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The Effects Of Dietary Conjugated Linoleic Acid (CLA), Sunflower Oil And Soybean Oil On Fatty Acid Composition of Yolk and Egg Quality in Laying Hen

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Abstract: A trial was conducted to investigate to effects of dietary conjugated linoleic acid (CLA), sunflower oil and soybean oil on the concentration of CLA, other fatty acids of egg yolk lipids, rate of albumen, yolk, shell and color of eggs, productive performance of laying hens. Sixty, 70- wk-old Lohman hens kept in individual cages, were assigned to each of five dietary treatments that consisted of diets containing 2.8% sunflower oil, 2.8% soybean oil, 1.4% sunflower oil + 0.84% CLA (1.4% CLA source), 1.4% soybean oil + 0.84% CLA (1.4% CLA source), or 1.4% soybean oil + 1.4% sunflower oil. The CLA source contained 60% CLA. Eggs were collected daily and stored at 4 C at the end of the treatment. The eggs were processed to fatty acid composition, color, proportions of yolk, albumen and shell. In this study, saturated fatty acid (SFA) and polyunsaturated fatty acid (PUFA) increased ($p<0.01$) by dietary CLA whereas concentration of monounsaturated fatty acid (MUFA) decreased. Feed conversion and egg production were negative influenced from dietary CLA. Dietary CLA increased the proportion of egg yolk but decreased the albumen ratio.

Key words: Conjugated linoleic acid, laying hen, fatty acid composition, egg quality

INTRODUCTION

Conjugated linoleic acid is a collective name referring to the positional and geometric (*cis*, *trans*) conjugated dienoic isomers of linoleic acid. CLA is formed as a result of microbial biohydrogenation in the rumen; hence it is found primarily in ruminant products[1]. Foods received from non ruminant animals, however, contain much less CLA than those from ruminants. Poultry products contain relatively low CLA. Chicken meats and egg yolks contain approximately 0.9 and 0.6 mg of CLA/g of fat, respectively[1].

CLA is currently recognized as having a beneficial effect on human health, atherosclerosis, hypercholesterolemia and anticarcinogenic[1-3]. Similarly, Szymczyk and Pisulewski[4] reported that CLA-enriched egg yolk tended to induce hypocholesterolaemia in adult rats.

CLA can be used as a supplement of animal diets, thus, providing an interesting opportunity to improve CLA concentration in products from monogastric animals. Increasing the concentration of CLA in food is a possible way for humans to increase their CLA intake and obtain the potential benefits of CLA consumption.

Chamruspollert and Sell[5] demonstrated that chicken eggs could be enriched in CLA to as high as 11% by feeding hens 5% CLA in the diet. The CLA is incorporated into all the lipid classes of egg yolk in amounts proportional to the dietary level of CLA[5]. Dietary CLA increased the proportion of saturated fatty acid and decreased monounsaturated (MUFA) and polyunsaturated fatty acid (PUFA) of yolk[6].

In this study, diets rich in linoleic and linolenic acid were formulated by using sunflower and soybean oil to assess the effects of dietary CLA on selected quality characteristics and lipid composition of fresh eggs.

MATERIAL AND METHOD

Eighty, 75- wk-old Lohman hens kept in individual cages, were assigned to each of five dietary treatments that consisted of diets containing 2.8% sunflower oil, 2.8% soybean oil, 1.4% sunflower oil + 0.84% CLA (1.4% CLA source), 1.4% soybean oil + 0.84% CLA (1.4% CLA source), or 1.4% soybean oil + 1.4% sunflower oil. The CLA source contained 60% CLA. Compositions of the experimental diets are presented in Table 1. Feed and water were provided for *ad libitum* consumption throughout the experiment. Egg production and feed consumption data were recorded daily. Each of five dietary treatments was assigned randomly to sixteen.

