

Effects of intravenous infusion of trans-10, cis-12 or cis-9, trans-11 conjugated linoleic acid (CLA) on milk fat synthesis and composition in dairy goats during mid-lactation

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Abstract

The effects of an intravenous infusion of trans-10, cis-12 or cis-9, trans-11 conjugated linoleic acid (CLA) were evaluated during two consecutive days on milk fat synthesis and fatty acid profile of milk fat in dairy goats. Neither milk yield nor milk fat content were modified by any of the CLA isomers. The concentration of each CLA was not increased after each infusion. Milk fatty acid profile was not affected by any of the tested CLA's, except for an increase in the proportion of linoleic acid. This suggests that goats and cows respond in different manners regarding mammary metabolism of these fatty acids.

Keywords: Conjugated linoleic acids, milk fat, milk composition, goat

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Introduction

Conjugated linoleic acids (CLA) are positional and geometrical isomers of linoleic acid (cis-9, cis-12 Δ C18:2) found mainly in dairy products of ruminants. Numerous studies have recently focused on these fatty acids (FA) because of their putative or demonstrated health benefits in animal or human models (Martin & Valeille, 2003). Moreover, in dairy cows the cis-9, trans-11 isomer (rumenic acid) and more probably the trans-10, cis-12 isomer have been shown to be potent inhibitors of milk fat synthesis when infused in the abomasum (Baumgard *et al.*, 2000).

In dairy goats very little data are available on the concentrations of the CLA in milk fat (Schmidely *et al.*, 2002) and it has been suggested (Chilliard *et al.*, 2003) that the mammary metabolism of these FA could differ between goats and cows. Since an intravenous infusion of CLA produced the same drop in fat content as an abomasal infusion in cows (Viswanadha *et al.*, 2003), we studied the effect of the intravenous infusion of these two CLA isomers separately on milk fat yield and composition in dairy goats.

Materials and Methods

Four multiparous dairy goats (150 \pm 15 DIM) were fed a total mixed ration (TMR) *ad libitum* twice daily. The TMR was formulated to contain 35% lucerne hay, 25% sugar beet pulp and 40% concentrate on a dry matter (DM) basis. The CP, ADF and EE concentrations of the diet were 160, 218 and 41 g/kg DM, respectively with a net energy for lactation value of 6.75 MJ/kg DM.

Each goat was infused for two days, alternatively with one of the CLA isomers in a random order, with a 2-day washout period between the two infusions to minimize any carry-over effect of the infused CLA. The infusions of CLA commenced at 09:00 after the morning milking and 1 h after the morning feeding and lasted eight hours. The CLA were diluted in 200 mL of pure 10% Intralipid and were infused through catheters inserted in the jugular vein. The dose of cis-9, trans-11 CLA and trans-10, cis-12 CLA were 1 g/d and 0.2 g/d, respectively, which was estimated to approximately double their proportion in milk fat.

Milk samples were collected at each milking the day before, during and after infusions. For both morning and evening milking the evaluation criteria were the change from baseline in milk yield, milk fat content and milk fatty acid profile after a 2-day infusion. Baselines were defined as the measurements assessed prior to infusion, at morning and evening milking, respectively. Changes from baseline were compared to 0, using a sign-rank test (Proc Univariate of SAS). Data are presented as means \pm standard error of the means (s.e.m.).

Results

Milk yield, milk fat content and cis-9, trans-11 CLA concentration in milk fat were 1440 (\pm 70) g/d, 43 (\pm 2) g/L and 0.48 (\pm 0.06) g/100 g milk fat before cis-9, trans-11 CLA infusion and 1415 (\pm 88) g/d and 37 (\pm 2) g/L and 0.51 (\pm 0.06) g/100 g fat before trans-10, cis-12 CLA infusion. Trans-10, cis-12 CLA was not detected in any milk sample before the infusions. Infusion of the trans-10, cis-12 CLA or of the cis-9, trans-11 CLA isomers had no effect on milk yield or fat yield at morning or evening milking (Table 1). Milk fat content was not affected by the infusions of CLA. However, after the infusion of cis-9, trans-11 CLA, 2 goats exhibited a sharp decrease in milk fat content at the evening milking (-15 and -12 g/L).

