UNIVERSITY OF FLORIDA

IFAS EXTENSION

Using Fat in Lactating Cow Rations [1]

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Added fats have been used successfully for a number of years in poultry and swine rations but only recently in dairy cattle rations. The reason is probably because most of the earlier work showed little to no advantage in adding fat to dairy cattle rations and frequently the results were negative in terms of both fat percent and milk production.

In recent years, with a greater understanding and desire to use higher energy rations for early lactation and high producing cows, a renewed interest has developed in the potential of fat as a more concentrated source of energy. Such a product could increase the energy density of the diet. Other possible advantages would be to improve palatability and to reduce dustiness.

Fats presently being studied and used in lactating cattle rations include tallow (animal fat), blends of animal and vegetable oils and, more recently, protected or "rumen bypass" fats.

Protected indicates that the fat is inert or bypasses the rumen and as such does not interfere with rumen metabolism. Natural sources of fat as found in whole cottonseed and soybeans are frequently used as sources of energy for dairy cattle. A comparison of several feedstuffs is given in Table 1 .

Conventional diets for lactating dairy cows (without added fat or fat-rich feedstuffs) will generally contain less than 3% ether extract (fat). Since fat is a concentrated source of energy, the National Research Council lists fats and oils as having an energy value of 182% total digestible nutrients (TDN) or 238 Mcal/cwt (2.38 Mcal/1b) (NRC 1978).

Metabolism of Fats

A large portion of the energy needs for ruminants is derived from short chain volatile fatty acids such as acetic and propionic acids. These are produced by microbial fermentation of various concentrates and fibrous feedstuffs in the diet.

In contrast, the fatty acids which result from the hydrolysis of most dietary fats by microbial enzymes are primarily long-chain fatty acids, but do vary depending on type of fat. Long chain fatty acids are mostly insoluble in rumen digests [2] and are therefore not absorbed through the rumen wall. They are, however, readily incorporated into cell membranes of rumen bacteria and protozoa and some escape or bypass the rumen.

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The presence of either saturated or unsaturated long chain fatty acids in the rumen may modify microbial populations and alter rumen fermentation. Unsaturated fatty acids appear to have more adverse effects on rumen fermentation than do saturated fats. Physical coating of the fiber with added fat has been proposed as a possible theory for the sometimes observed depressed fiber digestibility. Also, the addition of cations such as calcium has in some cases tended to reduce the negative effects of added fat on fiber digestibility.

Mineral Elements and Fats

It has recently been proposed that the addition of certain mineral elements, especially calcium, to ruminant rations can partially overcome the negative effects of added fat on rumen microbes. A simultaneous depression in fiber digestibility and a lower retention of calcium due to the excretion of calcium soaps led to the belief that reduced availability of calcium to the rumen microbes decreased fiber digestion (5). Apparently, the extra supplemental calcium (0.8 to 1.0% calcium in total ration dry matter) is used in the formation of insoluble soaps with the long chain fatty acids (LCFA) and in this form the LCFA's are less detrimental to the rumen microbes (2). In the abomasum, the calcium soaps dissociate and become available for absorption because of a lower pH (more acid). As pH increases in the ileum and large intestine, soaps are reformed and excreted (5, 12, 14). The addition of more calcium appears to be unrelated to the needs of calcium by the animal (5).

Increasing Energy Density

A common practice in dairy herds in recent years has been to feed early-lactation high-producing cows a more energy-dense ration because high-producing cows are often in negative energy balance during early lactation. In order to obtain such a ration, the use of fat or fat-rich feedstuffs was a logical step for increasing the energy content of rations for high-producing cows. Adequate amounts of good quality roughage remain very important if success is to be obtained with such rations.

Whole cottonseed is a fat-rich feedstutf that has been fed successfully by Florida dairymen even though research has frequently shown a reduction in milk fat percentage when roughages were limited or not fed free choice. Field observations have shown that adequate amounts of roughage are important if success is to be obtained with whole cottonseed rations as with rations containing added fat.

