

Effect of level of rumen protected CLA supplementation on milk yield and composition in Saanen goats

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Abstract

The objective of this study was to investigate the effect of level of rumen protected conjugated linoleic acid (CLA) 35 on milk yield and composition in Saanen goats. Eight multiparous goats were used in an eight animals and four periods repeated Latin square experimental design. Supplementation levels were based on 10% of the recommended level for cows. Goats were fed either a control, 1.3 g/d, 2.6 g/d or 3.9 g/d. The rumen protected CLA 35 contained 17.5% of each of the *cis* 9-*trans* 11 and *trans* 10-*cis* 12 isomers respectively. Supplementation of up to 3.9 g rumen protected CLA 35, which is on a bodyweight basis, equivalent to 150% of the recommended level for cows, did not affect milk yield or composition. In a second trial 10 additional goats were used in a two treatment factorial design and fed either 30 or 60 g of rumen protected CLA 35. Milk lactose, protein and milk urea nitrogen concentrations were not affected. When the average milk fat percentage of the two days prior to the trial was compared with the fat percentage on day 8, 60 g rumen protected CLA 35 reduced milk fat by 0.57 percentage units compared to 0.07 units when 30 g rumen protected CLA 35 was fed. The results suggest that much higher levels of rumen protected CLA/unit of body weight would be needed in goats, as compared to cows, to suppress butterfat production to the same extent as in cows. Therefore, dairy goats cannot merely be used as a model for cows in butterfat depression studies and more long-term studies on CLA supplementation of goats are needed.

Keywords: Conjugated linoleic acid, Saanen goats, milk composition, milk yield

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Introduction

Conjugated linoleic acids (CLA) are a group of fatty acids that are microcomponents of ruminant fat. Research interest in CLA stemmed from the fact that CLA has been shown to have anticarcinogenic properties and possibly other effects that would be positive for human health (Pariza, 2001).

As a consequence of the positive health effects of CLA, there has been a large effort to increase CLA content in milk, thus increasing the value of milk. A surprising result from studies that attempted to increase milk CLA was that CLA also significantly reduced milk fat percentage and yield (Chouinard *et al.*, 1999; Mackle *et al.*, 2002). Rumen protected CLA also decreased milk fat in cows fed either a total mixed ration (TMR) or pasture grazing (Giesy *et al.*, 1999; Medeiros *et al.*, 2000). The magnitude of milk fat depression depends on the amount fed and can be up to 50% (Baumgard *et al.*, 2002). The CLA supplements used in abovementioned studies contained various types of CLA. It is now well accepted that the *trans*-10, *cis*-12 CLA isomer is responsible for milk fat depression and the *cis*-9, *trans*-11 isomer is important due to its potential health benefits (Bauman *et al.*, 2001).

In most milk payment schemes a premium is paid for milk volume, milk fat, milk protein and hygienic quality. Nutritional strategies therefore aim to prevent depression of milk solids. There are, however, some scenarios in which reduced output of milk fat would be advantageous (Bauman *et al.*, 2001).

More than one third of fresh milk consumed in South Africa is purchased on the basis of volume and hygienic quality. Only some milk buyers require a minimum fat %. It would be pointless for milk producers supplying these milk buyers, to sell milk with a high fat content. They could benefit from CLA supplementation by producing higher volumes of low fat milk. Theoretically it would be possible to adjust the level of CLA supplementation to produce milk with a fat % preferred by the milk buyers.

Supplementation with CLA is also a strategy that could be employed during the immediate *post partum* phase to decrease the magnitude of the energy deficit by decreasing the amount of energy secreted as

milk fat. Theoretically a milk fat depression would relieve some of the energy demands of the fresh cow, allowing the cow to reach a higher peak production and increase overall performance (Baumgard *et al.*, 2002).

Results available in dairy cows, goats and sheep showed that responses to fat supplementation differ considerably between the species. Milk yield increases in mid-lactation cows, but not in goats and ewes. Milk fat content and secretion sharply increase in dairy ewes and goats, but not always in dairy cows in which it could often either decrease or remain unchanged. Milk protein content decreases in dairy cows and ewes, but not in goats. The reasons for these differences in dairy performance in response to fat supplementation between ruminant species are not easy to identify since less information is available for goats and ewes than for cattle (Chilliard *et al.*, 2003).

The demand for goat milk has increased significantly in South Africa and goat milk producers are constantly looking for ways to increase fluid milk production. A controlled milk fat depression through CLA supplementation has shown to increase milk production in Holsteins (Giesy *et al.*, 1999), but it is questionable whether these results can be extrapolated to goats. The purpose of this study was to determine the effect of short term supplementation of various levels of CLA on milk composition and yield in Saanen goats and to determine whether lactating goats could be used as a model for cows when conducting milk fat depression studies.

