Journal of Animal and Feed Sciences, 13, Suppl. 1, 2004, 499–502

Effects of fat supplementation in early lactation dairy cows

T. Kokkonen[1,6], J. Taponen[2], M. Tuori[1], S. Lohenoja[1], M. Kulcsar[3], C. Delavaud[4], Y. Chilliard[4] and A.T. Tesfa[5]

[1]Department of Animal Science, University of Helsinki, P.O. Box 28, 00014, Finland
[2]Department of Clinical Veterinary Medicine, University of Helsinki
Pohjoinen pikatie 800, 04920 Saarentaus, Finland,
[3]Faculty of Veterinary Science, Szent István University
P.O. Box 2, H-1400 Budapest, Hungary
[4]Herbivore Research Unit, INRA
Theix-63122 St-Genes Champanelle, France
[5]National Veterinary and Food Research Institute (EELA)
P.O. Box 45, 00581 Helsinki, Finland

ABSTRACT

Twenty-four cows were fed with 0 (NF), 3.5 (MF) or 7 (HF) % of calcium salts of palm fatty acids in the concentrate for 8 weeks after calving. The increase of total DMI in group MF tended to be slower than in the other groups during lactation weeks 1 to 4. Fat supplementation increased milk fat content linearly during lactation weeks 1 to 4. Liveweight and fat depth changes and concentration of plasma NEFA suggest that tissue mobilization was greater in MF than in other groups. Treatment did not significantly affect plasma hormone concentrations.

KEY WORDS: dairy cow, energy intake, milk production, tissue mobilization

INTRODUCTION

Fat supplementation of early lactation diets is an attractive alternative to diminish the gap between energy intake and the demand of high milk yield. Energy density of fat is high and long chain fatty acids are used efficiently for milk fat synthesis. Large amounts of fat may, however, have a negative impact on microbial fibre digestion in the rumen and reduce feed intake. Feeding calcium salts of fatty acids alleviates this problem (Coppock and Wilks, 1991). Another potential drawback of fat supplementation can be, paradoxically, increased lipid mobilization from adipose tissue, which is possibly facilitated by decreased blood insulin or merely a consequence of increased milk yield (Chilliard, 1993; Staples et al., 1998).

[6] Corresponding author: e-mail: tuomo.kokkonen@helsinki.fi

MATERIAL AND METHODS

In a randomised complete block design 24 Ayrshire cows were divided to groups with 0 (NF), 3.5 (MF) or 7% (HF) of calcium salts of palm fatty acids (Ca-PFA) in concentrate (Raisio Feed Ltd, Raisio, Finland). For the first 8 weeks of lactation, grass silage was fed *ad libitum*, and concentrate allowance was increased to 15 kg/d within 20 days. A digestibility experiment was conducted with 12 cows, using acid-insoluble ash (AIA) as an internal marker. Metabolizable energy (ME) content of the silage was 11.0 MJ/kg DM, and ME contents of the concentrates were 12.6, 13.1 and 13.6 MJ/kg DM for NF, MF and HF.

Milk yield and feed intake were recorded daily. Milk samples for composition analyses were taken at 1, 2, 4, 6 and 8 wk after parturition. Liveweights (LW) were recorded daily during the week of calving, and at 2, 4, 6 and 8 wk after calving. Ultrasonic measurements of fat depth (FD) were made at calving day, and 4 and 8 weeks after calving. Blood samples were taken from superficial epigastric (mammary) vein at 1, 3, 5, 7, 14, 21, 28 and 56 d after calving and from coccygeal (tail) vessel 5 and 28 d after calving.

The data for milk yield, composition, and feed intake from weeks 1 to 4 and weeks 5 to 8, as well as blood composition data from 1 to 28 d, were analysed as repeated measures. The statistical model included effects of treatment, block, time, and interactions of time and treatment, and time and block. The changes of LW and FD, digestibility of diet, average ME balance within the two periods and plasma NEFA at 56 d after calving were analyzed with the model including the fixed effect of treatment and random effect of block.

RESULTS

Although silage and total dry matter intakes (DMI) were not significantly different between treatments (Table 1), the increase of total DMI in group MF tended to be slower during lactation weeks 1-4 (time x treatment $P<0.10$) than in the other groups. Organic matter digestibility of diet did not differ between treatments. Digestibility of ether extract increased (linear effect, $P<0.001$) and NDF digestibility decreased (linear effect, $P<0.05$) with Ca-PFA.

Ca-PFA had no significant effect on milk yield, but the decline of milk yield during lactation weeks 5 to 8 tended to be smaller in MF and HF groups than in NF group (time x treatment $P<0.10$). Ca-PFA increased milk fat content (linear effect, $P<0.05$) during lactation weeks 1 to 4.

Group MF had greater LW loss (quadratic effect, $P<0.05$) (Table 2) during lactation weeks 1 to 4 and tended to have greater decrease of FD during lactation weeks 5 to 8 than the other groups (quadratic effect, $P<0.10$). Plasma NEFA increased linearly ($P<0.01$) with Ca-PFA 8 weeks after calving.

