixture. Either way, fats can provide an important nutritional value to dairy rations.

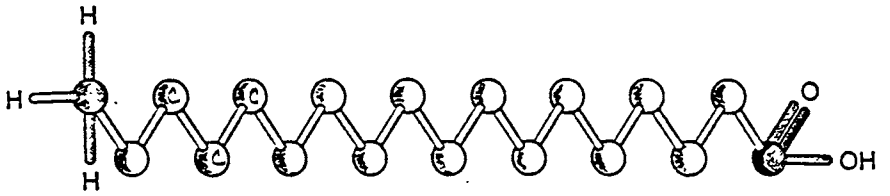
Like grains, proteins and roughage, there are several quality considerations to evaluate before purchasing fat from a vendor. To understand the role of fats in the diet and quality of those fats, some basic information on the chemical nature of fats is important.

*This material was prepared by the Van Hoven Company, for use by the Dairy Extension at the University of Minnesota. The Van Hoven Company is a manufacturer of animal proteins and fats for use by the animal feed industry.

FATTY ACIDS

Fatty acids are the main constituents of fats. They are comprised solely of carbon (C), hydrogen (H), and oxygen (O). Fatty acid molecules consist of carbon atoms linked to one another to form a chain of varying lengths from 4 to 26 carbon atoms. Several common fatty acids and their respective carbon chain lengths are listed below. A schematic illustration of Stearic Acid is also included.

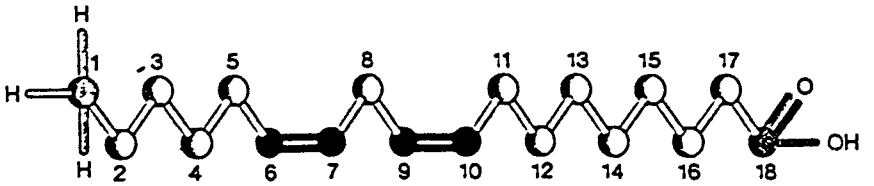
Common name	Carbon chain length
Butyric acid	4
Lauric acid	12
Palmitic acid	16
Stearic acid	18
Arachidic acid	20



STEARIC ACID

SATURATED, MONOUNSATURATED & POLYUNSATURATED FATTY ACIDS

The terms saturated, monounsaturated and polyunsaturated fat are commonly used when discussing fats. These terms refer to the chemistry involved in the number of carbon to carbon double bonds a fat contains. For example, saturated fats contain no double bonds, and monounsaturated fats, one double bond. Polyunsaturated Fats are unique in that they have two or more double bonds. An example of a double bond is schematically illustrated below by examining the polyunsaturated fatty acid, Linoleic Acid (two double bonds).



LINOLEIC ACID

In nature, fats and oils contain combinations of fatty acids. These specific combinations make each fat unique. Several common fats and oils are listed below illustrating their specific fatty acid compositions.

COMPARISON OF DIETARY FATS

Common name	% Saturated	% Mono unsaturated	% Poly unsaturated
Butterfat	66	30	4
Tallow (beef)	52	44	4
Lard (swine)	41	47	12
Soybean oil	15	24	61
Olive oil	14	77	9
Corn oil	13	25	62
Sunflower oil	11	20	69

The number of double bonds affects the physical chemistry (liquid vs. solid) of a fat at a given temperature. For example, a saturated fat has a higher melting point or titre level (the temperature stated in degrees centigrade at which the fat turns from a liquid to a solid) than a monounsaturated fat, than a polyunsaturated fat. Therefore, beef tallow (a saturated fat) has a higher melting point than olive oil (a monosaturated fat), which has a higher melting point than sunflower oil (a polyunsaturated fat).

The official definition for tallow is a minimum forty degrees centigrade melting point. Any fats above forty degrees are classified as tallow and those below forty degrees as grease. Therefore, beef fat is designated as tallow and fat of pork or poultry origin as a grease. A good quality tallow should have a minimum titre level of 41.5 degrees centigrade.

Dairy nutritionists recognize that fats of different origin can affect rumen fermentation. Excessive amounts of polyunsaturated fatty acids (ex. vegetable oils) are toxic to some ruminal microorganisms. Saturated fats (ex. beef tallow) are believed to be relatively inert in the rumen because of their high melting point. Reducing fat solubility in the rumen presumably diminishes the potential negative interaction of fat with rumen microorganisms.

