Case Report: Ration Manipulations During Passover and Milk Fat Depression in an Israeli Dairy Herd

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ABSTRACT

This report describes a case of milk fat depression (MFD) that occurred in a commercial Israeli dairy herd during spring 2012. Fat yield decreased by 15% during two weeks in response to changes in the rumen fermentation profile. Diet changes included a decrease in effective fiber content of the ration as a result of changes in roughage sources and the feeding of finely ground concentrates. Fat yield responded positively to corrections made in the roughage source together with changes in concentrate processing method. During the episode cows did not show any apparent health disorders. In the following months following adjustments to the diet there was an increase in claw lesions related to increased rumen fermentation changes.

Key Words: Milk Fat, Depression, Biohydrogenation, Rumen, Concentrates, Nutrition

INTRODUCTION

Milk fat arises from two sources: The first is the *de novo* synthesis within the mammary gland during which short and some of the medium chain fatty acids are synthesized by the mammary gland using acetate and to a lesser extent, β-hydroxybutyrate as carbon sources. The second source of milk fat is the uptake of preformed fatty acids from the circulation. These include the remainder of the medium chain and all of the longer chain fatty acids which are absorbed from the digestive tract or originate from the mobilization of body fat reserves (1).

Fat yield and composition are affected markedly by physiological and environmental factors. One example of a physiological factor is the elevated milk fat content post calving as a response to the animal's energy requirements (2, 3). Nutrition is an environmental factor affecting milk fat content and represents a practical tool to alter its yield and composition. An example of a nutritional effect on milk fat is the low milk fat depression syndrome, typically referred to as MFD (4). MFD is most accurately diagnosed by a reduction in milk fat yield and not milk fat percent (4). The later can be influenced by a change in milk volume with no apparent changes in fat yield. Milk fatty acid composition changes during MFD and therefore diagnosis of MFD can be further verified through fatty acid analysis of milk in affected herds (5).

Diet-induced MFD is a consequence of two combined processes: the first is a digestive process in the rumen and the second is a reduction in synthesis in the mammary gland (6). Research in the past years has established that changes in ruminal microbial processes are an essential component for the development of MFD, these changes are often associated with an increase in ruminal acidity (7). For MFD to occur polyunsaturated fatty acids (PUFA) must be present in the rumen and the pathways of their biohydrogenation must be altered. Therefore, the induction of MFD requires both the presence of PUFA in the diet and an altered rumen environment (8, 9, 10).

Many theories have evolved regarding MFD, current knowledge supports the "biohydrogenation theory" (4, 11). This theory hypothesizes that under certain dietary conditions the pathways of rumen biohydrogenation are altered to produce unique fatty acid intermediates which are potent inhibitors of milk fat synthesis at the mammary gland level (11, 12, 13, 14).

MFD occurs in different feeding situations, these include diets supplemented with fish or plant oils and low roughage diets (13). Alterations of the rumen environment arise either due to the fiber content of the diet, the physical characteristics of the roughage, the acid load through fermentable carbohydrates or the combination of the above. Although ration composition is not the only parameter determining rumen stability, nutritionists should pay attention when formulating diets to potential rumen motility, acid production and buffer flow (15). When roughage supply is inadequate less fermentable carbohydrates should be supplied and more buffers should be included in the diet (11).

This case report describes an exceptional case of true milk fat depression in an Israeli dairy herd that occurred between March and May 2012.

Table 1: Diet composition and nutrient supply before nutritional changes

Item	% DM
Sorghum silage	13.6
Wheat silage	13.5
Wheat hay	4.6
Alfalfa hay	3.2
Concentrate mix	65.1
DM	60
CP	16.7
NDF	32.3
Roughage NDF	18.5
NE_L Mcal/kg	1.77
NFC	38.1
Fat	5.3

DM = Dry Matter
CP = Crude Protein
NDF = Neutral Detergent Fiber
NE_L = Net Energy for lactation
NFC = Non-Fibrous Carbohydrates

STATISTICAL METHODS

Milk fat content was modeled using a marginal model (PROC MIXED, SAS 9.3) (17). The model used was:

$$Y = PAR\ (3\ \text{index variables}) + MIM\ (10\ \text{index variables}) + PAR*MIM + e$$

Where Y was the mean milk fat content (kg) for a particular test-day, PAR the parity group for a given cow (parity 1, parity 2 or parity 3 or greater), MIM was the month in milk for a given test-day and "e" a complex error term representing the within-cow correlation of milk fat measurements and the residual error. The covariance structure chosen for the R (error) matrix was autoregressive, i.e. $\left(\sigma^2 \rho^{|i-j|}\right)$.

