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Influence of Different Vegetable Oils on Characteristics of Egg and Egg Yolk Cholesterol in Laying Hens

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Abstract: The present study aimed at investigating the effects of different sources of soybean, olive and grape seeds on qualitative and quantitative characteristics of eggs and egg yolk cholesterol in laying hens. 139 wk old Leghorn laying hens were used in the study and following one week of adaptation period the hens were randomly distributed into 4 groups with 3 replicates, per group containing 6 hens. Experimental rations included 4 rations of 1) control diet, 2) diet with olive oil supplementation, 3) diet with soybean oil supplementation and 4) diet with grape seed oil supplementation. Results revealed that experimental groups using olive, soybean and grape seed oils, had a significant mean increase in their egg weight compared with that of the control group in end of period (29-42) and total period (0-42) Meanwhile, results showed no significant differences between the experimental and control groups ($P>0.05$) in terms of egg production percent, egg mass, yolk index and egg form, Haugh unit, shell weight and shell thickness of egg, yolk color and egg yolk cholesterol.

Key words: Unsaturated oil · Soybean · Olive · Grape seed · Egg yolk cholesterol

INTRODUCTION

Animal products such as meat, milk and egg play a significant role in human nutrition and the past few years have witnessed an increasing awareness of people of the quality of the food consumed. Due to the increasing public demand for animal products low in fat and cholesterol, studies have been focusing on improving the quality of foods from animal origin [1-3].

There has been an eye catching development in the growth rate and feeding efficiency in commercial broiler chickens in the 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 a 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 [4]. Additionally, unsaturated vegetable oils have higher energy levels than that of saturated animal fats [5-8]. In general, oil supplements are added to the layer hen rations in order to increase the absorption of the vitamins and enhance egg yield and egg weight.

Some of the oil sources are so rich in long chain polyunsaturated fatty acids (PUFA) that can change the proportion of the constituents of egg yolk [2, 9]. Although some plant oils used in animal diets contain the same or similar concentrations of fatty acids, they may differ significantly from each other in terms of their physical properties due to the ratio of fatty acids and triglycerides in their structures. These differences may be caused by many factors such as climate, soil type, vegetative stage and the genetics of the plant [10]. Investigations have been conducted on the effects of some plant oils and fat on certain production criteria in poultry [1, 11-18] though results for some parameters investigated have been in consistent [12, 15, 19]. Furthermore, a comprehensive investigation of the effects of different plant oils sources on the interior and exterior egg quality and egg yolk fatty acid composition of laying

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hens has not been conducted. Therefore, this study was performed to investigate the effects of different sources of soybean, olive and grape seeds on quality and quantity characteristics of eggs and egg yolk cholesterol in laying hens.

MATERIALS AND METHODS

The present study was conducted at the Razi University farm, in the Kermanshah province of Iran (34°18_N and 47°3_E), from December to February, 2009- 2010. Ninety six 139 wk old Leghorn laying hens were used in this study. Following one wk of adaptation period the hens were randomly distributed to four groups with three replicates per group containing six hens each. Diets were formulated according to the nutrient requirements of laying hens presented in NRC. Experimental rations including 4 rations of 1: control diet, 2: diet with olive oil supplementation, 3: Diet with soybean oil supplementation and 4: diet with grape seed oil supplementation is represented in Table 1.

Environmental conditions such as lighting program (16 hours light: 8 hours darkness) were similar for all groups.

Egg production percent, egg weight mean and the egg mass were calculated during 42 days: in the beginning period (0-14 days), in the middle period (15-28 days) and in the closing period (29-42 days) and the total period (0-42). Yolk and form index of egg, haugh unit, shell quality (weight and thickness of shell) and yolk color were calculated throughout the study and the mean of the total period was analyzed. Measurement of egg yolk cholesterol was performed 2 times and each with 3 eggs in each replicate randomly.

