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A Conjugated Linoleic Acid Supplement Containing *Trans*-10, *Cis*-12 Conjugated Linoleic Acid Reduces Milk Fat Synthesis in Lactating Goats[1]

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ABSTRACT

The effect of conjugated linoleic acid (CLA) supplements containing *trans*-10, *cis*-12 for reducing milk fat synthesis has been well described in dairy cows and sheep. Studies on lactating goats, however, remain inconclusive. Therefore, the current study investigated the efficacy of a lipid-encapsulated *trans*-10, *cis*-12 CLA supplement (LE-CLA) on milk production and milk fatty acid profile in dairy goats. Thirty multiparous Alpine lactating goats in late lactation were used in a 3 × 3 Latin square design (14-d treatment periods separated by 14-d intervals). Does were fed a total mixed ration of Bermuda grass hay, dehydrated alfalfa pellets, and concentrate. Does were randomly allocated to 3 treatments: A) unsupplemented (control), B) supplemented with 30 g/d of LE-CLA (low dose; CLA-1), and C) supplemented with 60 g/d of LE-CLA (high dose; CLA-2). Milk yield, dry matter intake, and milk protein content and yield were unaffected by treatment. Compared with the control, milk fat yield was reduced 8% by the CLA-1 treatment and 21% by the CLA-2 treatment, with milk fat content reduced 5 and 18% by the CLA-1 and CLA-2 treatments, respectively. The reduction in milk fat yield was due to decreases in both de novo fatty acid synthesis and uptake of preformed fatty acids. Milk fat content of *trans*-10, *cis*-12 CLA was 0.03, 0.09, and 0.19 g/100 g of fatty acids for the control, CLA-1, and CLA-2 treatments, respectively. The transfer efficiency of *trans*-10, *cis*-12 CLA from the 2 levels of CLA supplement into milk fat was not different between treatments and averaged 1.85%. In conclusion, *trans*-10, *cis*-12 CLA reduced milk fat synthesis in lactating dairy goats in a manner similar to that observed for lactating dairy cows and dairy sheep. Dose-response comparisons, however, suggest that the degree of reduction in milk fat synthesis is less in dairy goats compared with dairy cows and dairy sheep.
Key words: conjugated linoleic acid, milk fat depression, goat, lactation

INTRODUCTION

Trans-10, *cis*-12 conjugated linoleic acid (**CLA**) is an intermediate produced in the biohydrogenation of linoleic acid by rumen bacteria (Bauman and Griinari, 2003). As reviewed by Bauman et al. (2008), this bioactive fatty acid is associated with diet-induced milk fat depression, and its role in the regulation of milk fat synthesis has been extensively characterized in dairy cows. Formulations of CLA that offer some protection against rumen biohydrogenation have been developed and used as management tools to examine the controlled reduction in milk fat during situations in which dietary energy intake may be inadequate to meet nutrient requirements (Griinari and Bauman, 2006).

Trans-10, *cis*-12 CLA has also been found to reduce milk fat yield or content, or both, in other lactating nonruminant and ruminant species in addition to the dairy cow (Bauman et al., 2008). In lactating sheep, administration of a supplement containing *trans*-10, *cis*-12 CLA decreases milk fat production, with the magnitude of the reduction being similar to dairy cows when the dose is expressed on a metabolic BW basis or when compared on the basis of the *trans*-10, *cis*-12 content of milk fat (Lock et al., 2006; Sinclair et al., 2007; Weerasinghe et al., 2007). In contrast, recent investigations involving goats reported that *trans*-10, *cis*-12 CLA had little or no effect on milk fat yield (Erasmus et al., 2004; Schmidely and Morand-Fehr, 2004; de Andrade and Schmidely, 2006). These findings contrast from the consistent effects of CLA on decreas-

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ing milk fat production observed with cows and sheep, and may be a result of species differences and the fact that the goat may be unresponsive or less sensitive to *trans*-10, *cis*-12 CLA (Sanz Sampelayo et al., 2007). Alternatively, it may be a consequence of experimental design or study differences in the aforementioned goat investigations, or both.

Our objective was to determine if a lipid-encapsulated supplement containing *trans*-10, *cis*-12 CLA would inhibit milk fat synthesis in lactating goats. We based our approach on published studies with cows and sheep in terms of CLA dose, duration of treatment, and experimental design. A secondary objective was to examine the effects of *trans*-10, *cis*-12 CLA on milk fatty acid composition and transfer of this CLA isomer to milk fat. In some cow and sheep studies, the CLA-induced reduction in milk fat has been associated with an increase in milk yield and milk protein yield, although this appears to coincide with situations when energy or protein was limiting (Griinari and Bauman, 2006); thus, responses in these variables were also of interest.

