Meta-analysis of nutritional effects on conjugated linoleic acid (CLA) in milk fat of dairy cows

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ABSTRACT: A meta-analysis was carried out on 41 selected studies to obtain more reliable results about the influence of some nutritional factors on conjugated linoleic acid (CLA) in milk fat. Data were analysed with a linear mixed model, including the study as random variable, that highlighted a significant effect on milk CLA content of fat source and the physical form of the lipid supplement used in the diet. The content of fat in the diet and the forage/concentrate ratio seem do not have significant effects.

Key words: Meta-analysis, Dairy cow, Nutrition, Milk CLA.

INTRODUCTION – The analysis of data developed by statistical technique with the purpose of integrating the findings from a large collection of studies is usually named Meta-analysis. It is widely employed in epidemiological studies and its use is increasing in animal science (Hristov *et al.*, 2005; Lean *et al.*, 2006**).**
Several statistical techniques can be applied to combine results of different studies. However, when data to be analyzed are quantitative and the independent variables are quantitative (or qualitative but simply to be encoded), the linear mixed model is a valid option. Actually, it is able to achieve reliable results and accurate evaluation of their errors, mainly when the study effect is included in the model as random variable (St-Pierre *et al.*, 2001).
In the present study a meta-analysis is used to synthesize the results from different experiments designed to compare different fat sources and amount of dietary fat on CLA content in cow milk. Actually, the researches on CLA show a marked variation in the response of dairy cows to supplemental fats, even if it is well recognized that diet is the most important factor influencing milk CLA concentration (Bauman *et al.*, 1999).

MATERIAL AND METHODS – Data (n. 150) were from 41 studies published in the Journal of Dairy Science and others papers identified from Pubmed and ScienceDirect. The search was update through October 2006. The factors extracted were the number of animals per group, the DIM, the content of fat supplemented in the diet, the source of fat, the physical form of the supplemented fat, the forage/concentrate ratio, basal diet composition, and the intake of dietary components. Each independent variable was scored in 4-7 class. Due to the lack of connection between the levels of several independent variables, a reduced number of them were selected for the final model of analysis, using a backwards elimination technique. The final mixed model was:

$$Y_{ijlmn} = \mu + PF_i + TF_j + FF_l + FC_m + S_n + \varepsilon_{ijlmn}$$

Where Y = cis-9,trans-11 CLA content; PF = fixed effect of the content of fat supplemented in the diet (0%, <2%, 2-2.99%, 3-3.99%, >4%), TF = fixed effect of the type of fatty acid predominant in the fat source (control, C18:1, C18:2, C18:3, CLA, C18+C16, fish oil alone or mixed with other fat source), FF = fixed effect of the physical form of the supplemented fat [oil, mix of oil, soap of FA, other form (i.e ground seed, meal or extruded)], FC = fixed effect of forage/concentrate ratio (Low = <40/60; low-medium 40-50/60-50; medium = 50-60/50-40 and high = >60/40), S = random effect of the study and ε = random residual. The study was included as random effect, because it is a block variable that, if ignored, could have serious consequences on the estimation of parameters of the regression model.

RESULTS AND CONCLUSIONS - The main results highlighted by the present study (Table 1) are: a) Milk CLA content is affected by the type of fatty acid predominant in the fat source and by the physical form of the fat supplement. In particular, the fish oil results in the highest CLA concentration in milk, whereas the saturated fatty acid (C18:0+C16:0) is the less efficient. A very interesting result is the lacked influence of dietary CLA supplement on milk CLA content, that weakens the basis of the wide employment of commercial CLA to the improvement of the fat from a nutritional point of view. As far as the physical form of supplement, the highest milk CLA content is obtained by oil and mix of oil with other fat.

Table 1. Effect of the content of fat in the diet, the source of fat, the physical form of the supplemented fat and the forage/concentrate ratio on milk c9, t11 CLA content.

	Multifactor model		One factor model	
	CLA	SE	CLA	SE
Oil content	*ns*		*	
Control	0.99	0.27	0.52	0.20
<2%	0.94	0.26	0.78	0.21
2-2.99%	0.69	0.25	0.99	0.21
3-3.99%	1.02	0.24	1.29	0.24
>4	1.28	0.30	1.93	0.27
Fat supplement type	*		*	
Control	1.05	0.33	0.54	0.15
Rich in C18:1	0.92	0.27	0.95	0.19
Rich in C18:2	1.12	0.23	1.45	0.16
Rich in C18:3	0.83	0.29	1.17	0.21
CLA supplementation	1.02	0.34	0.70	0.24
Fish Oil	1.89	0.32	2.19	0.21
C18:0+C16:0	0.54	0.31	0.71	0.22
Physical form of supplement	*		*	
Control	0.62	0.31	0.44	0.16
Mix	1.29	0.43	1.74	0.38
Oil	1.45		1.78	0.16
Soap	0.82	0.27	0.62	0.20
Other	0.74	0.25	0.90	0.19
Forage/concentrate ratio	*ns*		ns	
Low	0.79	0.30	1.18	0.33
Low-medium	0.90	0.44	0.72	0.49
Medium	1.08	0.16	1.14	0.19
High	1.17	0.34	1.00	0.36

** P<0.05; ns = not significant.*

b) The one factor model (Table 1) would suggest that milk CLA content increases linearly with the content of supplemental fat. On the contrary, the multifactor model used in meta-analysis shows the content of fat supplemented in the diet has not significant effects. Therefore, the meta-analysis explains that the effects of the oil content can be overcame by the others factors, particularly by the effect of the type of fat source and the physical form of the supplement.

c) Finally, using both the complete multifactor model and the one factor model, no significant effect is produced by changing the forage/concentrate ratio.

In conclusion, the meta-analysis has been revealed a useful statistical tool able to summarize the results of several studies. It confirm some widespread opinions about the main nutritional factors that influence the milk CLA content, at the same time putting in doubt some nutritional strategy commonly accepted, for example the use of CLA supplement to obtain a marked increase of milk CLA content.

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REFERENCES - **Bauman** D.E., Baumgard L.H., Corl B.A., Griinari J. M. Biosynthesis of conjugated linoleic acid in ruminants. 1999. Available online: http://www.asas.org/jas/symposia/proceedings/0937.pdf. **Hristov** A.N., Price W.J., Shafii B. 2005. A meta-analysis on the relationship between intake of nutrients and body weight with milk volume and milk protein yield in dairy cows. J. Dairy Sci. 88: 2860-2869. **Lean** I.J., DeGaris P.J., McNeil D.M., Block E. 2006. Hypocalcemia in dairy cows: meta-analysis and dietary cation anion difference theory revisited. J. Dairy Sci. 89:669-684. **St-Pierre** N.R. 2001. Invited review: Integrating quantitative findings from multiple studies using mixed model methodology. J. Dairy Sci. 84:741-755.