Table 1: experimental diets of study

Ingredients (%)	1	2	3	4
maize	67.92	57.76	57.37	58.43
Soybean meal	18.42	18.03	17.92	18.21
Wheat bran	-	7.76	8.27	6.92
Olive oil	-	3	-	-
Soybean oil	-	-	3	-
Grape seed oil	-	-	-	3
Dicalcium phosphate	1.25	1.16	1.15	1.17
Oyster shell	11.23	11.26	11.26	11.25
Salt	0.36	0.36	0.36	0.36
Vitamin and mineral premix	0.5	0.5	0.5	0.5
metyonine	0.1	0.1	0.1	0.1
lysine	0.22	0.07	0.07	0.06

-per kg vitamin supplement include 8500000 IU vitamin A, 2500000 IU Vitamin D3, 11000 IU Vitamin E, 2200 mg Vitamin K3, 1477 mg Vitamin B1, 4000 mg Vitamin B2, 7840 mg Vitamin B3, 34650 mg Vitamin B5, 2464 mg Vitamin B6, 110 mg Vitamin B9, 10 mg Vitamin B12, 400000 mg choline chloride.

-per kg mineral supplement include 74400 mg Mg, 75000 mg Fe, 64.675 mg Zn, 6000 mg Cu, 876 mg iodine, 200 mg selenium.

RESULTS AND DISCUSSION

The mean of egg production in the experimental groups containing olive, soybean and grape seed oils as feed ingredients and that of the control group are presented in Table 2 below.

Results revealed no significant difference between the egg production percent in the treatment groups of olive, soybean and grape seed and that of the control group in the ending period (29-42) and total period (0-42) ($P<0.05$). Shafey *et al*., [15] showed that there was no significant difference between the laying hens with feed diets containing olive and soybean oil and the control group in egg production, however, Filardi *et al*., [18] reported that using soybean and grape seed oil in ration of laying hens had no significant effect on the egg production. However, the differences obtained in the egg production of the oil sources used in this study compared to Filardi *et al*'s [18] report might be due to many factors such as production of the crops in different climates and differences on the vegetation stage of the plants. This in turn could have affected the fatty acid composition of oils.

The average of egg weight in experimental groups fed diets containing olive, soybean and grape seed oils and the control group are represented in Table 3.

Table 2: Mean of egg production in the treatments of the experimental groups containing oil sources and the control group (%)

		Experimental treatments			
Control group		olive	Soybean	Grape seed	SEM
Beginning of period (0-14)	54.55	57.14	53.17	52.38	1.650
Middle of period (15-28)	53.96	61.50	59.92	58.01	1.917
End of period (29-42)	51.03^{a}	59.12^{b}	59.14^{b}	60.31^{b}	1.898
Total period (0-42)	52.52^{a}	61.26^{b}	60.74^{b}	60.90^{b}	1.475

Table 3: Mean of egg weight in treatments containing oil sources and control group (gram)

		Experimental treatments			
Control group		olive	Soybean	Grape seed	SEM
Beginning of period (0-14)	64.85	67.77	67.60	66.75	0.608
Middle of period (15-28)	65.15	67.89	68.04	68.05	0.599
End of period (29-42)	63.27^{a}	66.68^{b}	67.96^{b}	68.56^{b}	0.624
Total period (0-42)	64.42^{a}	67.45^{b}	67.87^{b}	67.87^{b}	0.511

Table 4: Mean of egg mass in treatments containing oil sources in the experimental and control groups

		Experimental treatments			
Control group		olive	Soybean	Grape seed	SEM
Beginning of period (0-14)	35.87	38.69	35.95	34.84	0.944
Middle of period (15-28)	35.17	41.74	40.91	39.29	1.369
End of period (29-42)	32.26	39.42	38.82	41.30	1.374
Total period (0-42)	34.43	39.95	38.56	38.48	1.007

Table 5: Mean of quality trait in treatments containing oil sources in the experimental and control groups

