Dietary conjugated linoleic acid supplementation of laying hens: effects on egg fatty acid composition and quality

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RIASSUNTO – Integrazione di acido linoleico coniugato alla dieta per galline ovaiole: effetti sul profilo acidico e sulle caratteristiche qualitative dell'uovo – *Al fine di verificare l'effetto dell'integrazione dietetica di acido linoleico coniugato (CLA) sulla composizione acidica e sulla qualità dell'uovo, è stata condotta una prova su tre gruppi di ovaiole di 9 soggetti ciascuno, alimentate con diete integrate con 0, 1,25 e 2,5% di CLA. Aumentando la concentrazione di CLA nella dieta il contenuto di CLA nel tuorlo passa da 0,15 (Controllo) a 6,04 e 11,73 mg/g di tuorlo (rispettivamente CLA 1,25 e CLA 2,50). L'isomero più rappresentativo del tuorlo ed anche biologicamente più attivo è il* cis-9, trans-11. *La concentrazione di acidi grassi saturi e monoinsaturi nel tuorlo rispettivamente aumentano e diminuiscono utilizzando diete integrate con CLA. La produttività ed i parametri qualitativi dell'uovo non hanno evidenziato differenze significative tra i gruppi.*

KEY WORDS: laying hen, egg, conjugated linoleic acid (CLA).

INTRODUCTION – Conjugated linoleic acid (CLA) is a common term for a group of positional and geometric isomers of linoleic acid; the most commonly found in natural products is *cis-9, trans-11*-octadecanoic acid. Naturally occurring CLA is produced as an intermediate product of microbial metabolism of linoleic acid in the rumen. For this reason the CLA concentration is higher in ruminant products, such as milk, cheese and meat compared to products derived from monogastrics, particularly chicken meat and egg yolk. Recent investigations suggest that CLA have anticarcinogenic properties, antiatherosclerotic and antioxidant activity (Ip *et al.*, 1995; Nicolosi *et al.*, 1997; Du *et al.*, 2001). Since the lipid composition of eggs, particularly the polyunsaturated fatty acids (PUFA) content can be improved modifying the hen diet, a study was carried out to asses the effect of dietary CLA supplementation on the fatty acid composition of the egg yolk, on egg quality and on productive performance of laying hens.

MATERIAL AND METHODS – Twenty-seven Hyline brown hens, 20 wks old, were randomly divided into three groups and housed in conventional cages (3 hens/cage) in an environmentally controlled room at a light regimen of 16 h light and 8 h dark. Hens received for 8 weeks, a commercial diet added either with 0 (Control) or 1.25 (CLA 1.25) or 2.5% (CLA 2.50) a CLA source containing 60% of CLA methyl esters. Hen productivity was recorded and at the end of the 8-wk of dietary treatments, eggs were singularly weighted and their components were also measured, as well as Haugh index. Yolk and albumen colour were evaluated according to CIE L* a* b* system using a colour meter Minolta C300. Four weeks after the beginning of the dietary treatment, 3 pools of 4 yolks each per group were prepared for the fatty acid analysis and evaluated following the method reported by Sirri *et al.* (2003). Data were submitted to one-way ANOVA using the General Linear Model of SAS package and mean differences were assessed by Student Newman Keuls test.

RESULTS AND CONCLUSIONS – Increasing CLA concentration in the diet, the yolk CLA concentration linearly increased from 0.15 (Control) to 6.04 and 11.73 mg/g of yolk (CLA 1.25 and CLA 2.50

respectively). The most representative isomer was isomer *cis-9, trans-11* (Tab. 1). Saturated fatty acids of yolk significantly (P<0.01) increased whereas monounsaturated fatty acids (MUFA) concentration, particularly palmitoleic and oleic acids, decreased in CLA groups. Similar results were observed in yolk, chicken meat, fat pad and skin (Ahn *et al.*, 1999; Shäfer *et al.*, 2001; Sirri *et al.*, 2003). This phenomenon is probably due to the inhibitory effect of CLA on D-desaturase enzyme system in the liver, reducing the conversion of saturated fatty acids into MUFAs promoting therefore their accumulation in the yolk. As for PUFA, emerged that both arachidonic acid (n-6) and docosahexaenoic acid (n-3) decreased in CLA groups and this trend is again due to the inhibition of Δ6-desaturase, the enzyme involved both in n-6 and n-3 pathway.