High Producing Dairy Cows

It is common knowledge that high-producing cows convert feed energy to milk energy more efficiently than low producers. Also, production responses to added energy intake is greater in high producing cows in early lactation while there is less response in later lactation. Cows in early lactation can frequently utilize 90 to 100% of the added net energy toward milk production whereas in late lactation, only 40 to 50% will end up in milk; the remainder is stored as body fat (Table 2). Feeding extra grain at the expense of feeding adequate amounts of roughage, however, frequently reduces energy efficiency due to milk fat depression and possible acidosis type conditions.

The information in Table 2 shows the expected milk response of cows at different stages of lactation, and levels of milk production to each additional pound of daily dry matter intake. Note that the greater production responses are in early lactation and for high producing cows. As an example, cows producing above 60 lbs of milk and in the first 150 days of lactation would have a response of about two pounds of milk for each one pound added dry matter intake.

In order to take advantage of this naturally occurring phenomenon, dairymen will want to develop a system of feeding so that the early lactation cows (high group) will have access to a high-energy and well-balanced ration over a long period (14 to 16 hrs) per day (high group). Use of high quality forages such as corn silage and alfalfa hay should be emphasized. Cottonseed hull type rations remain an acceptable alternative but should be supplemented with adequate amounts of good quality forage to maintain normal milk fat percent.

Cows in lactation beyond 200 days should be challenged but fed more according to level of milk production (see Fact Sheet DS 15 on group feeding cows). An attempt to stimulate late lactation cows may result in only marginal returns and possibly cause fattening and less milk production. Excessive fattening usually leads to an increase in metabolic problems in the next lactation. (Figure 1)

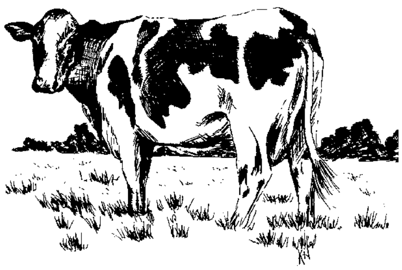

Figure 1.

Research

A series of studies have been conducted at the University of Florida to study the value of added fat to lactating dairy cattle rations. In trial 1, 36 lactating Holstein cows were used to study two different forms of cottonseed hulls (CSH) and sunflower hulls with and without an added commercial blended hydrolyzed fat (0 or 2.5%) and 35% byproduct roughages on an air dry basis. The results are shown in Table 3 .

Addition of a high energy fat (HEF) decreased milk fat from 3.47 to 3.31%(P <.10) and milk protein from 2.96 to 2.86% (P <.05). Dry matter intake was slightly less with added fat and actual milk yield slightly greater (56.1 vs 55.9 lb/day). With the reduced fat percent, 3.5% FCM was lower (54.1 vs. 55.0 lb/day) for cows receiving added fat in their diets. There were no significant differences between dry matter intake and organic matter or acid detergent fiber digestibility values.

In trial 2, 24 early lactating Holstein cows were used during the hot season to study the effect of three different byproduct roughages (CSH, ground corrugated boxes (GCB) and a combination of CCB and coarse peanut hulls (PNH)) and added animal tallow (0 or 2.5%) on an as dry basis. Rations contained 30% CSH, 20% GCB, and a combination of 10% CCB and 10% PNH. The results are shown in Table 4 .

Main effects of added animal tallow were not significant except for depressing effects on milk fat percent (3.12 vs. 3.43). Examination of means showed that added fat had no depressing effect on milk fat percent in GCB diets (3.31) but did in PNH (3.14) and CSH (3.20) diets. Apparently, the GCB rations contained a more effective fiber or greater buffering capacity.

In trial 3, corn silage was used as the source of roughage at two levels (35% and 66% of ration dry matter) to study a new experimental protected fat (calcium tallowate). The dried calcium tallowate contained 14% calcium and 156% TDN and was fed at three levels (0, 2 and 4% of diet dry matter). The results are shown in Table 5 .