	Experimental treatments				
	Control group	Olive	Soybean	Grape seed	SEM
Form index	73.67	72.73	71.78	72.81	0.553
Yolk index	41.33	41.66	41.99	42.33	0.271
Haugh unit	73.24	73.64	73.98	73.35	0.632
Shell weight	6.02[a]	7.51[b]	6.07[a]	6.15[a]	0.063
Shell thickness	0.319[a]	0.347[b]	0.308[a]	0.313[a]	0.027
Yolk color	7.00	6.83	6.66	7.00	0.072

Results show that by adding of olive, soybean and grape seed oils to the experimental ration, the mean of egg weight in these groups has significantly increased compared to that of the control group at the closing period (29-42) and that of the total period (0-42). Celebi and Utlu [19] reported that rations containing linoleic acid have a positive effect on stradiol metabolism of plasma that leads to the higher synthesis of fat and protein to form egg.

The results related to egg mass in the experimental groups which were fed with diets containing olive, soybean, grape seed oils and control group are presented as Table 4, below.

Results show that there was no significant difference between egg mass in treatments of olive, soybean and grape seed and that of the control group (P>0.05). Shafey *et al*., [15] showed that there was no significant difference between the laying hens with feed diets containing olive and soybean oil and the control group in the egg mass.

As represented in Table 5, there is no significant difference between the yolk index and egg form in the experimental groups with feed diets containing olive, soybean and grape seed oil and that of the control group (P>0.05).

Also as shown in Table 5, there is no significant difference between the Haugh unit in the experimental groups fed diets containing olive, soybean and grape seed oils and that of the control group (P>0.05). Grobas *et al*., [12] presented that there was no significant difference in the haugh unit between laying hens using olive and soybean oil in their diet and that of the control group.

Shell weight and shell thickness of egg in the experimental groups with feed diets containing olive, soybean and grape seed oils and that of the control group are presented in Table 5.

As shown in Table 5, there is a significant difference between the shell weight and shell thickness of egg in the experimental groups with feed diets containing olive, soybean and grape seed oils and that of the control group (P>0.05). Guclu *et al*., [20] reported similar improvements in the shell weight and shell thickness of egg when birds are fed with the olive oil.

Also As shown in Table 5, there is no significant difference between the yolk color in the experimental groups with feed diets containing olive, soybean and grape seed oils and that of the control group (P>0.05).

The results related to egg yolk cholesterol in the experimental groups with feed diets containing olive, soybean and grape seed oils and that of the control group are presented in table Results show that there is no significant difference in the egg yolk cholesterol between the treatments of olive and soybean and that of grape seed and the control group (P<0.05) at the beginning period (0-14 days). Similar to the very results, Weiss [21] reported that transmission of cholesterol from liver to ovary is affected by the type of diet fat; meanwhile, Shafey *et al*., [15] showed that the type of diet fat has no significant effect on the egg yolk cholesterol.

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 heart stroke. Mono and poly-unsaturated fats may lower blood cholesterol levels when they replace saturated fat in the diet. Howell *et al*., [22] 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 the factors that influence the deposition of cholesterol and fatty acids in the egg yolk. Despite extensive research, little progress has been made in reducing cholesterol content of eggs [15].

Cholesterol and fatty acid concentrations of egg yolk vary depending on dietary manipulation and pharmacological agents as well as genetics, age and production level of the bird. Concerning nutrition one of the methods developed to change the lipid profile of eggs has been the use of different oil sources commonly used as energy sources in the diets of laying hens [12, 15, 17, 23].

CONCLUSION

The results of the present study demonstrated that different oil sources had varying effects on quality and quantity characteristics of eggs of the birds, as well as on the egg yolk cholesterol. This is reflected by the fatty acid composition of the oils added to the diet.

Since olive oil improved eggshell quality and soybean oil and grape seed oil along with the olive oil had positive effects on egg production and egg, incorporation of these oils, especially soybean oil, in the diets of laying hens may have a practical value in the manipulation of quantity characteristics of eggs.

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