Feeding Fat, in Moderation, to Dairy Cows

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Introduction

Dairy cows need a tremendous amount of energy; a dairy cow weighing 1,400 lb and producing 70 lb/day of milk with 3.6% fat and 3.3% protein needs about 33 Mcal/day of net energy for lactation (NE_L). Although the units are somewhat different, this is about 26 times more energy than for a person consuming a recommended 2,000-calorie diet.
Concentrates are higher in energy density than forages, but adequate dietary effective fiber is needed to maintain rumen function, so concentrates need to be limited in the diet. Thus, one of the primary purposes of feeding supplemental fat to dairy cows is to increase energy intake. Fats are higher in energy density than carbohydrates and proteins; therefore, adding fat increases the energy density of the diet. At the same time, feed intake must be maintained; otherwise, an increase in energy intake may not occur.

Feeding excessive amounts, especially unsaturated fat, can reduce feed intake and occasionally energy intake.

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Sources of Fats

Some of the common sources of fats fed to dairy cows are listed in Table 1. The most common whole oilseeds fed to dairy cows are soybeans and cottonseeds. Because of the value of the oils, the whole seeds of canola, linseed, safflower, and sunflower are not typically fed, but the respective meals that result after the oil is extracted are commonly fed. The amount of oil remaining in some of these meals can be an important contributor to the total amount of fat in the diet. In addition, several plant and animal by-products, such as distiller's grains (high and low fat available), hominy, fish meal, and meat and bone meal, may contain 10% to 12% fat. Fish meal is fed primarily as a high-quality, rumen-undegradable protein source, and the fatty acid (FA) composition is distinctive, with about 24% of the fat being unsaturated FA with 20 or more carbons. Feeding grease, lard, or tallow requires these fats to be heated for transport, storage, and mixing. Thus, special storage and handling equipment is needed. The costs of this equipment and the handling of liquid feed are deterrents for some producers who blend these sources of fat in diets on the farm.

Fat Source	% Fat	NE_L-3x (Mcal/lb)	Unsaturated Fat (% of fat)
Oilseeds			
Canola	40	1.60	94

Cottonseed	20	0.88	71
Linseed (flaxseed)	36	1.22	89
Safflower	35	0.94	89
Soybean (raw, roasted, extruded)	20	1.25	85
Sunflower[1]	28-42	0.87-1.29	83
Animal Sources			
Fish meal	10	1.06	68
Grease (choice white, yellow, etc.)[2]	99	2.06	67
Lard (swine)	99	2.06	64
Tallow (beef)	99	2.06	52
[1] Varieties vary with concentration of fat and fatty acid profile as well as whether hulls are present. [2] These fats are primarily from the restaurant industry, and quality can be variable depending on the source and handling of the fats.			

Table 1. Plant and animal sources of dietary fat for dairy cattle.

Several commercial sources of fat are available that are rumen inert (do not cause reduction of fiber digestibility in the rumen), while some are designed to deliver specific FA to the cow. Most of these are in the form of calcium salts of FA or highly saturated FA. The calcium salt products usually are from palm oil (high in palmitic acid; C16:0) or other plant sources (e.g., soybean) and are in granular form. The highly saturated FA sources are processed into very small beads (prills), much like in a powder form, to aid in digestibility and handling. Some of the commercial fat products are developed to deliver higher amounts of C16:0 to the cows for possibly increasing milk fat yield given that milk has a relative high concentration of C16:0, and C16:0 may be more digestible than C18:0. Other fat sources are enriched in

omega-3 FA (usually from aquatic sources or linseed) which may positively influence reproductive and immune function.

Energy Concentration and Cost

The amount of NE_L from fat is primarily affected by the digestibility of the respective fat source. The digestibility of the FA can be affected by these factors:

- the **physical nature of the fat source** (e.g., free oil vs. in seed; seed ground vs. extruded; size of the prills, and so on)
- **chemical form of the fat source** (e.g., triglyceride or free FA)
- **dry matter (DM) intake** as it affects rate of digesta passage
- **FA intake** as it might affect ruminal fermentation and FA absorption
- the **FA composition of the fat source** (e.g., saturated vs. unsaturated).

As an example, tallow contains about 90% FA and 10% glycerol and has an energy value of about 2.06 NE_L/lb (NRC, 2001; Table 1). With the 6-year average of NE_L being worth \$0.10/Mcal NE_L (St-Pierre, 2014), tallow would be worth on average about \$0.21/lb (St-Pierre, 2014). However, the volatility of energy prices has been huge in recent years; thus, the value of tallow can fluctuate over time (Table 2).