The results in Table 5 show a dramatic drop in milk production when corn silage was increased from 35 to 66% of the ration dry matter. Also, fat percent due to feeding calcium tallowate showed a linear decrease (P <.01). Both actual milk production and 3.5% FCM decreased as level of fat increased in the ration.

In trial 4, a mid-lactation field trial was conducted at North Florida Holsteins Dairy during the summer to study the value of a new protected fat Megalac on animal performance. Megalac is a protected fat containing calcium salts of palm oil fatty acids (44% palmitic, 40% oleic, 9.5% linoleic and 6.5% other fatty acids), 8 to 10% calcium and about 85.0% fat. Approximately 300 Holstein cows were divided into two groups and fed either 0 or 1.2 lb of Megalac daily for 60 days. The two groups were balanced for pretreatment milk yields and days in milk. Animals were fed twice daily, milked three times a day and while in corrals had free access to shade, cooling ponds and fair quality hay. All cows received rations containing corn silage, wet brewers' grains, whole cottonseed, corn distillers and concentrate. The results are in Table 6 .

Megalac fed cows consumed less daily dry matter intake and produced slightly more milk. Cows apparently reduced their feed intake to correspond with their energy needs under hot weather conditions rather than consuming more of a slightly higher energy feed. In contrast to other fat experiments conducted at Florida, Megalac showed no depressing effect on milk fat percent. Similarly, Chalupa et al. (3) reported an increase in milk production (44.7 vs. 49.5 lb/ day) and fat percent (3.23 vs. 3.49%) when feeding two levels of Megalac (0 and 4%) to a limited number of lactating cows. Their results agree with our larger lactation study and certainly demonstrates the effectiveness of Megalac as a good "bypass" fat.

In trial 5, an early lactation field trial was conducted at North Florida Holsteins Dairy to further study the effect of Megalac on animal performance. The cows were divided into two groups of approximately 140 cows per group and milked three times a day during the trial. Group 2 received one pound of Megalac daily for 90 days. The 90-day period was divided into three periods of approximately 30 days each according to the normal scheduled DHI test day. All cows in groups 1 and 2 received similar diets containing a mixture of corn silage, wet brewers' grains, whole cottonseed and concentrate. Whole cottonseed was fed at the rate of four pounds daily per cow. The results are in Table 7 .

Dry matter intake was slightly greater for Megalac cows (56.7 vs. 55.1 lb/day) than for control cows. As in the previous field trial, Megalac fed cows produced more milk and had a slightly higher fat percent. The results show that cows receiving the protected fat were gradually increasing in milk production as the experiment progressed.

Economic Considerations

Profit margins become exceedingly important when a new product or feed additive is being considered for feeding to lactating dairy cows. The product should provide a response that would result in higher returns to the dairy. Responses are frequently difficult to measure unless research has been conducted using the product under controlled and unbiased conditions with statistical analysis. Without sound research, a response may not be predictable, repeatable or real. Responses may be measured in terms of increased milk production, higher fat test, more dry matter intake, improved conception, or meaningful and useful measurements such as improved health.

Fats produced from animal and vegetable byproducts have been commercially available for a number of years and are less expensive than protected fats. Such fats, however, tend to give variable results and often cause fat depression. Protected fats are more expensive but do give more consistent results in high producing cows. The higher the milk production potential of the animal, the greater will be the response during early lactation.

Summary

Research conducted to date suggests possible adverse effects when adding animal tallow and/or blends of animal and vegetable fat to lactating dairy cattle rations in Florida. Most of our studies have shown a linear decrease in milk fat percent with increasing levels of added fat. Some studies (12), however, have shown increases in both milk production and fat percent . In the studies with a protected fat (Megalac), increases were obtained in milk yield and fat percent.

Studies by several investigators (12) suggests the importance of feeding adequate roughage when adding fat to lactating dairy cattle rations. The type of roughage used may be equally important . It appears that a more positive response in performance can be obtained when alfalfa hay is a part of the diet.

