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Influence of Different Dietary Oil Sources on Performance and Cholesterol Content of Egg Yolk in Laying Hens

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ABSTRACT

This study was conducted to determine the effects of different dietary oil supplements on performance parameters (feed consumption, egg weight and egg production) and cholesterol content of egg yolk in laying hens. A total of 180 Hysex Brown layer hens which were 36 weeks old were assigned to four treatment groups that also have three subgroups (3 hens per cage) and fed with the experimental diets for 8 weeks. During this period the hens had *ad-libitum* access to feed and water. The basal diet (Table 1) was formulated to contain 17% crude protein and 2750 kcal/kg metabolisable energy. Diets of experimental groups were designed so that they include different oil supplements (sunflower oil, fish oil, soybean oil and hazelnut oil) at 3% concentration. Hens accommodated in a poultry house with a light regimen of 17 h light and 7 h darkness. At the end of the study, it is found out that when different dietary oil supplementations were added to the diet feed consumption and feed efficiency were not affected (p>0.05). Similarly, no significant differences were observed in egg quality parameters and egg cholesterol values (p> 0.05). Egg production and egg weight values were found to be significantly higher (p< 0.05) in the group fed with 3% soybean oil. The results of this study clearly demonstrate that supplementation of different oil sources does not create statistically significant effects on egg quality parameters and egg cholesterol value in laying hens. Compared to other experimental groups, relatively higher positive effects on production parameters were obtained in the group of animals that were fed with soybean oil containing ration.

Key Words: Oil sources, Laying hens, Performance, Cholesterol level

INTRODUCTION

There is an important development in the growth rate and feed efficiency in commercial broiler chickens in last 20 years. Commercial hybrids, which have a very high production performance, require high energy and high protein diets. There is a problem to supply such high energy level with conventional feed ingredients such as maize, wheat, barley and soybean. Oil sources provide a source of energy to achieve high energy broiler diets (Leeson and Summers 2001). Additionally, unsaturated vegetable oils have higher energy levels than of saturated animal fats (Carew et al. 1961). In general, to increase the absorption of the vitamins and to enhance egg yield and egg weight oil supplements are added to layer hen rations. Essential fatty acids (EFAs) cannot be synthesized by human and animals, thus, they must be obtained from diet. EFAs are long-chain polyunsaturated fatty acids derived from linolenic acid (Omega-3, ω 3FA), linoleic acid (Omega-6, ω 6FA) and mono unsaturated fatty acids namely oleic acid (Omega-9). Only the latter can be synthesized both by the human and animals. The positive effects of omega-3 fatty acids (ω 3FA) on health are well demonstrated. As it is known that an adequate intake of EFAs, may reduce the risk of life-style diseases such as coronary artery disease (Wahlvist 1998), hypertension (Howe 1997), arthritis and immune disorders as well as some type of cancers (Wesley 1998, Rose et al. 1999). Moreover, these EFAs are essential for normal growth and development of the brain and retina.

Consumers limit their intake of egg due to adverse publicity about saturated fats and cholesterol, whereas, health professionals suggest decreasing saturated fat intake only. Consumption of poly-unsaturated fatty acid has been reported to reduce the risk of atherosclerosis and stroke (Lada et al. 2003). Mono and poly-unsaturated fats may lower blood cholesterol levels when they replace saturated fat in the diet. Howell et al. (1997) investigated the relationship between diet and blood cholesterol levels and found that saturated fat in the diet, but not dietary cholesterol, influences blood cholesterol levels. Modification of egg yolk cholesterol and fatty acid contents requires better understanding of factors that influence the deposition of cholesterol and fatty acids in egg yolk. Despite extensive research, little progress has been made in reducing cholesterol content of eggs (Hargis 1988, McDonald et al. 1999, Shafey et al. 1999).

Different feeds, such as flaxseed, safflower oil, perilla oil, marine algea, fish, fish oil and vegetable oil have been added to chicken feeds to increase the ω 3FA content in the egg yolk. The nutritional manipulation of the diets of laying hens, which include sources of ω 3FA, promotes the deposition of these nutrients in the

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egg yolk (Jiang et al. 1991, Kim et al. 1997, Van Elswyk 1997). An increase in the amount of omega-3 fatty acids leads to some decrease on the effect of cholesterol levels (Hargis et al. 1991, Jiang et al. 1991).