A common approach to feeding fat is to supply approximately the first pound of fat from oilseed sources such as whole soybean or cottonseed. The second pound of fat should then come from an animal fat source such as tallow. The dry rumen inert fats are usually the third source of fat added to rations; mainly because of higher cost relative to the first two sources.

FREE FATTY ACIDS

In nature, fats occur as triglycerides; three fatty acids attached to a glycerine molecule (see diagram 1). Free Fatty Acids (FFA) are formed when a fatty acid separates from the glycerine portion of the fat molecule. Free fatty acids can result from either of two chemical reactions.

* Natural lipases (enzymes that split fatty acids from the glycerine molecule) in the animal by-product material can cause FFA formation.

* Exposure of fat to moisture can split fatty acids from glycerine.

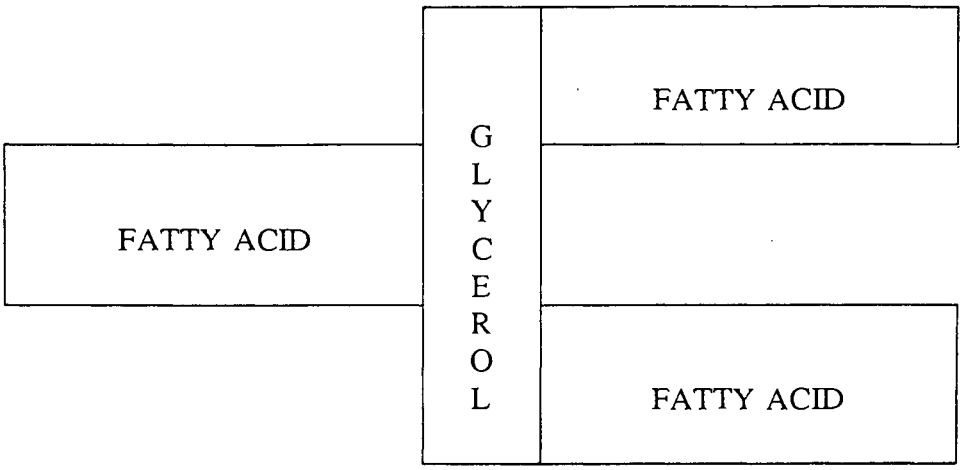


Diagram 1 - Schematic illustration of a triglyceride.

If animal by-products are not processed quickly, free fatty acid levels will rise. Likewise, if care is not taken to keep moisture from getting into the fat, fatty acid levels will rise. Therefore, FFA levels are an indicator of the care taken in the processing of the animal by-product and/or the presence of excess moisture in the fat.

In the dairy cow, it doesn't seem to matter if the fat supplement is in free fatty acid or triglyceride form. This is due to the rumen bacteria being able to hydrolyze triglyceride to fatty acids and glycerol. The glycerol portion is converted to volatile fatty acid in the rumen.

Although FFA levels do not appear to have a negative impact in dairy rations, it is still a good indicator of fat quality and more specifically, the freshness and care taken in processing of the raw material. We would suggest buying fat with a level of no more than 10% FFA.

MIU (MOISTURE, INSOLUBLE IMPURITIES, UNSAPONAFIABLE MATTER)

Moisture is primarily an indicator of the control and care used in handling the fat. Moisture in fat can negatively affect free fatty acid levels, hence a deterioration of the fat in storage.

Insoluble impurities consist of small particles of fiber, hair, hide, bone, soil, or polyethylene. These insoluble impurities can cause clogging problems of screens and nozzles and contribute to the build up of sludge in storage tanks.

Unsaponafiable matter is material soluble in pure fat but will not combine with soda to make soap. This is especially undesirable in the soap making industry. Sources that can contribute to unsaponafiable matter include: impure household or salvage fat and hydraulic oil.

Guidelines to follow when purchasing fat would be: a moisture level not more than 0.25%, insoluble impurities not more than 0.25% and unsaponafiable matter not more than 0.50%. Total MIU content should be not more than 1.00%.

TOTAL FATTY ACIDS

Total fatty acids in fat should be guaranteed at not less than 90% fatty acids. This is because fats in their natural state are approximately 90% fatty acids and 10% glycerine. Therefore, a fat with a guarantee of less than 90% fatty acids would suggest the fat has a high MIU content. As mentioned earlier, the dairy cow can utilize fatty acids individually or in the triglyceride form.