Statistical significance was considered significant at P values of less than 0.05

CASE HISTORY

During March 2012 an Israeli commercial dairy herd of 310 Holstein cows located in the Beit She'an valley suffered from a substantial decrease in milk fat yield. Milk production estimated for 305 days and corrected for parity (mature equivalent 305 milk production) was 12,190 kg per cow. At the time of the event the herd was 197 days in milk; daily milk production was 37 kg with a fat yield of 1.37 kg and a protein yield of 1.1 kg. Lactating cows were fed a standard milking cow total mixed ration (TMR) three times a day. Diet composition and nutrient supply is displayed in Table 1.

Cows were housed in large covered loose housing systems and were milked 3 times daily in computer controlled milking parlor. Milk components were monitored by a real time milk analyzer, AfiLab (Afikim Computerized Systems, Israel). From the beginning of April all lactating animals received cooling showers prior to milking in the holding pen and high pressure water evaporation at the feed bunk. The herd was insured through the "Hachaklait" a mutual society for veterinary medicine which provided a complete herd-health service and was visited by a veterinarian at least twice weekly during the described period.

Few days prior to the drop in fat yield the two major changes in the nutrition strategy were performed. The first change (Figure 1: Point 1 on the 13/3/2012) was a switch of all the sorghum silage to corn silage on a dry matter basis. At the same time the herd shifted to a new concentrate supplier who processed all concentrated feeds by grinding them to a fine particle size. These two changes were immediately followed by a remarkable drop of 15% in fat yield two weeks later (Figure 1: Point 2 on the 27/3/2012). Due to the Jewish Passover religious restrictions just prior to the religious holidays, the amount of corn silage in the ration was further increased at the expense of the wheat silage. This

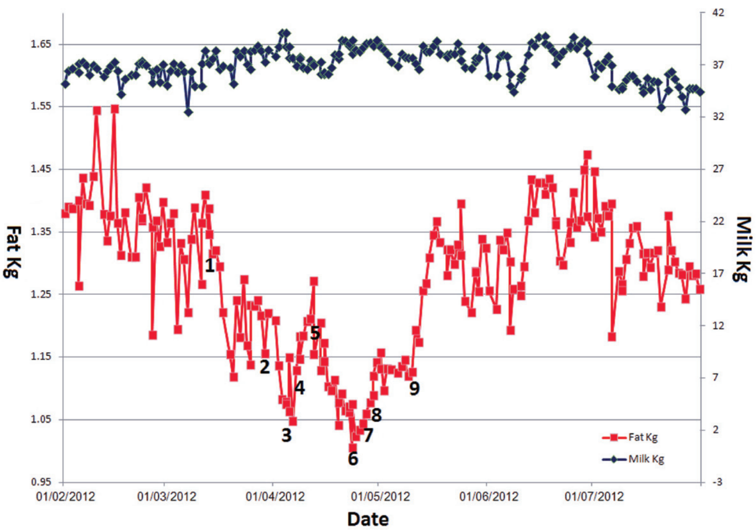

Figure 1: Milk fat content and milk yield by date. The point in time when changes in diet were affected are annotated by numbers on the graph and described in the text.

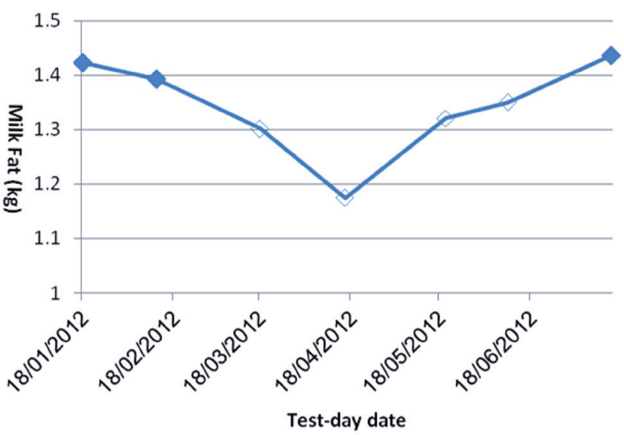

Figure 2: Milk FAT Content (Kg) by Test Day Date
Empty markers indicate a value that differs from the value on the last test-day (i.e. 15/07/2012), P < 0.001.

change was followed by a further drop in fat yield by 8%. During the following weeks milk, protein and lactose yield remained constant. Group feed consumption remained at the same level with no observable apparent health disorders.

A few attempts were made to correct milk fat content. These changes are listed in Table 2 and annotated in Figure 1.

From point 9 onwards on the 10/5/2012, milk fat content remained stable and within normal ranges in spite of heat stress that began at the end of May. In the following months there was an increase in incidence of lame cows; most of these cows were diagnosed as suffering from metabolic related lesions such as laminitis, abscesses and white line disease. Apart from the lame cows no other signs of sub-Acute Rumen Acidosis (SARA) such as displaced abomasums (DA's), diarrhea or reduced feed efficiency were apparent (16).