Chamruspollert, [7] reported that maximum effects of dietary CLA on CLA content of egg yolk lipids occurred at 10 to 11 d after feeding a CLA source began. After

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Table 1: Percentage composition of diets fed to laying hens

Ingredients and analyses	Composition (%)
Corn	39
Soybean meal	22
Wheat middling	19
Meat and bone meal	3
Sunflower meal	3
Limestone	8.9
Dicalcium phosphate	0.40
Vitamin premix[1]	0.3
Mineral premix[2]	0.3
Salt	0.05
DL-methionine	0.14
Sunflower oil	2.8[3]
Soybean oil	2.8[3]
CLA source[4]	1.4[3]
Calculated analysis	
CP	16
ME, kcal kg^{-1}	2650

[1]Supplied per kilogram of diet: Mn, 80 mg; Zn, 90 mg; Fe, 50 mg; Cu, 12 mg; Se, 0.15 and sodium chloride,2.5 g; [2]:Supplied per kilogram of diet: Vitamin A,8000 IU; cholecalciferol, 1580 IU; dl-á-tocopherly acetate, 12 IU; vitamin B_{12}, 16 μg ;vitamin K, 2 μg; riboflavin, 4 mg; pantothenic acid, 12.8 mg; niacin, 75 mg; choline, 509 mg; folic acid, 1.62 mg; biotin, 75 μg; ethoxyquin, 15 mg. [3]: In A group, sunflower oil 2.8%. In B group, soybean oil 2.8%. In C group, sunflower oil 1.4% +0.84% CLA (1.4% CLA source). In D group, soybean oil 1.4% + 0.84% CLA (1.4% CLA source). In E group, soybean oil 1.4% + sunflower oil 1.4%; [4]: CLA source was obtained by Pharmanutrients, Lake Bluff, IL 60044

Table 2: Influence of dietary conjugated linoleic acid (CLA), sunflower oil and soybean oil on performance of laying hens

Groups	Feed consumption g/hen/d	Rate of egg production %	Feed efficiency kg:kg	Egg weight g/egg
SFO	98.40±11.18[c]	74.22±15.46[a]	1.95±0.42[b]	70.73±3.65[a]
SO	110.91±12.81[a]	75.5.44±7.49[a]	2.25± 0.12[b]	71.68±3.71[a]
SFO+CLA	112.5±10.10[a]	73.33±6.67[b]	2.38±0.11[a]	72.15±7.22[a]
SO+CLA	108.49±4.50[b]	74.05±13.81 [b]	2.35±0.49[a]	68.56±5.02[b]
SFO+SO	105.67±6.40[b]	76.99 ±4.40[a]	2.27±0.13[b]	61.78±1.09[c]
SEM	2.45	2.70	0.080	1.18
P	**	**	**	**

**: p <0.01 a, b: Means within the same column with no common superscript differ significantly

Table 3: Influence of dietary conjugated linoleic acid (CLA), sunflower oil and soybean oil on percentage of yolks, albumens and shells of egg and yolk color

Groups	Yolk %	Albumen %	Shell %	Color
SFO	29.44[a]	59.41±0.22[b]	11.15±0.30	8.66±1.15
SO	28.96[b]	61.03±1.08[a]	9.97±0.74	9.66±0.57
SFO +CLA	29.40[a]	60.46±2.83[b]	10.13 ±0.75	10.0± 1.00
SO+CLA	29.05[a]	60.86±2.56[b]	10.08±0.31	9.96±1.15
SFO + SO	28.66[b]	61.16±1.04[a]	10.16±0.28	9.0±0.00
SEM	0.429	0.475	0.137	0.231
P	*	*	NS	NS

*: p<0.05 NS: not significant a, b: Means within the same column with no common superscript differ significantly

feeding hens for 6 wk, eggs were collected for 4 consecutive d and four eggs (from different hens) per treatment were randomly selected and analyzed. Eggs used for evaluation of yolks and albumen were broken and the weights of yolks, albumens and shell recorded. Color of egg yolk was determined using a 14-point Improved Roche Color Fun.

Fatty acid analysis: Four eggs from each group were obtained after the 21 d feeding treatment. A representative sample of 2 g of yolk was taken and lipids were extracted. Analysis of fatty acid methyl esters (FAME) were prepared by reaction with 4 mL of HCL in 100 mL of methanol for 20 min at 60°C and the composition of FAME was determined by gas chromatography.