Table 1. Influence of dietary CLA on yolk fatty acid composition (mg/g of yolk).

	Control	CLA 1.25	CLA 2.50	SEM
Palmitic acid	45.95B	57.52 A	61.21 A	1.78
Stearic acid	17.33 B	30.12 A	34.47 A	1.61
Total saturated	64.71 B	90.17 A	96.41 A	3.29
Palmitoleic acid	4.34 A	2.27 B	1.94 B	0.22
Oleic acid	61.99 A	40.10 B	37.63 B	2.25
Total monounsaturated	66.82 A	42.70 B	39.86 B	2.39
Linoleic acid	45.36 a	42.48 a	32.85 b	1.98
CLA *cis*9,*trans*11	0.15 Bc	4.32 Ab	7.86 Aa	0.69
CLA *trans*10,*cis*12	0.00 Bc	1.63 Bb	3.69 Aa	0.34
Others CLA	0.00 Bb	0.08 ABb	0.19 Aa	0.03
Arachidonic acid	4.17 A	3.30 B	2.62 C	0.10
Docosahexaenoic acid	1.60 a	0.98 b	0.83 b	0.16
Total polyunsaturated	53.77	55.74	50.97	2.71
Total CLA	0.15 C	6.04 B	11.73 A	1.05

A, B, C= P<0.01; a, b, c= P<0.05.

As for egg quality traits, no significant differences among groups were observed for egg weight and its components, as well as for Haugh index (Tab. 2). The diet with the highest level of CLA increased yolk lightness (L*) and decreased redness (a*), whereas slight but significant differences were observed in lightness of albumen (Tab. 3).

Table 2. Effect of dietary CLA on Haugh index, egg weight and its parts.

Groups	Egg (g)	Yolk (g)	Albumen (g)	Shell (g)	Haugh index (HU)
Control	55.13	12.75	37.37	5.01	87.35
CLA 1.25	55.50	12.47	37.96	5.07	89.19
CLA 2.50	58.56	13.03	40.36	5.17	88.17
SEM	1.21	0.23	0.99	0.14	1.85

Table 3. Effect of dietary CLA on yolk and albumen colour.

	Yolk			Albumen		
Groups	L*	a*	b*	L*	a*	b*
Control	50.53 b	6.05 A	37.14	50.53 b	- 3.54	18.71
CLA 1.25	52.17 ab	5.89 A	38.97	52.17 ab	- 3.67	18.64
CLA 2.50	52.87 a	2.22 B	36.87	52.87 a	- 3.31	17.28
SEM	0.56	0.49	1.06	0.56	0.49	1.06

Performances of the laying hens appeared not affected by the dietary treatment, however, feed consumption and feed conversion rate (FCR) were lower in all CLA groups compared with the Control, but these differences were not statistically significant due to the low number of hens involved in this study (Tab. 4). Our data agree with results of Sell *et al.*, (2001) who observed that either feed consumption or FCR linearly decreased increasing CLA dietary supplementation.

Table 4. Effect of dietary CLA on laying hen performance.

Groups	Feed intake (g/hen/d)	Egg weight (g)	FCR (kg/kg)	Egg production (%)	Egg mass (g)
Control	100.61	54.05	2.11	88.96	48.02
CLA 1.25	96.45	54.24	2.00	89.18	48.35
CLA 2.50	95.93	56.59	1.90	89.61	50.63
SEM	3.02	0.74	0.07	1.97	1.06

This study showed that using suitable diets is possible to enrich egg yolk with consistent amounts of CLA, particularly the most biological active isomer *cis-9, trans-11*, enlarging the choice of consumers for functional foods.

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