Also, increasing the amount of calcium in the diet appears beneficial in the digestive tract by alleviating the detrimental effects the long chain fatty acids have on microbes. The added calcium partially prevents this inhibitory effect by forming insoluble calcium soaps in the rumen (5, 12). Thus, calcium should be increased from 0.70 to about 0.8 to 1 percent and magnesium from 0.20 to about 0.25 to 0.30 percent of the total ration dry matter.

References

1. Beede, D.K 1985. "Whole cottonseed interactions with different forage." Proceedings of the 22nd annual Florida Dairy Production Conference. pp. 64-69.

2. Chalupa, W., B. Vecchiarelli, A.E Elser, D.S. Kronfeld, D. Sklan, and D.L. Palmquist. 1986. "Ruminal fermentation In Viro as influences by long-chain fatty acid." *J. Dairy Sci* . 69:1283.

3. Chalupa, W., B Vecchiarelli, D. Sklan and D.S. Kronfeld 1985. "Responses of rumen microorganisms and lactating cows to calcium salts of long chain fatty acids." *J. Dairy Sci* . 68 (Suppl. 1): 110 (Abstr.).

4. Erdman, R . 1987. "Take advantage of how cows use energy. " *Hoard's Dairyman* , April 10.

5. Fielding, A.S. and W.J. Miller. 1986. "Calcium and fat interactions in ruminant nutrition." Proc. Ga Nutr. Conf. pp.51-53.

6. Harris, B. Jr., J.V. Briceno, and H.H. Van Horn. 1987. "Influence of feeding a bypass fat during hot weather on performance of lactating cows in a large dairy." *J. Dairy Sci* . 70(Suppl. 1): (Abstr.).

7. Heinrichs, A.J., T.E. Noyes, and D.L. Palmquist. 1981. "Added dietary fat for milk and fat production in commercial dairy herds." *J. Dairy Sci.* 64:353.

8. Heinrichs, A.J., D.L. Palmquist, and H.R. Conrad. 1982. "Feed intake patterns of cows fed high fat grain mixtures." *J. Dairy Sci.* 65:1325.

9. Herbein, J.H., L.A. Bower, and C.N. Miller. 1986. "Lactational and metabolic responses to calcium stearate or tallow in diets of primiparous and multiparous cows in early lactation." *J. Dairy Sci* . 69(SuppL 1):213 (Abstr.).

10. Johnson, R.R, and K. E. Mcclure, 1973. High fat rations for ruminants. II. "Effects of fat added to corn plant material prior to ensiling on digestibility and voluntary intake of silage." *J. Animal Sci* . 36:397.

11. Palmquist, D.L and H.R. Conrad. 1978. High fat rations for dairy cows. "Effects on feed intake, milk and fat production, and plasma metabolites." *J. Dairy Sci* . 61:890.

12. Palmquist, D.L. and T.C. Jenkins. 1980. "Fat in Lactation Rations: Review." *J. Dairy Sci* . 63:1.

13. Smith, N.E., W.E. Dunkley, and A.A. Franke. 1978. "Effects of feeding protected tallow to dairy cows in early lactation." *J. Dairy Sci.* . 61:747.

14. Spearow, A.C., and A.K. Clark. 1984. "Digestibilities of complete rations containing whole-rolled sunflower seeds treated with three levels of calcium." *J. Dairy Sci* . 67(Suppl. 1):129 (Abstr.).

15. Van Horn, H.H., B. Harris, Jr., M.J. Taylor, K.C. Bachman, and C.J. Wilcox. 1984. "By-product feeds for lactating dairy cows: Effects of cottonseed hulls, sunflower hulls, corrugated paper, peanut hulls, sugarcane bagasse, and whole cottonseed with additives of fat, sodium bicarbonate, and Aspergillus oryzae product on milk production." *J. Dairy Sci.* 67:2922.

Table 1.