FAT STABILITY

Oxygen is a constant threat to the stability and potential rancidity of all fats. When oxidation occurs, peroxides are formed. Peroxidation (measured in milliequivalents of peroxide per kilogram of fat) reactions lead to the formation of various by-products. The first of these being free radicals which are responsible for the bad odor and unpleasant taste of rancid fats and oils. Peroxides in fat can also destroy Vitamins A, D and E, thereby increasing their requirement in feeds.

The procedure for determining fat stability can be measured by subjecting samples to actual storage conditions and examining them periodically. This method of testing usually requires too much time to be practical. For this reason, accelerated tests conducted under controlled conditions are normally used to measure fat stability and shelf life.

Two main tests are used to measure stability of fats: 1) an IPV (initial peroxide value) test, and 2) a 20 hour AOM (Active Oxygen Method) test. The IPV test measures the initial level of peroxides in the fat sample submitted for test. This gives the quality control person a good idea of fat quality at time of testing but does not evaluate fat stability under storage conditions. The Active Oxygen Method (AOM) test is an established accelerated test procedure for evaluating

fat stability under storage like conditions. The 20 hour AOM gives an evaluation of fat stability and its resistance to peroxide formation.

A level less than 20 milliequivalents per kilogram (mE/kg) after the 20 hour AOM test is a specification that should be met. Fats that have been exposed to high temperature and/or moisture (such as restaurant grease) may have an IPV greater than 20 mE/kg. Regardless of the amount of antioxidants added to this material, the peroxide value cannot be lowered. Subsequently, fat vendors will blend low peroxide fat with high peroxide fat and add antioxidants to stabilize them. Unfortunately, the fat can still possess a bad odor and off flavor. Fat classified as yellow grease may contain a combination of restaurant greases and rendered fats.

To avoid potential problems with off flavors, it is recommended to not purchase yellow grease or fats that have been blended with restaurant grease. The use of animal fats and tallow from freshly rendered animal by-product should provide consistent results and help prevent potential palatability problems. Also, the addition of antioxidants such as Ethoxyquin, TBHQ or BHT should be a standard practice to assure adequate shelf life and stability.

COLOR

Fats vary in color from the pure white of refined beef tallow, to the yellow of poultry fat and restaurant grease. Color is an important component of fat to the chemical and soap industry, but does not affect the nutritional value of fat when fed to livestock.

PCB's & PESTICIDES

PCB's and pesticides are a threat to your livestock operation. One potential source of contamination is through the feeding of animal fats. For this reason, all purchased fats should be tested and guaranteed free of PCB's and pesticides before delivery.

MOST COMMON FEED FATS SOLD

Feed Grade Animal Fat - could be derived from by-products from many species, but is primarily from rendered beef and pork.

Choice White Grease - comes primarily from the rendering of pork. Certain blends of beef, pork and poultry fat are sold as choice white grease since they meet soaper specifications.

Tallow - is primarily derived from rendered beef tissue, but could contain other animal fat. If the product meets a 40.5 titre, it can be sold as tallow with the understanding it is not necessarily 100% cattle fat.

Yellow Grease - is primarily restaurant grease but can contain dead stock and/or dark color, high free fatty acid and high MIU fat from any type of rendering operation.

Blended Animal and Vegetable Fat - can include blends of all types of animal fat, vegetable oil, acidulated vegetable oil, soapstock and/or restaurant grease.

REFERENCES

1) Grummer, R., Ruminally Inert Fats for Dairy Cattle, unpublished material.

2) Fats and Proteins Research Foundation, Inc., Animal Fats Manual.

QUESTIONS TO ASK YOUR FAT SUPPLIER

Is the fat you are selling designated as tallow or grease?

What is the composition of your fat (beef, pork, poultry, restaurant grease, vegetable oil, or a blend of fats and greases)?

What is the titre level of your fat? A titre value above 40°C is classified as tallow and under 40°C as grease.

Is your fat stabilized with an antioxidant? If yes, with which antioxidant? (BHT, TBHQ, Ethoxyquin, Vitamin E. . .)

Has the fat been tested for stability using a 20 hour AOM test? If yes, do they guarantee a level under 20 milliequivalents of peroxides at 20 hours?

What are the MIU (moisture, impurities, and unsaponafiables) specifications of your fat? The levels should not exceed 0.25%, 0.25%, and 0.50% respectively, or 1.00% total MIUs.

What is the Free Fatty Acid level of your fat? A level under 10% is a good indicator of fat quality.

Is the fat tested and guaranteed free of PCB's and pesticides?