Increased Conjugated Linoleic Acid (CLA) in Milk Fat of Grazing Cows is not Explained by More CLA Production in the Rumen

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Introduction

Grazing and feeding high-oil diets increase the concentration in milk of conjugated linoleic acid (CLA), a demonstrated anticarcinogen. The increase has been attributed to more production of CLA as an intermediate in biohydrogenation of linoleic acid (18:2(n-6)) in the rumen. This theory explains the increase in milk CLA during oil feeding but cannot satisfactorily explain the increase during grazing, because formation of CLA (*cis* 9, *trans* 11 18:2) from 18:2(n-6) is known but formation from 18:3(n-3) is unknown. The predominant fatty acid in pasture forage is linolenic acid (18:3(n-3)) (60 to 70%) rather than 18:2(n-6) (5 to 20%). The objective of this study was to determine the relationship between production of CLA in the rumen and its secretion in milk, utilizing cows fed a TMR in confinement or grazing a mixed grass-legume pasture.

Materials and Methods

The experiment was conducted in June to July. Eight ruminally cannulated multiparous Holsteins were paired based on milk yield and each member of the pair was fed a TMR or grazed on a grass-legume (2 : 3) mixed pasture. Grazing cows were supplemented with a grain mix. After 21 days, cows within a pair were changed to the opposite diet and continued with the new diet for another 21 days. The TMR consisted of alfalfa silage, corn silage, and a concentrate portion containing primarily corn and soybean meal. The grain supplement offered to the grazing cows was the same as the concentrate contained in the TMR. The supplement was fed at the rate of 8.4 kg/day (DM), accounting for about 40% of the total feed intake. Rumen contents, omasal contents, blood plasma, and milk were sampled during the last 7 days in each of the 21-day periods and analyzed for CLA concentrations.

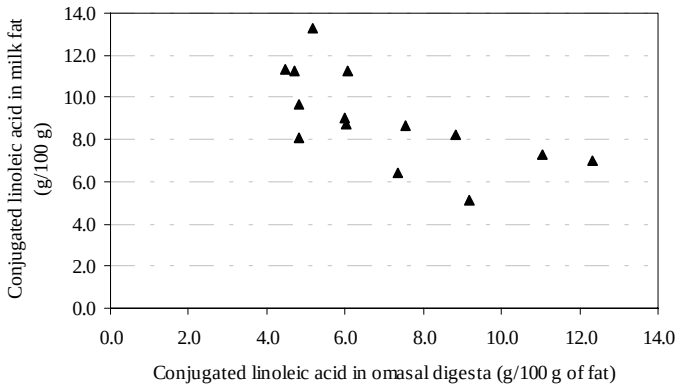

Figure1. Concentration of CLA in milk and omasal digesta fat.

Results and Discussion

Fat content of milk did not differ between treatments, but the concentration of CLA in milk fat was approximately 50% higher ($P < 0.05$) during grazing than during TMR feeding (Table 1). Unlike milk fat, fatty acids contained in ruminal and omasal digesta had lower ($P < 0.05$) concentrations of CLA during grazing than during TMR feeding. Figure 1 illustrates a negative relationship between CLA content in milk fat and CLA content of fat in omasal digesta.

Because the increased concentration of CLA in milk during grazing cannot be explained by production of CLA in the rumen, sources of milk CLA other than from metabolism in the rumen must exist. Possibly, CLA can be formed from *trans* 18:1(n-7) in body tissues by the activity of D-9-desaturase, an enzyme known to convert 18:0 to 18:1(n-9) in mammary microsomes. Conversion of *trans* 18:1(n-7) to *cis*-9, *trans*-11 18:2 (CLA) by this enzyme has not been demonstrated in vivo. However, a recent study (Corl et al. 1998) showed increased concentrations of conjugated *cis*-9, *trans*-11 18:2 and non-conjugated *cis*-9, *trans*-12 18:2 in milk fat when *trans* 18:1 isomers (n-7) and (n-6) were infused into the abomasum, substantiating this possibility. In the present study the concentration of CLA in blood plasma doubled during grazing as compared with TMR feeding, supporting the idea of synthesis of CLA in the body. It also suggests that the synthesis can occur in tissues other than the mammary gland.

If CLA is synthesized in the body, then why does grazing enhance this synthesis? Conceivably, availability of the essential cofactors that are involved in the D-9-desaturase activity could be a factor. However, a hypothesis that is gaining support is related to milk fat liquidity. A liquid form of milk fat is necessary for milk fat droplets to move to the surface of the secretory cell to be pinched off and for fat globules to be suspended in milk (Moore and Christie 1979). Normally, liquidity is assured by acylation of short chain fatty acids (low melting point) to the *sn*-3 position of the glycerol moiety. If short chain fatty acids are less available, 18:1(n-9), also low in melting point (14 °C), could be substituted. In general, short and medium chain fatty acids decrease in milk fat during grazing. Thus, more CLA may be synthesized during grazing in response to reduced supply of short and medium chain fatty acids. Because *trans* 18:1(n-7) (melting point 44 °C) does not exist as a liquid at body temperature and physicochemically resembles 18:0 (melting point 69 °C) rather than 18:1(n-9), its conversion into CLA (*cis*-9, *trans*-11 18:2) would be physiologically sound. Interestingly, desaturation of 18:0 is inhibited by short and medium chain fatty acids. If this was also true for desaturation of *trans* 18:1(n-7), more CLA would be produced when short and medium chain fatty acids are in low supply.

Conclusions

The content of CLA in milk was higher when cows were grazed on pasture than when fed a TMR. The increase in milk CLA could not be explained, however, by more CLA production in the rumen. Rather, higher CLA content of milk fat in grazing cows appeared to be related to desaturase activities in the body. It is possible that increased CLA production in the body is in compensation for a decreased supply of short and medium chain fatty acids required for maintenance of milk fat liquidity.

Reference

Corl, B.A., P.Y. Chouinard, D.E. Bauman, D.A. Dwyer, J.M. Griinari, and K.V. Nurmela. 1998. Conjugated linoleic acid in milk fat of dairy cows originating in part by endogenous synthesis from trans-11octadecenoic acid. J. Dairy Sci. 81(Suppl. 1):233.

Moore, J.H. and W.W. Christie. 1979. Lipid metabolism in the mammary gland of ruminant animals. Prog. Lipid Res. 17:347-395.

Table 1. Fatty acids in rumen contents, omasal contents, blood plasma, and milk fat of cows fed a total mixed ration or grazed on pasture.

Fatty acid	TMR	Grazing	SEM	*P*
Rumen contents				
Total fatty acids, % of DM	2.99	3.38	0.07	0.01
CLA, g/100 g of total fatty acids	0.43	0.27	0.04	0.02
Omasal contents				
Total fatty acids, % of DM	3.12	3.39	0.13	0.19
CLA, g/100 g total fatty acids	0.88	0.52	0.07	0.02
Blood plasma CLA, mg/l	0.53	1.04	0.16	0.07
Milk fat, %	3.21	3.19	0.09	0.89
CLA, g/100 g of total fatty acids	0.72	1.07	0.07	0.02