Therefore, this study was conducted to investigate the effects of different types of dietary oil supplements on performance (feed consumption, egg weight, egg production) and cholesterol content of egg yolk in laying hens.

MATERIALS AND METHODS

Chicks, experimental design and diet

In the present research a total of 180 Hysex Brown hens, 36 weeks of age, were weighed and randomly assigned to four experimental groups each having 45 birds. Each group was further subdivided into three replicate of 15 hens. The hens were randomly assigned to cages (40x 40x 46 cm), as 3 hens per cage. During the experiment, hens were exposed to a lighting program of 17 hours per day including day light. The rations containing 17% crude protein and 2750-kcal/kg metabolisable energy (ME) were used. The diets were based on barley, maize and soybean meal. In the first treatment group 3% sunflower oil (SFO) (group I), in the second treatment group 3% fish oil (FO) (group II), in the third treatment group 3% soybean oil (SBO) (group III) and in fourth treatment group 3% hazelnut oil (NO) (group IV) were added into the basal ration. The formulation of the basal ration is shown in Table 1. Feed and water were supplied *ad libitum.* The animals were fed with the research rations for 8 weeks.

Table 1. Ingredients and chemical composition of ration

Ingredients	**%**
Corn	40
Barley	24
Soybean Meal	20.55
Meat and bone meal	3
Limestone	8.5
DCP	0.25
Vegetable oil	3
Vitamin- premix[1]	0.15
Mineral-premix[2]	0.10
Salt	0.25
Chemical analysis, dry matter (DM) basis	
Dry matter,%	89.55
Crude protein,%	17.01
Ash,%	11.19
Calcium,%	3.56
Phosphorus,%	0.56
Metabolisable energy, kcal/kg*	2743

* : This value was found to with calculation

[1] Rovimix 123-T; each 2.5 kg Rovimix 123-t contained : Vitamin A 12 000 000 IU, Vitamin D_3 2 000 000 IU, Vitamin E 35 000 IU, Vitamin K_3 5 000 mg, Vitamin B_1 3 000 mg, Vitamin B_2 6 000 mg, Vitamin B_6 5 000 mg, Vitamin B_{12} 15 mg, Niacin 20 000 mg, Folic acid 750 mg, D-biotin 45 mg, choline chloride 125 000 mg and Vit C 50 000 mg, calcium D- pantothenate 6 000 mg

[2] Remineral S; each kg Remineral S contained : Mn 80 000 mg, Fe 60 000 mg, Zn 60 000 mg, Cu 5 000 mg, Co 200 mg, I 1 000 mg, Se 150 mg and Ca 446 925 mg

Data collection, performance and biochemical measurements

The proximate analysis of the feeds was performed using the methods of AOAC (1994). The metabolisable energy level (ME) of the feeds was calculated by the following formula which is described in Turkish Standards No: 9610 (1994) [ME (kcal/kg) = 38(A+B+C+D)+53] where A: % crude protein x 1.0; B: % crude fat x 2.25; C: % stark x 1.10; D: % sugar x 1.05. Ingredients and chemical composition of the basal diet are shown in Table 1. Feed consumption, feed efficiency and egg weight were recorded weekly. Feed conversion ratio was calculated as kg feed : kg egg. The hen-day egg production was recorded daily.

Egg quality parameters (yolk index, albumen index, haugh unit, shell thickness, shell breaking strength) were assessed once a month. For that purpose, the eggs were collected, stored for 24 hours and then measurements were performed. Egg shell breaking strength was measured by using a cantilever system by applying increased pressure to the broad pole of the shell by with an instrument (Imada, Newton) (Rauch 1965). Shell thickness was measured at three locations on the egg (air cell, equator and sharp end) using a micrometer (Mitutoyo, 0.01 mm, Japan) (Wells 1968). Albumen height (H_A) was measured by a tripod micrometer (Mitutoyo, 0.01 mm, Japan) and albumen length (L) and width (W_A) was measured by a compass (Swordfish, 0.02 mm, China). Then, the albumen index was calculated with the following formula [Albumen index = $(H_A / \{L + W_A\})$ x 100]. Yolk height (H_Y) was measured by tripod micrometer (Mitutoyo, 0.01 mm, Japan) and yolk diameter (D) was measured by a compass (Swordfish, 0.02 mm, China). Then, the yolk index was calculated by using the following formula: [Yolk index = (H_Y / D) x 100]. Haugh unit was calculated with a formula where the H_A is albumen height and W_E is egg weight (Haugh unit = 100 log H_A + 7.57 - 1.7 W_E 0.37) (Card and Nesheim 1972).

