Short Communication: Seasonal Variation in *cis*-9, *trans*-11 Conjugated Linoleic Acid Content in Milk Fat from Nordic Countries

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ABSTRACT

We investigated the content of *cis*-9, *trans*-11 isomer of conjugated linoleic acid (CLA) and its seasonal variation in bovine milk fat from Denmark, Finland, Iceland, Norway, and Sweden. Milk samples were collected during winter and summer and analyzed using gas chromatography. The CLA content in milk samples from the Nordic countries ranged from 0.41 to 1.02 g/100 g total fatty acids. The CLA content was higher in Iceland (0.64 ± 0.02) than in the other countries together (0.57 ± 0.02), and the concentration in Icelandic and Danish milk (0.63 ± 0.03) was higher than in Finnish milk (0.48 ± 0.02) in a comparison of single countries. The CLA concentration during summer was on average 41.6% (11.9) higher than during winter (0.48 g/100 g (0.03) vs. 0.068 g/100 g (0.07)). Season exerted similar changes in all 5 countries. The concentration of CLA in milk fat from the Nordic countries seems lower than in milk from European countries reported previously in the literature, which may be due to shorter summers and longer winters in the Nordic countries. Health implications of varying concentrations of CLA need to be studied.

(Keywords: conjugated linoleic acid, milk fat, variation, Nordic countries)

Abbreviation key: CLA = conjugated linoleic acid.

The various isomers of conjugated linoleic acid (CLA) have been associated with positive health outcomes in animal (Terpstra et al., 2002) and human studies (Riserus et al., 2001; Belury et al., 2003). Bovine milk fats exhibit far higher CLA content than plant fats (Belury, 2002). According to Parodi (1997), the *cis*-9, *trans*-11 CLA isomer is the predominating CLA isomer (90%) in bovine milk fat. In experimental studies it has been demonstrated that CLA content in cow's milk is vari-

able and depends on, for example, the amount and kind of fatty acids in animal food (Chouinard et al., 2001; Ward et al., 2002). Recently, Precht and Molketin (2000) investigated the CLA content in milk from European countries and showed that there is seasonal variation. However, milk samples from all 5 Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden) were not included in this analysis. In Iceland, the use of fish meal in animal feeding is widespread, and cows are pastured during the summer months (Icelandic Agricultural Information Service, 1997), possibly resulting in a high content of CLA in cow's milk compared with milk from other Nordic countries. The aim of this study was to measure the CLA content in milk from the 5 Nordic countries and to investigate its seasonal variation.

A total of 84 samples of cows' milk as sold to consumers were collected: 48 from Denmark, Finland, Norway, and Sweden, in the capital areas, and 36 from Iceland, in 3 different places (west, northeast, and south). Samples collection was carried out during one year, twice in winter (December and March) and twice in summer (June and August).

Milk fat content was measured by the standard method from Rose-Gottlieb (IDF standard 9C, 1987). Fatty acids were analyzed as fatty acid methyl esters using capillary gas chromatography and quantified using methods from Ackman and Sipos (1964) and Bannon et al. (1986). The CLA content in cows' milk was measured as *cis*-9, *trans*-11 CLA isomer and expressed in wt% of total fatty acids.

Statistical analyses were performed using SPSS 10.0 (SPSS, 1999), and the values are shown as mean and standard error of the mean (Table 1). The variables were tested for normality using Kolmogorov-Smirnov test. The difference in the mean CLA content between Icelandic milk and milk from the other Nordic countries was calculated using an independent samples *t*-test. The effects of season and country on CLA content in milk were calculated using a split-plot ANOVA model. If the overall *F*-test was significant ($P < 0.05$), then Bonferroni posthoc tests were performed to discern differences between the 2 seasons and the 5 Nordic coun-

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Table 1. Effect of season and country on *cis*-9, *trans*-11 conjugated linoleic acid (CLA) content in milk.¹