Our results demonstrate that deviations in milk fat content in the months between February and July were statistically significant. (Figure 2, Table 3)

Table 3. – Milk fat Content (Kg) by Test Day Date

Date	Fat Reduction	Std Error	P Value
18/01/2012	-0.01	0.02936	0.6864
12/02/2012	-0.04	0.02878	0.1361
18/03/2012	-0.13	0.02737	<0.0001
16/04/2012	-0.26	0.02635	<0.0001
20/05/2012	-0.11	0.02516	<0.0001
10/06/2012	-0.09	0.02292	0.0002
15/07/2012	0		

Table 2: Ration manipulations carried out by date to correct the decline in the milk fat content. The time-line is annotated in Figure 1 by the critical points indicated in the table.

Date	Description Of Ration Manipulation
4/4/12	The amount of coarse hay was increased (Point 3)
8/4/12	The amount of corn silage was increased (Point 4)
15/4/12	At the end of Passover the ration concentrates was changed back to composition fed prior to Passover (Point 5)
24/4/12	Addition of 1 kg wheat silage as fed on top of ration with addition of 50 grams sodium bicarbonate (Point 6)
26/4/12	Addition of 2 kg wheat silage as fed on top of ration with addition of 80 grams sodium bicarbonate and water for homogenization of the TMR (Point 7)
1/5/12	New ration formulation: Reduction in the amount of corn silage, reduction in the amount of unprotected fat and a change in the profile of fermentable carbohydrates (Point 8)
10/5/12	A reversion to the original concentrate supplier; feeds are rolled as opposed to fine grinding (Point 9)

DISCUSSION AND CONCLUSIONS

To our best knowledge this is the first report of a true MFD in Israel. Most complaints of MFD in Israel refer to fat percent of milk and not fat yield. Unfortunately apart from the statistical analysis that was done fatty acid analysis of milk to verify MFD was not preformed in this case.

Two nutritional factors altered rumen environment and contributed to the reduction in fat synthesis in this herd. The first factor was the abrupt change in roughage source from sorghum silage to corn silage without compensating for the reduction in fiber effectiveness of the corn silage. A change of this nature would cause a reduction in the size of the floating mat in the rumen, decrease rumination time, decrease buffering capacity and flow to the rumen and would probably increase the acid load in the rumen due to an increased amount of non- structural carbohydrates in the corn silage (7, 18). (Unfortunately sorghum and wheat silages were not available by the time this investigation took place).

The second factor contributing to the milk fat content reduction was the change in the physical properties of the concentrates. It is well accepted that rumen motility is driven by fiber particle size (19, 20). Some researchers (21) showed that particles greater in size than 1.18 mm. are required for rumen motility while others (22) showed that particles greater in size than 3.35 mm. are required. This indicates that in addition to fiber from roughage the particle size of concentrated feeds contributed to motility and constant conditions in the rumen. Fine processing of grains especially in low fiber diets would eliminate their contribution to rumen health (15). Although not documented in the literature, previous experience of nutritionists with fine grinding of concentrate premixes (usually as part of the pelleting process) has led to decreases of fat content in milk in the past.

Major Points Supporting Conclusions:

1. Response of fat content to the corrections made in the ration: Fat content appeared to respond both to the increased amount of roughage added before Passover and to the increased amount of roughage added at the end of April. The sharp decrease in fat content observed at the end of Passover was a consequence of the reintroduction of fermentable carbohydrates such as wheat and barley with no correction to the amount of roughage or source.
2. The increased incidence of lame cows suffering from lesions related to rumen health that appeared in the following months after Passover supported the diagnosis of a compromised rumen environment that was probably a result of increased acidity (23). This conclusion does not fit with the lack of other health disorders related to SARA. One explanation for the lack of these health disorders could be related to the good management on the farm and especially the bunk management (15). Another explanation could be that rumen fermentation was altered in a manner that was suitable for the formation of the described unique fatty acid intermediates but not in a way that would compromise the function of the floating mat (15). In this case scenario, lameness would be the result of farm conditions such as quality of previous hoof trimming, increased environmental humidity or increased trauma to the claws due to extended standing time during cooling showers.
3. Fat content returned to normal values once the ratio of roughage to concentrates was increased. This change in fat content was accompanied by a decrease in protein yield which might have reflected a decrease in fermentable energy sources in the diet.

   As previously described fat production in the mammary gland is dependent on the consumption of PUFA in combination with an altered rumen environment, typically due to increased acidity. When troubleshooting events for MFD, one should check the amount of PUFA in the diet and determine whether the rumen environment is compromised. These investigations should be carried out by the herd nutritionist and veterinarian together.

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