Effects of feeding rapeseed oil, soybean oil or linseed oil on stearoyl-CoA desaturase expression in the mammary gland of dairy cows

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Introduction

Extensive biohydrogenation of dietary fatty acids (FA) occurs in the rumen of dairy cattle, giving rise to a high proportion of saturated FA in milk fat. Saturated FA may contribute to increased risks of cardiovascular disease and the metabolic syndrome (Williams, 2000). Saturated FA, as well as several mono-unsaturated FA, can be desaturated by Δ9-desaturase, also known as stearoyl-CoA desaturase (SCD), present in the mammary gland of dairy cows. It is known that nutrition, especially polyunsaturated FA (PUFA), can affect the expression of SCD in rodents (Ntambi, 1999). Although various FA have been identified which can affect mammary SCD expression in dairy cattle, such knowledge is limited compared with rodents. Therefore, the objective of this study was to investigate the effect of dietary FA supplementation of C18:1 *cis*-9, C18:2 *cis*-9,12 or C18:3 *cis*-9,12,15, by feeding rapeseed oil, soybean oil or linseed oil respectively, or its mixture, on SCD expression in the mammary gland of dairy cows.

Material and methods

Twenty-eight Holstein-Friesian cows in mid-lactation, averaging 153±82 days in milk (DIM), were blocked according to parity, DIM, milk yield, fat content and protein content, and randomly assigned to one of the four dietary treatments. The total mixed ration (TMR) of the four treatments included 2% of either: rapeseed oil (RO), soybean oil (SO), linseed oil (LO) or 2% of a 1:1:1 mixture of the three oils (MO). Cows were milked daily at 06:00 h and 18:00 h and were grazing on pasture from 08:00 h until 16:00 h. At other times, cows were inside the barn and fed the TMR. Treatment period lasted 3 weeks and after the treatment ended, cows were fed a control diet again (without oil supplementation) for 4 weeks. Individual milk production and feed intake for each treatment group were recorded daily. On the last day of the treatment period and control period, a biopsy from the mammary gland was taken, according to the method of Farr *et al.* (1996) with minor modifications. These biopsies were used for analysis of SCD expression by using quantitative RT-PCR, and 18S was used as endogenous control. In addition, on the last day of the treatment period and control period, one milk sample (combined morning and evening milking) was obtained for FA analysis. The FA were extracted (Folch *et al.*, 1957), methylated and analysed by gas chromatography (TRACE GC Ultra™). Methylated FA were separated using a fused silica capillary column (100m, 0.25mm, i.d. 0.2μm thickness; Restek RT-2560).

Results

Milk yield and milk fat, protein and lactose content did not differ (P>0.05) between the four dietary treatments (data not shown). Feeding SO resulted in a significant down-regulation (P=0.003) of SCD compared to RO and LO (Figure 1).
In addition, the desaturase indices calculated from FA pairs in milk, which are frequently used to estimate *in vivo* SCD activity, were lower for SO and this was significant (P=0.038) for C16:1 c9/C16:0 compared to MO (Table 1).

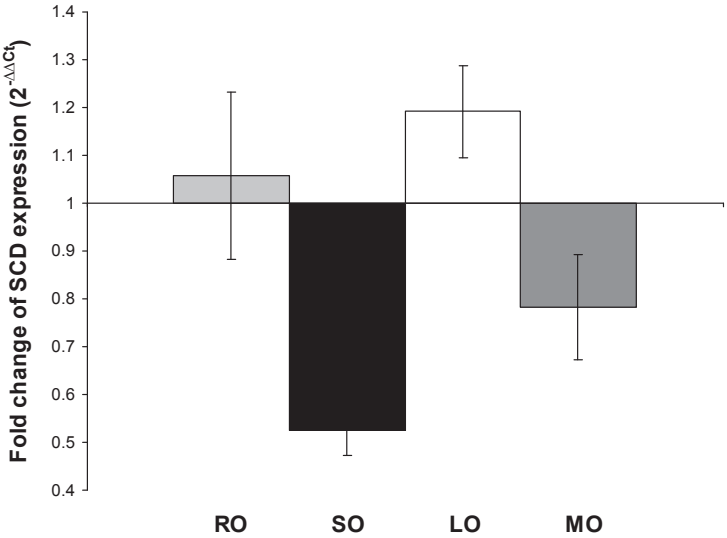

Figure 1. SCD expression of cows fed various oil supplements. Expressed as fold change compared to control ($2^{-\Delta\Delta Ct}$ method). Vertical lines represent the SEM with n=7 per group.

Table 1. Desaturase indices from milk fatty acids of cows fed various oil supplements; n=28 for the control group, and n=7 per treatment group.

Treatment	Control[1]	RO	SO	LO	MO	sem	P
Desaturase indices (calculated from milk FA)							
C14:1 c9/C14:0	0.13	0.13	0.10	0.11	0.15	0.02	0.112
C16:1 c9/C16:0	0.08	0.08[ab]	0.06[b]	0.08[ab]	0.09[a]	0.01	0.038
C18:1 c9/C18:0	2.35	2.44	1.94	2.19	2.54	0.17	0.068

[1] Control values are shown for comparison only, and are not statistically analysed against the treatments.
[a,b,c,d] Means within a row without common superscript differ (P<0.05).

Conclusion

This study shows that mammary SCD expression is significantly down-regulated in dairy cows by feeding soybean oil, and this is partly reflected by the lower desaturase indices in the milk.

References

Farr, V.C., K. Stelwagen, L.R. Cate, A.J. Molenaar, T.B. McFadden and S.R. Davis, 1996. An improved method for the routine biopsy of bovine mammary tissue. J. Dairy Sci. 79: 543-549.

Folch, J., M. Lees and H. Sloane Stanley, 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226: 497-509.

Ntambi, J.M., 1999. Regulation of stearoyl-CoA desaturase by polyunsaturated fatty acids and cholesterol. J. Lipid Res. 40: 1549-1558.

Williams, C.M., 2000. Dietary fatty acids and human health. Ann. Zootech. 49: 165-180.