\$/Mcal	0.06	0.08	0.10	0.12	0.14	0.16	0.18
\$/lb tallow	0.12	0.16	0.21	0.25	0.29	0.33	0.37

Table 2. Relative value of tallow with changes in value of energy (Mcal NE_L).

The cost of energy from fat is higher than from carbohydrates, but due to the limitations discussed previously, fat can increase energy intake of cows in situations in which additional

starch cannot be fed because of acidosis concerns. The value of fat based on energy provision will depend on the concentration of fat in the source, the digestibility of the FA, and, most important, the relative cost of NE_L; however, other aspects beyond energy, such as FA composition and physical form to improve handling properties, must be considered when evaluating the price for a fat source.

Level of Dietary Fat

The amount of fat to include in the diet should be determined based on the desirable energy concentration in the diet or intake of specific FA. However, this should be determined based on the other ingredients in the diet (e.g., high- vs. low-quality forage and level of unsaturated fat contributed by sources). High concentrations of fat, especially unsaturated fat, can reduce fiber digestibility in rumen (and thus reduce feed efficiency), depress feed intake, and result in milk fat depression. The resultant lowered milk and milk fat yields can reduce profitability. Generally, 1% to 3% supplemental fat in the diet can be fed without adverse effects; however, the amount of fat fed from common sources depends on the saturation level of the fat and fiber level in the diet. To illustrate this, Jenkins (1997) proposed the following equations to calculate the amount of supplemental fat to add to a diet based on fiber level in the diet and unsaturated FA (UFA) in the fat source (Table 1):

> Fat, % of diet DM = (6 × ADF)/UFA or
>
> Fat, % of diet DM = (4 × NDF)/UFA,

where UFA = C18:1 + C18:2 + C18:3 as a percentage of total FA, ADF = acid detergent fiber, and NDF = neutral detergent fiber. For

example, a diet for dairy cows with 32% NDF and the consideration of using roasted soybeans, (4 x 32)/85 = 128/85 = 1.5% fat from the roasted soybeans. However, because roasted soybeans contain about 20% fat, then 7.5% of the diet could be roasted soybeans to provide 1.5% unsaturated fat in the diet from the soybeans.

The basal diet for dairy cows generally contains 2% to 3% fat from plant sources (primarily from cereal grains, forages, and oilseed meals), so adding another 1% to 3% from supplemental plant or animal sources results in about 5% fat in the diet. Beyond this concentration, rumen inert sources need to be used to add another 1% to 2%, resulting in 6% to 7% total fat in the diet.

Very small amounts of specialty fats (those that deliver specific FA) are sometimes fed prepartum during the close-up dry period. Feeding supplemental fat during early lactation as an energy source has to be done with caution. Even though this period is characterized with body weight loss because the energy demand for maintenance and milk yield exceed energy intake, adding dietary fat may not improve energy status during this time. It can actually be a detriment if the addition of the fat causes a depression in DM intake. Thus, low inclusion (approximately 1%) of natural or specialty fats is advised in diets of cows during early lactation. After 30 to 60 days in milk, the higher levels of fat can be fed that were discussed previously.

Summary

Dietary fat will continue to play a role in provision of energy to lactating dairy cows, and the energy concentration for a FA source will primarily be determined by digestibility of the fat. Digestibility is affected by physical and

chemical characteristics of the fat source, FA intake, and FA composition of the fat source. The economic value of the energy from fat will be affected by market costs of other energy sources such as cereal grains and alternative uses of fats. Fat must be fed *in moderation* to dairy cattle. About 2% to 3% fat will be present from typical dietary ingredients, and initial levels of supplemental fat generally will be 1% to 3% of dietary DM for increasing energy concentration of diets or delivery of some specific FA. Using common unsaturated sources necessitates basing the inclusion rate on the level of saturation and dietary fiber concentration. Including an additional 1% to 3% supplemental fat (total dietary fat at 6% to 7%) usually requires feeding of specially processed fats that are ruminally inert. Although some positive aspects of specific FA on reproduction and immunity have been identified, further research is needed. Supplemental fat will continue to have a "space" in diets for dairy cattle, but selection of sources should be determined based on cost, energy value, composition of specific FA, and ease of handling and blending into diets.

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