Country	<i>cis</i> -9 <i>trans</i> -11 CLA (g/100 g total fatty acids)					
	Winter		Summer		Mean of all seasons ²	
	Mean	SEM	Mean	SEM	Mean	SEM
Denmark	0.52	(0.01)	0.74	(0.06)	0.63 ^a	(0.03)
Finland	0.41	(0.01)	0.55	(0.02)	0.48 ^{ab}	(0.02)
Iceland	0.51	(0.02)	0.76	(0.02)	0.64 ^b	(0.02)
Norway	0.51	(0.01)	0.72	0.06)	0.61	(0.04)
Sweden	0.46	(0.02)	0.64	(0.03)	0.55	(0.02)
Mean of all countries	0.48	(0.02)	0.68	(0.02)	0.58	(0.02)

¹Effect of season: $P < 0.001$; season $\times$ country interaction: $P > 0.05$.

²Bonferroni posthoc tests. ^aSignificant difference between Denmark and Finland: $P = 0.024$. ^bSignificant difference between Iceland and Finland: $P = 0.003$.

tries. A one-sided *t*-test was used to calculate whether the difference between the mean CLA content in Nordic samples compared to the mean reported from 11 European countries (calculated from Table 1 in Precht and Molketin, 2000) was significant.

Depending on season and origin of the milk samples, the CLA content is subjected to strong variations. The CLA content in milk samples from the Nordic countries ranged between 0.41 and 1.02 g/100 g of total fatty acids. The results of the split-plot ANOVA indicate that the CLA content was on average 41.6% (11.9) higher in summer than in winter (Table 1). The variation was similar in all 5 countries, that is, season exerts similar changes in CLA content in these countries.

The mean CLA content differed between the 5 Nordic countries (Table 1). The CLA content was higher in Icelandic milk than in milk from the other countries together ($0.64\% \pm 0.02$ vs. $0.57\% \pm 0.02$, $P = 0.030$). Fish oil is among the various dietetic factors known to increase CLA concentrations in milk fat. Thus, the use of fish meal in the animal diet, which is common in Iceland (Icelandic Agricultural Information Service, 1997), may explain the increase of CLA content in Icelandic milk compared with the other Nordic countries. Indeed, in a study conducted by Chouinard et al. (2001), supplementation of the animals' diets with fish oil (200 and 400 mL/d) resulted in a 3-fold greater CLA content than using a control diet. A comparison between single countries showed that Icelandic and Danish milk contained more CLA than Finnish milk; other differences between single countries were not significant.

The mean CLA content in milk samples from the Nordic countries was lower than that reported in milk from 11 other European countries ($0.58 \pm 0.02\%$ vs. 0.89% , $P < 0.001$). Seasonal variation in CLA content was also detected in the above-mentioned analysis of

European countries by Precht and Molketin (2000). According to the authors, this seasonal variation can be explained by the different feeding periods in winter and summer. In Germany, the seasonal variation was very high, with nearly 3-fold higher CLA concentrations in summer than in winter. On the other hand, Banni and Martin (1998) detected higher CLA concentrations in Italian milk fat in the winter season because in south Italy, cows are pastured during the mild winters rather than during the dry summers. Interestingly, CLA in milk from, for example, Ireland, shows no seasonal variation, because the cows are fed on pasture throughout the whole year (Precht and Molketin, 2000). It is well known that pasture feeding (summer) increases the content of CLA in milk fat compared to high concentrate allocations in winter. This is due to the high concentrations of omega-3 fatty acids in grass, which are a source of CLA. Shorter summers and longer winters in the Nordic countries could explain these indicated CLA differences between the Nordic and other European countries.

There is seasonal variation in the CLA content of Nordic milk samples. The CLA content is higher in summer than in winter, all Nordic countries showing similar seasonal changes. The use of fish meal as animal fodder in Iceland may explain the increase of CLA concentrations in Icelandic milk fat, which was significantly higher than in milk from the other countries together. However, in a comparison of single countries the only significant difference was a higher CLA content in Icelandic and Danish milk compared with Finnish milk. The results indicate a lower CLA content in Nordic than in European cows' milk on average, which may be related to shorter summers and, hence, to short periods of pasture feeding in the Nordic countries. The implications for varying CLA concentrations on health have to be studied.

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