At the end of experiment, three eggs, randomly taken from each replicate group were boiled and cholesterol content of egg yolks was determined by the given method (Boehringer 1989). Results were read at spectrophotometer in 520-nm wavelength and evaluated with the following formula.

$$\text{Cholesterol content in extract (ECV) (mg/dl)} = \frac{\text{Read value in sample}}{\text{Read value in standard}} \times CS$$

$$\text{Egg yolk cholesterol (mg/g)} = \frac{(ECV/100) \times 4}{\text{Sample values (g)}}$$

(CS: Concentration of standard)

Statistical analysis

Statistical analyses of data were performed with the SPSS 10.0 version of Microsoft. One-way ANOVA (Snedecor and Cochran 1980) was used for the differences between groups. When the *P*-values were significant, a Duncan’s multiple range test was performed (Duncan 1995). All the data were expressed as means ± standard errors.

RESULTS AND DISCUSSION

Oil supplements are the main source of energy in the poultry diets. Using different types of oil sources may be important from economical aspects as well as production parameters and consumers’ expectations such as low cholesterol content. The present study investigates the effects of 4 dietary oil sources on production parameters and egg yolk cholesterol content.

Supplementation of different dietary oil (3% sunflower, fish, soybean and hazelnut oil) did not significantly ($p > 0.05$) modify feed consumption (Table 2). Mean egg production values were calculated to be 74.06%, 82.14%, 82.69% and 77.47% for experimental groups, respectively (Table 2). The differences observed between the experimental groups were statistically significant ($p < 0.01$). Feed conversion values, which were calculated as kg feed / kg egg, were 2.14, 2.03, 2.02 and 2.15 for the experimental groups, respectively (Table 2). There was not a significant ($p > 0.05$) effects of different oil supplements on feed efficiency. Egg weights obtained in the groups are shown in Table 2. The heaviest eggs were in the experimental group III, which was supplemented with soybean oil. Mean egg quality parameters and egg yolk cholesterol content is shown in Table 3. These parameters were not determined to be statistically significant ($p > 0.05$).

Table 2. Mean feed consumption, egg production, feed efficiency and egg weight values of experimental groups

Parameters	SFO (group I)		FO (group II)		SBO (group III)		NO (group IV)		
	X	± Sx	X	± Sx	X	± Sx	X	± Sx	P
Feed consumption (g/day/hen)	98.58	0.23	103.07	1.65	106.43	2.14	103.16	2.15	NS
Egg production (%)	74.06	0.61[b]	82.14	0.28[a]	82.69	0.77[a]	77.47	3.79[ab]	*
Feed efficiency (g feed/g egg)	2.14	0.003	2.03	0.006	2.02	0.002	2.15	0.006	NS
Egg weight (g)	63.65	0.42[ab]	62.65	0.38[b]	64.34	0.34[a]	62.61	0.37[b]	**

Experimental groups: SFO (group I), FO (group II), SBO (group III), NO (group IV)

[a,b] The mean values within the same row with different superscript differ significantly ; NS: not significant
*: p< 0.05, **: p<0.01
SFO:Sunflower oil FO:Fish oil SBO: Soybean oil NO:Hazelnut oil

Table 3. Mean egg quality parameters and egg cholesterol values of experimental groups

Parameters	SFO (group I)		FO (group II)		SBO (group III)		NO (group IV)		
	X	± Sx	X	± Sx	X	± Sx	X	± Sx	P
Egg shell breaking strength (kg/cm^2)	3.76	0.24	3.47	0.23	3.63	0.32	3.88	0.28	NS
Egg shell thickness ($mm x 10^{-2}$)	43.02	0.38	42.56	0.39	42.47	0.28	42.40	0.42	NS
Egg yolk index	41.17	0.65	42.12	0.69	41.05	1.84	42.67	0.30	NS
Egg albumen index	6.17	0.27	6.02	0.36	5.81	0.29	6.35	0.30	NS
Egg haugh unit	83.00	1.64	86.16	1.68	82.25	3.53	85.25	3.51	NS
Cholesterol (mg/egg)	279.65	13.99	230.88	15.08	227.52	23.24	210.68	33.44	NS