Materials and Methods

Multiparous Saanen goats (58 ± 10 days in milk) were used in an 8 animal and 4 period repeated Latin square design (Gill, 1978). Conjugated linoleic acid supplementation levels were calculated on a body weight (BW) basis and based on 10% of the manufacturer's recommended level for cows (26 g/d). The treatments were control (C), 50% of the recommended level for cows (0.5 CLA, 1.3 g/d), 100% of the recommended level for cows (1.0 CLA, 2.6 g/d) and 150% of the recommended level (1.5 CLA, 3.9 g/d). The rumen protected CLA 35 (RP CLA 35) contained 17.5% of the *cis*-9, *trans*-11 and 17.5% of the *trans*-10, *cis*-12 isomers, respectively (BASF Aktiengesellschaft, 67056 Ludwigshafen, Germany). Each of the four periods lasted eight days.

The goats were fed a pelleted lucerne and maize based total mixed ration (170 g CP/kg, 10.9 MJ ME/kg DM) *ad libitum*. The RP CLA 35 was administered orally each morning after milking. Milking times were 06:00 and 18:00 and goats were milked in a 10 point herringbone parlour. Milk production and dry matter intake were recorded daily and composite milk samples were taken two days before the onset of the trial and thereafter on days 1, 3, 5, 7 and 8 of each experimental period. Milk was analyzed for fat, protein, lactose and milk urea nitrogen (MUN) using a Milkoscan 6000 system (Hillerod, Denmark). An analysis of variance with the ANOVA model (SAS, 1994) was used to determine the significance between different levels of rumen protected CLA for the Latin square design. Means and standard error of the mean (SEM) were calculated. Significance of difference (5%) between means was determined by multiple comparisons, using the Tukey t-test (Samuels, 1989).

Preliminary inspection of results suggested no response in milk fat and yield due to CLA supplementations and a second trial was conducted using 10 additional multiparous Saanen goats in a two treatment factorial design. The purpose of this trial was to determine if milk fat would be depressed when feeding 30 g or 60 g of RP CLA 35/goat/d. This represents approximately a 10 and 20 fold increase respectively of the "recommended" level. Each treatment was randomly allocated to five goats and was fed for eight days. The goats were in the same stage of lactation and similar in milk production and composition. Management and sampling were similar to experiment 1. An analysis of variance with the ANOVA model (SAS, 1994) was used to determine the significance between different levels for the balanced data. The response in milk components was determined as the difference between the average milk composition of the 2d prior to the trial and d 8 of the experimental period.

Results and Discussion

The effect of various levels of RPCLA 35 on intake, milk yield and composition is shown in Table 1 (Trial 1). None of the parameters measured was affected by supplementation of up to 0.63 g of the *trans*-10, *cis*-12 CLA isomer. This is in contrast to studies where abomasal infusions of 2.5 g and 3.5 g respectively of the *trans* 10, *cis* 12 isomer reduced butterfat from 3.12 to 2.60% and from 3.00 to 2.28% in

cows (Baumgard *et al.*, 2002). Chouinard *et al.* (1999) reported a production increase of 3.6 kg/d and fat reduction of 0.52% in cows after supplementation with rumen protected CLA. Results from trial 1 suggest that dairy cows and goats differ in their responses to fat supplementation, suggesting that the dairy goat is perhaps not suitable to be used as a model for milk fat depression studies in cows. It has been suggested by Hart (2000) that rate of passage of digesta in goats is higher than in cows. In goats this could decrease the effect of dietary fatty acids on the yield of some ruminal factors that reduced mammary lipogenesis in cows.

Table 1 Effect of level of rumen protected conjugated linoleic acids (CLA) on milk composition, yield and dry matter intake of Saanen goats (Trial 1)*

	Control	0.5 CLA	1.0 CLA	1.5 CLA	s.e.m.
Milk (kg/d)	3.96	3.88	3.80	3.89	0.19
Fat (%)	3.53	3.61	3.65	3.50	0.21
Protein (%)	2.97	2.98	2.93	2.98	0.10
Lactose	4.58	4.63	4.61	4.61	0.10
MUN (mg %)	32.0	32.5	31.4	31.2	1.83
DMI (kg/d)	2.75	2.69	2.62	2.78	0.20

^{ab}Values in the same row with different superscripts differ at $P < 0.05$

*0.5 CLA = 1.3 g/d; 1.0 CLA = 2.6 g/d; 1.5 CLA = 3.9 g/d

MUN - milk urea nitrogen; DMI - dry matter intake

The effect of high levels of RPCLA 35 (Trial 2) on milk yield and composition of Saanen goats is shown in Table 2. Milk protein, lactose and MUN levels were not affected. Sixty grams of RPCLA 35, however, caused milk fat % to be reduced by 0.57 percentage units ($P < 0.05$) compared to 0.07 units with 30 g RPCLA 35 when comparing the average milk fat of the two days prior to the trial with that on day 8. Results suggest that much higher levels of RPCLA 35/unit of BW are needed in goats to suppress butterfat % to the same extent as in cows. Our results support the conclusion of Gulati *et al.* (2000) that further long term feeding and dose response trials need to be undertaken to study the effect of RPCLA 35 on milk yield and composition of dairy goats.