Table 1 The effect of intravenous infusion of trans-10, cis-12 or cis-9, trans-11 conjugated linoleic acid (CLA) on milk yield, fat content and fat yield in dairy goats¹

Infusion Milking	cis-9, trans-11 CLA		trans-10, cis-12 CLA	
	Morning	Evening	Morning	Evening
Milk yield, g/milking	-269 \pm 130	+100 \pm 42	-131 \pm 76	+25 \pm 58
Fat yield, g/milking	-6.6 \pm 6.1	-6.4 \pm 7.1	+1.9 \pm 2.5	+6.0 \pm 6.1
Fat content, g/L	+1.12 \pm 3.1	-8.5 \pm 4.5	+2.5 \pm 0.8	+3.3 \pm 5.0

¹Data are presented as means \pm s.e.m. (n = 4)
 Within rows, effect of infusion not significant

The infusion of the two CLA isomers did not result in increased concentrations of these isomers in milk fat (Table 2). In particular, no trans-10, cis-12 CLA was detected in the milk of the goats infused with this FA. Short chain FA (C6:0 and C8:0), medium chain FA (from C10:0 to C16:0) and stearic acid concentrations were not altered by any FA infused, regardless of whether it was samples from morning or evening milking (data not shown). Trans vaccenic acid (trans-11 C18:1) was decreased by rumenic acid infusion only at morning milking. The most consistent change after infusion of each CLA was the increase in linoleic acid at both milkings. Simultaneously, the linolenic acid concentration in milk fat was increased but only significantly by the cis-9, trans-11 CLA infusion.

Table 2 Variations in fatty acid profile (g/100 g of fatty acids) of milk fat at morning and evening milkings in dairy goats intravenously infused with trans-10, cis-12 or cis-9, trans-11 conjugated linoleic acid (CLA)^{1,2}

Infusion Milking	cis-9, trans-11 CLA		trans-10, cis-12 CLA	
	Morning	Evening	Morning	Evening
Fatty acids				
Cis-9 C18:1	+1.16 \pm 0.36	+0.46 \pm 0.70	-0.78 \pm 0.3	+0.35 \pm 0.35
trans-11 C18:1	-0.21 \pm 0.02 (†)	-0.33 \pm 0.34	-0.12 \pm 0.09	0.01 \pm 0.13
Cis-9, trans-11 CLA	-0.08 \pm 0.03	-0.03 \pm 0.08	-0.10 \pm 0.09	+0.02 \pm 0.04
trans-10, cis-12 CLA	ND	ND	ND	ND
Cis-9, cis-12 C18:2	+0.95 \pm 0.25 (†)	+0.71 \pm 0.24 (†)	+1.00 \pm 0.13 (†)	+1 \pm 0.2 (†)
Cis-9, cis12, cis-15 C18:3	+0.05 \pm 0.01 (†)	+0.12 \pm 0.03 (†)	0.10 \pm 0.03	+0.10 \pm 0.10

¹Data are presented as means \pm s.e.m. (n = 4)
 Within rows † signifies differences significant at P < 0.10

²ND - not detected

Discussion

In dairy cows abomasal and blood infusions of mixtures of CLA or pure CLA proved that the trans-10, cis-9 CLA was a potent inhibitor of milk fat synthesis. Such a response was obtained with 3 mg/kg body weight with a 5-day infusion period (Viswanadha *et al.*, 2003), a dose equivalent to that used in our study. Moreover, the dose used for cis-9, trans-11 CLA in our study (17 mg/kg body weight) was higher than that

infused in the abomasum by Chouinard *et al.* (1999), who observed a reduction in milk fat content and milk fat yield. However, in our study, we did not observe any change in the milk fat content of dairy goats. The infusion of these CLA isomers induced a reduction in mammary synthesis of short-chain and medium chain FA (Chouinard *et al.*, 1999; Viswanadah *et al.*, 2003), which is in contrast to our results. Furthermore, we observed an increase in the milk fat percentage of linoleic acid and to a lesser extent for linolenic acid after the infusion of the two CLA isomers. This is in contrast with results obtained in cows and probably reflects a greater uptake of this long-chain unsaturated FA after the CLA infusion. This could be an indication that some differences in mammary metabolism of these conjugated FA exist between goats and cows, as suggested by Chilliard *et al.* (2003). However, difference in duration and in frequency of infusion between those cow studies and our study could also be responsible for this lack in response to CLA in goats.

Conclusion

Short-term intravenous infusion of cis-9, trans-11 or trans-10, cis-12 CLA isomers failed to induce a decrease in milk fat yield or milk fat content in mid lactation dairy goats. Further studies are needed to confirm this, perhaps utilising higher doses of CLA.

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