Table 1. Energy Provided by Various Feedstuffs		
	Mcal/lb dry matter[2]	
	Net Energy for Lactation	TDN %
Alfalfa hay	0.57	56
Corn meal	0.92	88
Whole cottonseed	1.04	98
Soybean meal	0.86	81
Whole soybean	0.99	94
Tallow (fats and oils)	2.38	182
Protected Fat (Megalac)	2.03	154
1Nutrient Requirements of Dairy Cattle (NRC) 1978. (Mcal) = Megacalories		

Table 2.

Table 2. Expected Milk Response from Increasing Dry Matter Intake By One Pound at Various Stages of Lactation					
MilkProduction	Days in Lactation				
(lb)	42	96	154	210	266
40	1.7	1.7	1.6	1.4	1.0
60	2.2	1.9	1.9	1.7	1.3
80	2.2	2.0	1.8	1.5	1.4
100	2.4	2.2	1.8	1.6	1.4
1Assumes 3.5% fat milk and a net energy value of 0.74 megacalories per pound of ration dry matter net energy for lactation (R. Erdman, Univ. Of Maryland)					

Table 3.

Table 3. Least Squares Means for Main Effects of Roughage Treatments and Added Dietary Fat (HEF)[1]

Dietary	DM Intake (lb)	Milk Yield(lb)	Fat (%)	Milk Protein (%)	3.5% FCM (lb)
Control	51.7	55.9	3.47	2.96	55.9
2.5 % Added Fat	50.6	56.1	3.31	2.86	54.1

1Van Horn et al. JDS 67:2922. DM=dry matter, FCM= fat-corrected milk, HEF=high energy fat.

Table 4.

Table 4. Least Squares Means for Main Effects of Roughage Source and Added Fat. [1]

Dietary	DM Intake (lb)	Milk Yield (lb)	Fat (%)	3.5% FMC (lb)	Digestible Oragnic Matter (%)
Control	40.5	49.9	3.43*	49.3	62.1
2.5 % Added Fat	40.0	49.7	3.12	46.6	64.2

Van Horn et. Al. HDS 67:2922.*P<.01

Table 5.

Table 5. Least Squares Means for Dry Matter Intake, Milk Yield and Composition.[1]						
Dietary		DM Intake (lb)	Milk Yield(lb)	Fat (%)	Milk Protein (%)	3.5% FCM (lb)
Corn Silage (35 %)						
	Control	57.0	67.2	3.33	3.32	65.4
	2% Ca. Tal.	59.7	67.0	3.23	3.27	64.1
	4% Ca. Tal.	53.1	66.6	2.75	3.27	58.5
Corn Silage (66%)						
	Control	50.1	57.0	3.73	3.28	59.1
	2% Ca. Tal.	50.0	58.6	3.50	3.21	58.6
	4% Ca. Tal.	46.2	59.6	3.32	3.25	57.9
1Unpublished data, Van Horn and Harris.						

Table 6.

Table 6. Least Squares Means for Dry Matter Intake, Milk Yield and Composition.[1]					
Dietary	DM Intake (lb)	Milk Yield(lb)	Fat (%)	Milk Protein (%)	3.5% FCM (lb)
Megalac (1.2 lb)	38.9	45.3	3.60	3.08	46.0
Control	42.7	44.8	3.58	3.05	45.4
*Church and Dwight Co., Inc., Princeton, N.J.					

Table 7.

Table 7. Least Squares Means for Dry Matter Intake, Milk Yield and Composition.

Measurements	Control	Megalac
No. of Observations	407	366
Avg. days in milk	67.30	71.90
Dry matter intake (lb/day)	55.10	56.70
Milk yield (lb/day)	77.95	78.56
Fat, %	3.23	3.32
Protein, %	2.99	2.95
4% FCM (lb/day)	68.75	70.24
Somatic Cell Count	2.90	2.88
Period 1 (4% FCM) (lb/day)	66.55	67.45 + 0.90
Period 2 (4% FCM) (lb/day)	71.29	72.54 + 1.25
Period 3 (4% FCM) (lb/day)	67.99	70.93 + 2.94*
* (P<.05)		