Table 2 Effect of supplementation of 30 or 60 g of rumen protected conjugated linoleic acid 35 (RPCLA) on milk composition response in Saanen goats (Trial 2)

	30 g RPCLA ¹	60 g RPCLA	s.e.m.
Change in ² :			
Fat (%)	0.07 ^a	0.57 ^b	0.20
Protein (%)	0.05	0.01	0.54
Lactose (%)	0.00	0.06	0.23
MUN (mg%)	1.28	3.73	4.31

^{ab}Values in the same row with different superscripts differ at $P < 0.05$

¹Product contained 17.5% each of the *cis* 9, *trans* 11 and *trans* 10, *cis* 12 isomers

²Percentage units change when the average milk composition of the 2d prior to the trial is compared to the average milk composition on d 8

MUN - milk urea nitrogen

Conclusion

Rumen protected CLA, based on level of supplementation data extrapolated from cow data, did not affect short term milk yield and composition of lactating Saanen goats. Results suggest that much higher levels of rumen protected CLA might be needed to significantly depress butterfat and the dairy goat cannot merely be used as a model when conducting butterfat depression studies with cows. Further long term dose response and lactation studies are needed to quantify the effect of RPCLA on dairy goat performance.

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References

- Bauman, D.E., Corl, B.A., Baumgard, L.H. & Griinari, J.M., 2001. Conjugated linoleic acid in the dairy cow. In: Recent Advances in Animal Nutrition. Eds. Garnsworthy, P.L. & Wiseman, J., Nottingham University Press, Nottingham, UK. pp. 221-240.
- Baumgard, L.H., Moore, C.E. & Bauman, D.E., 2002. Potential application of conjugated linoleic acids in nutrient partitioning. Proc. Southwest Nutr. Mgmt. Conf. Univ. Arizona, AZ, USA.
- Chouinard, P.Y., Corneau, L., Barbano, D.M., Metzger, L.E. & Bauman, D.E., 1999. Conjugated linoleic acids alter milk fatty acid composition and inhibit milk fat secretion in dairy cows. J. Nutr. 129, 1579-1584.
- Chilliard, Y., Ferlay, A., Rouel, J. & Lamberet, G., 2003. A review of nutritional and physiological factors affecting goat milk lipid synthesis and lipolysis. J. Dairy Sci. 86, 1751-1770.
- Giesy, J.G., Viswanadha, S., Hanson, T.W., Falen, L.R., McGuire, M.A., Skarie, C.H. & Vinci, A., 1999. Effects of calcium salts of CLA and estimated energy balance in Holstein cows in early lactation. J. Dairy Sci. 82 (Suppl. 1) 74 (Abstr.)
- Gill, J.L., 1978. Design and analysis of experiments in the animal and medical sciences. Vol 2. Iowa State University Press, Ames, IO.
- Gulati, S.K., Kites, S.M., Ashes, J.R., Fleck, E., Byers, E.B., Byers, Y.G. & Scott, T.W., 2000. Protection of conjugated linoleic/acids from ruminal hydrogenation and their incorporation into milk fat. Anim. Feed Sci. Technol. 86, 139-148.
- Hart, S.P., 2000. Nutrition for the high producing dairy doe. J. Anim. Sci. 78 (Suppl. 1), 8.
- Mackie, T.R., Kay, J.K., Auldist, M.J., MacGibbon, A.K.H., Philpott, B., Baumgard, L.H. & Bauman, D.E., 2002. Effects of abomasal infusion of conjugated linoleic acid on milk fat concentration and yield from product fed dairy cows. J. Dairy Sci. (Submitted).
- Medeiros, S.R., Oliveira, D.E., Aroeria, L.J.M., McGuire, M.A., Bauman, D.E., & Lanna, D.P.D., 2000. The effect of long term supplementation of CLA of dairy cow grazing tropical pasture. J. Dairy Sci. 83 (Suppl. 1), 169.
- Pariza, M.W., Park, Y. & Cook, M.E., 2001. The biologically active isomers of conjugated linoleic acid. Progress in Lipid Research 40, 283.
- Samuels, M.L., 1989. Statistics for the life sciences. Collier MacMillan Publishers, London.
- SAS, 1994. Statistical Analysis Systems user's guide: Statistics (Version 6). SAS Institute Inc., Cary, North Carolina, USA.