Experimental groups: SFO (group I), FO (group II), SBO (group III), NO (group IV)

NS: not significant (p> 0.05)
SFO:Sunflower oil FO:Fish oil SBO: Soybean oil NO:Hazelnut oil

It is known that feed consumption in hens shows differences depending on some factors such as breed, live weight, age and energy level of the ration. During the trial, while the lowest daily mean feed consumption was 98.58 g for the group I, consuming the ration containing sunflower oil, the highest value (106.43g) was in group III, consuming soybean oil. There was not a statistical difference among the experimental groups (p>0.05). Feed consumption of the hens obtained in this study was higher than reported previously (Balevi and Coşkun 2000, Baucell et al. 2000). Differences between the studies may be due to the level of metabolisable energy in the ration. Moreover, insignificant effect of fish oil supplementation at 1.2 and 3% concentrations was also reported (Huang et al. 1990).

In this study, average egg productivity from the beginning to end of the trial was in the range of 74.06 - 82.69 % (Table 3) and there were statistical differences between the groups (p< 0.01). The highest percentage in egg production was found in group III containing soybean oil supplementation. Contrary to these findings, Cetingül and Inal (2003) determined that addition of sunflower oil (1.5%) and hazelnut oil (1.5-3%) to the ration did not affect egg productivity. Balevi and Coşkun (2000) reported that supplementation of nine different kinds (sunflower, cotton, corn, flax, soybean, olive, fish, tallow and rendering oil) of oil sources at 2.5% concentration did not have significant effect on egg production parameters. Another study, Jiang et al.

(1991) defined that addition of flaxseed oil and sunflower oil to the ration at the same level did not affect this parameter.

The amount of consumed for 1kg egg production did not change significantly. It was defined to be 2.14, 2.03, 2.02 and 2.15 in experimental groups supplied with sunflower oil, fish oil, soybean oil and hazelnut oil, respectively. The positively improvement (2.02) was in group III, consuming the ration containing soybean oil. In a previous study (Cetingül and Inal 2003) similar results were obtained by the addition of sunflower oil and hazelnut oil. In the same study (Cetingül and Inal 2003) feed consumption of layer hens found to be lower in the groups fed with hazelnut, but feed efficiency found as higher than the others. The other studies have not reported differences in feed efficiency in laying hens by using various oils (Balevi and Coşkun 2000, Huang et al 1990).

As shown in Table 2, there are differences observed among egg weights (g) obtained from experimental groups ($p< 0.01$). It is known that oil supplementation to the ration creates positive effect on egg weight (Inal et al. 1994, Coşkun et al. 1996). In a study (Shafey et al. 1999) which compared groups having rations with 2% soybean oil to the one which have no oil supplementation found out that egg weight was increased from 53.7 g to 54.5 g. However, in other studies egg weights have not effected ($p>0.05$) by addition of different oil supplementations (Balevi and Coşkun 2000, Baucells et al. 2000). There is another study (Whitehead et al. 1991) comparing the effect of high and low levels of oil on egg weight in layers. In the group where there was a high level of oil supplementation the egg weight was found to be 56 g and 64 g at the week 22 and 32, respectively, while it was 55 g and 61 g in the group containing low level oil.

The effects of different oil sources on egg quality parameters were not well examined in previous studies. Although the current study investigated egg quality parameters (shell breaking strength, shell thickness, egg yolk index, egg albumen index and haugh unit) no significant differences were found between groups. In this study the egg yolk cholesterol level (mg/ per egg) were 279.65 in group I (sunflower oil), 230.88 in group II (fish oil), 227.52 in group III (soybean oil) and 210.68 in group IV (hazelnut oil). There was no statistical difference among the groups, hence it is concluded that different oil sources used in this study have no effect on egg yolk cholesterol level in laying hens ($p>0.05$). These results agree with other research results, which pointed out that diet formulations have no effect on the egg cholesterol level (Caston and Leeson 1990, Cetingül and Inal 2003).

The current study clearly shows that supplementation of different oil sources into laying hen rations has no effect on egg quality parameters and egg cholesterol values. But it is worth to point out that the experimental group fed with the ration containing soybean oil exhibited the highest performance in production parameters (egg production, egg weight and feed efficiency) compared to other experimental groups.

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