Table 1. Feed intake, milk yield and diet digestibility

Item	Diet			SEM	Significance			
	NF	MF	HF		Lin.	Quadr.	time	time × treatm.
Weeks 1 to 4								
silage, kg DM/d	9.7	9.2	10.0	0.33			***	
total DMI, kg/d	19.9	19.4	20.5	0.46			***	º
ME, MJ/d	239	236	56	5.5	º		***	º
milk yield, kg/d	40.9	39.9	40.7	1.39			***	
milk fat content, g/kg	44.2	47.8	49.2	1.33	*		***	
Weeks 5 to 8								
silage, kg DM/d	9.5	9.3	9.3	0.49			º	
total DMI, kg/d	23.0	23.0	23.0	0.51			*	
ME, MJ/d	275	279	290	5.8			º	
milk yield, kg/d	46.3	48.2	48.4	1.33			**	º
milk fat content, g/kg	40.9	41.0	41.6	1.55				
Digestibility								
organic matter, g/kg	725	719	710	8.4			—	—
ether extract, g/kg	602	705	736	14.8	***	º	—	—
NDF, g/kg	592	547	546	22.1	*		—	—

º P<0.10, * P<0.05, ** P<0.01, *** P<0.001

Table 2. Energy balance, liveweight and fat depth changes and plasma NEFA

Item	Diet			SEM	Significance	
	NF	MF	HF		Lin.	Quadr.
Weeks 1 to 4						
ME balance, MJ/d	-43.8	-54.7	-40.2	12.62		
liveweight change, kg	-9	-38	-16	9.5		*
fat depth change, mm	-1.8	-2.3	-2.2	0.62		
NEFA (tail vein), mmol/l [1]	0.42	0.53	0.51	0.063		
NEFA (mammary vein), mmol/l [1]	0.39	0.52	0.48	0.042		
Weeks 5 to 8						
ME balance, MJ/d	-20.3	-30.9	-22.3	8.25		
liveweight change, kg	-9	-8	-2	6.4		
fat depth change, mm	-0.9	-2.4	-0.5	0.68		º
NEFA (mammary vein, 56 d), mmol/l	0.15	0.26	0.28	0.026	**	

[1] significant time effect (P<0.001), no significant (P>0.10) time x treatment interaction
º P<0.10, * P<0.05, ** P<0.01

Table 3. Concentrations of plasma hormones during lactation weeks 1 to 4

Item	Diet			SEM	Significance			
	NF	MF	HF		Lin.	Quadr.	Time	time x treatm.
Leptin, ng/ml	4.75	4.52	4.36	0.264			***	
Insulin, µIU/ml	14.58	13.54	12.99	1.350			***	
T3, nmol/l	2.04	1.71	1.83	0.126			***	
T4, nmol/l	36.37	31.80	34.56	2.558			***	
IGF-1, nmol/l	3.78	3.03	3.22	0.323			***	

*** P<0.001

Plasma leptin, insulin, T3, T4 and IGF-1 were not significantly affected by treatment (Table 3).

DISCUSSION

A review by Allen (2000) shows that supplementation of dairy cow diets with Ca-PFA has a linear negative effect on DMI, which may be partly a problem of acceptability. In the present trial, no acceptability problems were observed. Decreased NDF digestibility suggests that supplemental fat was not completely inert in the rumen. However, the effect of Ca-PFA on feed intake was not uniform. Feed intake tended to decrease in group MF, but not in group HF.

Supplemental dietary fat increases concentration of NEFA in plasma (Chilliard, 1993). Therefore, plasma NEFA is not a very good indicator of lipid mobilization in fat supplementation studies. Nevertheless, contrary to expected linear increase, plasma NEFA (in mammary vein) tended to be highest in MF group ($P=0.11$, quadratic effect) during lactation weeks 1 to 4. Along with greater LW and FD loss, this gives evidence for increased tissue mobilization in group MF. Reviews by Chilliard (1993) and Staples et al. (1998) suggested that dietary fat supplementation may depress plasma insulin and enhance lipolysis in adipose tissue. The present study cannot fully confirm this theory, as there were no significant differences in plasma hormone concentrations.

CONCLUSIONS

Ca-PFA increased milk fat content during lactation weeks 1 to 4 and tended to increase persistency of peak yield during lactation weeks 5 to 8. Although a tendency towards increased lipid mobilization was observed with medium Ca-PFA, no consistent shift towards increased catabolism was seen with Ca-PFA.

REFERENCES

Allen M.S., 2000. Effects of diet on short-term regulation of feed intake by lactating dairy cattle. J. Dairy Sci. 83, 1598-1624

Chilliard Y., 1993. Dietary fat and adipose tissue metabolism in ruminants, pigs, and rodents: A review. J. Dairy Sci. 76, 3897-3931

Coppock C.E., Wilks D.E., 1991. Supplemental fat in high-energy rations for lactating cows: effects on intake, digestion, milk yield, and composition. J. Anim. Sci. 69, 3826-3837

Staples C.R., Burke J.M., Thatcher W.W., 1998. Influence of supplemental fats on reproductive tissues and performance of lactating cows. J. Dairy Sci. 81, 856-871