Statistical analyses was performed by the statistical package SPSS for windows (1999), version 10.0 Multiple comparison of the data was done by using the Duncan test after one-way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The highest feed intake was established hens fed SFO+CLA and SO diet whereas the lowest feed conversion rate was found in hens fed the SFO+CLA and SO+CLA diets. The addition of CLA (SFO+CLA and SO+ CLA) decreased feed efficiency. Szymczyk *et al*[8] and Shang et al[9] reported that with dietary CLA feed efficiency was decreased. Rate of egg production was adversely negative affected by feeding CLA. The lowest egg weight was observed with hens fed the diet containing SFO+SO (Table 2).

Proportion of yolk of eggs from SFO, SFO + CLA and SO + CLA groups were higher than other groups. The highest rate of egg albumen was obtained from hens fed the SO and SFO + SO diet. Proportion of eggshell and yolk color was not influenced by diet (Table 3).

The effect of dietary conjugated linoleic acid (CLA), sunflower oil and soybean oil on fatty acid composition of egg yolk lipids are presented in Table 4.

The fatty acid composition of yolk lipids was significantly altered by dietary CLA. Feeding CLA significantly increased SFA and PUFA and decreased MUFA in the egg yolk (Table 4).

These results are similar to these reported by Du *et al*[5]. The palmitic, stearic and CLA (9-*cis*, 11- *trans* and 10-*trans*, 12-*cis*) content of yolk of eggs from CLA group was significantly greater than others groups. Since sunflower oil has high oleic acid concentration, the addition of it to diets caused a significant increase in oleic acid concentration of egg yolk. The addition of CLA (SFO+CLA and SO+ CLA) decreased oleic acid content of yolk. The concentrations of linoleic acid in egg yolk lipids from hens fed diets containing soybean oil were significantly higher than those of diets without soybean oil. Du *et al*[5] found that addition of soybean oil to diets caused an increase in linoleic acid level in eggs of laying hens, but the addition of CLA to diets reduced the linoleic acid level in eggs of laying hens.

Table 4: Influence of dietary conjugated linoleic acid (CLA), sunflower oil and soybean oil on fatty acid composition of egg yolk lipids

Fatty acids%	SO	SFO	SO+ CLA	SFO+CLA	SFO+SO	SEM	P
Palmitic	26.34^{c}	25.22^{d}	28.14^{a}	27.10^{b}	25.72^{d}	2.26	**
Stearic	6.84^{b}	7.02^{b}	11.4^{a}	12.2^{a}	7.00^{b}	0.54	**
Oleic	33.1^{c}	35.3^{a}	30.7^{d}	31.9^{d}	34.6^{b}	3.33	**
Linoleic	21.90^{a}	20.8^{c}	21.4^{b}	20.5^{c}	21.2^{b}	2.38	**
Linolenic	0.97^{a}	0.98^{a}	0.93^{b}	0.96^{a}	0.98^{a}	0.038	**
Arachidonic	1.61^{a}	1.57^{b}	1.30^{c}	1.26^{d}	1.58^{b}	0.003	**
9-*cis*, 11-*trans* CLA	-	-	0.98^{a}	0.93^{b}	-	0.004	**
10-*trans*, 12-*cis* CLA	-	-	0.53^{a}	0.42^{b}	-	0.006	**
SFA	33.18^{b}	32.24^{d}	39.18^{a}	39.12^{a}	32.72^{c}	2.97	**
MUFA	33.1^{b}	35.3^{a}	30.7^{c}	31.9^{c}	34.6^{a}	2.53	**
PUFA	24.48^{b}	22.63^{d}	25.14^{a}	24.08^{b}	23.18^{c}	1.66	**

**: $p<0.01$ a, b: Means within the same row with no common superscript differ significantly

Arachidonic acid contents in diet with 2.8% soybean oil was higher than other diets, indicating that dietary linoleic acid increased arachidonic acid level in yolk lipid. The addition of CLA to chicken diet reduced arachidonic acid content in yolk lipids. Du *et al*[10] reported that the percentage content of arachidonic acid in egg yolk lipids from hens fed diets containing CLA was lower than from without CLA diet.

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