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Study Review

Conjugated linoleic acid and vaccenic acid contents in cheeses: An overview from the literature

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ABSTRACT

The conjugated linoleic acids (CLA) and vaccenic (C18:1 *trans*-11; C18:1 *t*-11) acid contents of cheeses have been reported in many publications. Data on both constituents were collected from 58 references and statistically analyzed. The CLA content of cheeses varied widely from 0.050 to 2.86 g 100 g^{-1} total fatty in the published data. The type of milk, dietary feeding of lactating animals, geographical origin and year of publication had significant effects on CLA content of cheeses. Cheeses were grouped into hard, semi-hard, soft, moldy and processed. Differences in the CLA content of these groups were not significant. Also, cheese ripening had no significant effect of the CLA content in cheese. Positive correlations were found in the CLA and C18:1 *t*-11 contents of cow milk and sheep milk cheeses.

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1. Introduction

Conjugated linoleic acids (CLA) are the naturally occurring isomers of linoleic acid which are present mainly in milk, dairy products and ruminant meats. Studies with animal models have clearly established that CLA are nutraceutical components, especially for their potential role as anticarcinogens in the prevention of breast cancer (Ip et al., 1994). The CLA isomers have been reported to exhibit several beneficial effects on human health including protection against cancer, obesity, heart diseases and immune dysfunction (Benjamin and Spener, 2009). Extrapolating data from animal studies, the dose of CLA that may provide bioactive effects for human health has been estimated to be 700–800 mg d^{-1} for an individual weighing 70 kg (Watkins

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and Li, 2003). However, CLA isomers vary widely in their potential as anticarcinogens; the most effective is the *c*9,*t*11 isomer, which accounts for about 80% of CLA isomers in milk fat (Lawson et al., 2001).

The major dietary source for CLA in the human diet is found in dairy products, which account for about 70% of CLA intake (Lawson et al., 2001). In addition to CLA, dietary vaccenic acid (C18:1 *t*-11) may be converted in human tissues into the *c*9,*t*11 CLA isomer by stearyl Co A desaturase. Recently, it has been estimated that the effective CLA intake is in the range of 95–452 mg d^{-1} with large differences from country to country (Van Wijlen and Colombani, 2010). On the basis of this estimate, the daily intake of CLA needs to be increased by higher consumption of dairy products, particularly cheeses naturally enriched with *c*9,*t*11 CLA isomer and C18:1 *t*-11.

The CLA content in dairy products is influenced by genetic and environmental factors affecting milk production, milk processing aging and storage of products and food preparation. Cheeses as rich sources of CLA have received particular research attention (Lawson et al., 2001; Bisig et al., 2007). Studies and reports on individual cheeses showed that their CLA contents depend on the CLA content of the processed milk, whereas the role of processing technologies and maturation on CLA content of cheese is still controversial. Some studies found that processing conditions and maturation had little or no effect, while others reported increases in the CLA levels and changes in the distribution of CLA isomers in ripened cheeses. In order to verify the contribution of different factors on the CLA level of cheeses, it was considered desirable to analyze the reported data on CLA content of cheeses in the literature. Statistical analysis of the reported data on CLA of different cheeses would give better insight of the CLA content of cheeses as affected by different factors, and this was the objective of the present paper.

2. Materials and methods

2.1. Sources of data

Data on CLA and vaccenic (C18:1 *t*-11) contents of cheeses were collected from scientific publications and theses during the period 1998–2011. Articles were selected on the basis of their experimental design, the reliability of methods of sampling and fatty acid analysis, and statistical analysis of data. A total of 58 references were selected to evaluate the effect of different factors on the CLA and C18:1 *t*-11 contents of cheeses. Table 1 shows the number of the selected articles according to the year of publication, type of milk and geographic area. Data on fatty acid composition were reported in the different references as mg g^{-1} fat, g 100 g^{-1} fat, ppm of cheese fat, and g 100 g^{-1} total fatty acids. The cited data on CLA and C18:1 *t*-11 were recalculated using a factor of 0.945 to convert data given as mg g^{-1} fat, g 100 g^{-1} fat, ppm of cheese fat into g 100 g^{-1} total fatty acids and all have been expressed in three digits as mean g 100 g^{-1} total fatty acids as recommended in Greenfield and Southgate (2003).

Several interacting factors are responsible for the variations in CLA and C18:1 *t*-11 content of cheeses. The following factors have to be considered:

- milk type to show the effect of genetic factors;
- dietary feeding of the lactating animals;
- heat treatment of cheese milk;
- cheese type to show the effect of manufacturing conditions;
- cheese ripening to show the effect of biochemical changes;
- geographical area to show the effect of environmental factors; and
- year of publication to show changes over time.

Table 1
Number of publications on CLA content according to the year of publication, type of milk and geographic area.

Type of milk	Before 2000					After 2000				
	A	B	C	OPW	T	A	B	C	OPW	T
Buffalo	–	–	–	–	–	–	–	1	4	5
Cow	2	10	–	–	12	15	–	4	4	23
Goat	1	1	–	–	2	4	–	2	–	8
Sheep	–	–	–	–	–	17	1	–	–	18

A, Europe; B, North America; C, South America; OPW, other parts of the World; T, total.

Table 2
Conjugated linoleic and vaccenic acids content (g 100 g^{-1} total fatty acids) of cheeses made from buffalo milk.

Reference	Cheese type[a]	Heat[a]	Ripening[a]	Feeding[a]	Total CLA	C18:1 *t*-11	Country
Kumar et al. (2006)	H	Pa	F	NS	0.900	ND	India
	H	Pa	M	NS	0.900	ND	
	H	Pa	R	NS	0.920	ND	
Van Nieuwenhove et al. (2007)	S	Pa	F	NS	0.491	ND	Argentina
Tyagi et al. (2007)	S	Pa	F	C	0.756	ND	India
	S	Pa	F	G	1.13	ND	
	S	Pa	F	G	1.53	ND	
Talpur et al. (2008)	H	Pa	R	NS	0.821	2.48	Pakistan
	Pro	Pa	-	NS	0.912	2.25	
Romano et al. (2011)	SH	Pa	F	C	0.940	1.92	Italy
	SH	Pa	F	G	0.970	2.09	
	SH	Pa	F	G	1.02	1.90	
	SH	Pa	F	G	1.06	1.97	

Heat: Ra, raw; Pa, pasteurized. Ripening: F, fresh; M, medium; R, ripened. Feeding: C, conventional (indoor); G, pasture; NS, not stated. ND, not determined.
[a] H, hard; SH, semi-hard; S, soft; Mo, with mold (moldy), Pro, processed.