MATERIALS AND METHODS

Animals and Experimental Design

The experiment was conducted under the approval of Langston University's Institutional Animal Use and Care Committee. Thirty multiparous, nonpregnant Alpine dairy goats in late lactation (145 ± 36 DIM) were used from the E (Kika) de la Garza American Institute for Goat Research (Langston University). Goats were housed indoors and offered fresh feed once daily at 0800 h. Diet was provided as a TMR, and major dietary components included Bermuda grass hay, alfalfa pellets, and a concentrate mixture (Table 1). The diet was initially offered at approximately 3 kg/d, (DMI represented ~3.5% of BW) and was then adjusted daily to allow for an ad libitum intake. Daily feed intakes were recorded using the Calan headgate system (American Calan Inc., Northwood, NH). In addition, salt blocks (American Stockman, North American Salt Co., Overland Park, KS) and fresh water were available ad libitum.

Does were milked twice daily at 0430 and 1600 h, and milk yield was recorded at each milking throughout the experimental period by the automated Westfalia milking system (Westfalia Systemat, Elk Grove Village, IL). The regular milking routine included teat cleaning, automatic take-off of milking units, and teat dipping. At the start of the experiment, goats were free from clinical mastitis, and milk production averaged 2.87 ± 0.21 kg/d (mean ± SE).

Table 1. Ingredient and chemical composition of the experimental diet

Composition[1]	TMR
Ingredient, %	
Alfalfa pellets	19.69
Bermuda grass	19.93
Corn	22.16
Wheat middlings	17.01
Soybean meal	9.81
Liquid molasses	5.91
Megalac[2]	2.69
Sodium bicarbonate	0.90
Limestone	0.86
Vitamin A, D, E premix[3]	0.49
Trace mineral salt premix[4]	0.45
Magnesium oxide	0.10
Chemical analysis	
DM, %	90.2
CP, % of DM	11.4
NDF, % of DM	35.4
ADF, % of DM	20.5
NE_L, Mcal/kg of DM	1.39

[1]Ingredient and chemical composition do not include the lipid-encapsulated conjugated linoleic acid supplement.

[2]Calcium soap of palm oil fatty acids (Church & Dwight Co. Inc., Princeton, NJ). Fatty acid composition, as reported by the company, is 1.2% 12:0 + 14:0, 48% 16:0, 5% 18:0, 36% *cis*-9 18:1, and 9% 18:2.

[3]The vitamin premix contained the following per gram: 8,800 IU of vitamin A, 1,760 IU of vitamin D_3, and 1.1 IU of vitamin E.

[4]The traced mineralized salt contained the following: 96 to 99% NaCl and at least 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.011% Co, 0.004% I, and 0.032% Zn.

The experimental design was a 3 × 3 Latin square with 14-d treatment periods separated by 14-d washout intervals. The CLA supplement was a lipid-encapsulated formulation (**LE-CLA**; marketed as Lutrell by BASF AG, Ludwigshafen, Germany) comprised of 2 CLA isomers in equal proportions: *cis*-9, *trans*-11 and *trans*-10, *cis*-12 CLA. Dietary treatments were as follows: A) unsupplemented (control), B) supplemented with 30 g/d of LE-CLA (low dose; CLA-1), or C) supplemented with 60 g/d of LE-CLA (high dose; CLA-2). The LE-CLA supplement had a lipid content of 65% and a fatty acid composition of 15% *trans*-10, *cis*-12 CLA; 15% *cis*-9, *trans*-11 CLA; 9% 16:0; 42% 18:0; 12% *cis*-9 18:1; and 1% *cis*-9, *cis*-12 18:2. Thus, the CLA-1 and CLA-2 treatments provided *trans*-10, *cis*-12 CLA at a rate of 3 and 6 g/d, respectively. The LE-CLA supplement was mixed with dry molasses on a daily basis and given before feeding to assure it was consumed totally.

Goats averaged 50 ± 7.4 kg of BW and 2.5 BCS (1 to 5 scale by 0.5 increments; Villaquiran et al., 2005) at the start of the study. They were weighed, and condition was scored at the beginning and end of each 14-d treatment period. Milk was sampled at each milking and analyzed for fat, protein, lactose, solids, and SCC using a CombiFoss 5000 (Foss Food Technology, Eden Prairie, MN) at Langston University DHI Laboratory.