ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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International Journal of Poultry Science 11 (12): 769-776, 2012
ISSN 1682-8356

The Effect of Different Levels of Canola Oil on Performance, Egg Shell Quality and Fatty Acid Composition of Laying Hens

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Abstract: The effects of different levels of canola oil (0.0, 2.0, 4.0 and 6.0%) on the performance, egg shell quality and fatty acid composition of laying hens were investigated in the present study. A total of 96 chickens consisting of 24 chickens in each group were used in the four groups. Feed and water were offered as *ad libitum*. Egg production was recorded daily, while feed intake was recorded weekly. Egg quality criteria were determined in 12 eggs from each group. The egg yolk fatty acid profile was determined with gas chromatography. The use of increasing levels of canola oil decreased egg production, egg weight and daily feed intake (in group including 6.0% canola oil, 70.98%, 61.68g, 109.52g respectively), although these mentioned parameters increased in the control group according to the other canola oil groups and conversely did not affect the feed conversion. In addition, supplementation of canola oil increased the yellow colour of the eggs and the egg-yellow index. On days 21 TBARS (Thiobarbituric Acid Reactive Substance) value significantly increased depending on increasing levels of canola oil (13.60, 14.78, 16.68, respectively), while on days 42 TBARS value did not change. The egg yolk lipid profile was not significantly difference in the canola oil groups, conversely decreased a very small amount of in the control group. The blood serum lipid profile decreased in the canola oil groups according to the control group. In the same time, monoaçildigliserol also decreased in the canola additive groups. In parallel with increasing levels of canola oil (42.94, 42.14 and 43.51%, respectively), monounsaturated fatty acid (oleic acid) in the egg yolks significantly increased compared to the control group (36.05%). On the basis of the results, we concluded that canola oil supplementation into the diet of laying hens is important in producing monounsaturated fatty acid (MUFA)-rich functional eggs.

Key words: Canola oil, egg yolk fatty acids, performance, laying hens

INTRODUCTION

Oils are commonly used as a source of energy in layer diets (Rowghani *et al*., 2007). Studies showed that oils significantly alter egg yolk lipid profiles or lipid composition ratios (Rowghani *et al*., 2007; Skrtic *et al*., 2008). Approximately 30% of lipids make up egg yolks (Milinsk *et al*., 2003) which also contain an average of 4 g of fatty acid (Milinsk *et al*., 2003; Cherian, 2008; Mazalli *et al*., 2004a). Canola oil is a plant-derived oil rich in oleic acid (C18:1 Cis:9; 53.8%) which is a monounsaturated fatty acid (Antongiovanni *et al*., 2009; Özdoan and Sari, 2001). However, it also contains significant amounts of linoleic (22.1%) and alpha-linoleic fatty acids (Rowghani *et al*., 2007; Antongiovanni *et al*., 2009; Salamatdoustnobar *et al*., 2009; Aydin and Dogan, 2010). Soybean oil is rich in linoleic acid (51%). Linoleic acid can be converted into long chain omega-3 fatty acids in the form of docosahexaenoic acid (C22:6), docosapentaenoic acid (C22:5) and eicosapentaenoic acid (C20:5) through desaturation and elongation of fatty acids in chickens(Antongiovanni *et al*., 2009; Cherian *et al*., 2009; Mazalli *et al*., 2004b). Omega-3 fatty acids have beneficial effects on rheumatoid arthritis, cancer (Milinsk *et al*., 2003; Aydin and Dogan, 2010) and cardiovascular diseases (An *et al*., 2010; Mazalli *et al*., 2004b; Katleen *et al*., 2002; Sarica, 2003; Pita *et al*., 2010; Van Elswyk, 1997). They also strengthen the immune system (Xi He *et al*., 2007). The fatty acid composition of fats used in poultry diets is reflected as well in animal products. Being rich in omega-3 fatty acids (Mazalli *et al*., 2004a; Fouladi *et al*., 2008a; Agah *et al*., 2010), canola oil also increases the amount of omega-3 in the form of alpha-linoleic fatty acid (Fouladi *et al*., 2008b) in egg and animal tissue; the presence of omega-3 in the diet of food animals improves the taste of animal meat and increases the ratio of canola oil in these animals (Sarica, 2003). Canola oil has what is now considered to be an almost perfect balance of n-6 to n-3 PUFA; the

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n-6 to n-3 ratio in canola oil is 2:1 which perfectly matches human requirements. The inclusion of canola oil in the diet of laying hens resulted into the eggs with better proportion of n-3 PUFA. N-3 enriched eggs produced by canola oil feeding to laying hens are more valuable for human beings than ordinary commercial eggs (Shakeel *et al*., 2010).

The aim of the study was to investigated the effect of different levels of canola oil (2, 4 and 6%) on performance (egg production, egg weight, feed consumption, feed conversion ratio), egg quality parameters, blood serum cholesterol level and fatty acid composition as well as producing monounsaturated fatty acid (MUFA)-rich functional egg, of which consumption proposed in terms of cardiovascular health. Besides the benefits of canola oil, soybean oil is cheaper and can be obtained easily. Based on this feature, investigation of the availability and amount of canola oil as an energy source in layer diets was the primary aim of this study.

MATERIALS AND METHODS

Experimental design and animals: Research was conducted on the poultry unit of the Agriculture Department of Atatürk University. The experimental procedures were approved by the ethical animal research committee of Atatürk University. Ninety six Hisex Brown laying hens aged 40 week, with a uniformity of 92% were selected from the University Research Farm. The hens were blocked according to the location of the cages (50cm x 46cm x 46cm) and them assigned randomly to receive one of four diets containing 0.0, 2.0, 4.0 and 6.0% canola oil. Each treatment was replicated in 6 groups with each containing 4 hens housed in each cage. The basal diet (Table 1) was formulated to meet or exceed the NRC recommendations (National Research Council, 1994). Basal diet containing 2.0% soy oil was considered as a control group. In the experimental groups, different levels (0.0, 2.0, 4.0 and 6.0%) of canola oil was supplemented into the basal diet. The experiment was carried out in winter season and the diets were stored in cold conditions (-25, -30°C). Thus, additional antioxidant to prevent oil degradation was not required. The metabolizable 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 0.1; B;% crude fat x 2.25; C:% stark x 1.10; D:% sugar x 1.05) (TSE, 1994). During the 3 month experiment, the hens were fed ad libitum once daily at 07:30 with free access to water. The hens were housed in cages that were lit for 17 hours each day.

Egg quality analysis and collection of samples: The sample collection and analytical procedure are described as follows. The composites of the feed samples were analyzed for DM, CP, CF, NDF and ash contents (AOAC, 2000). Feed consumption and egg production were recorded daily; egg weight was measured biweekly. Before the determination of egg weight, a sample of 12 eggs from each experimental

Table 1: Chemical compositions and compound of rations (%)

Food items	Control	2.0% canola oil	4.0% canola oil	6.0% canola oil
Corn 7.5	52.00	52.00	52.00	45.00
Soybean meal	21.70	21.70	22.50	22.50
Barley	2.00	2.00	-	2.00
Wheat bran	10.22	10.22	9.42	12.42
Calcium carbonate	7.95	7.95	7.95	7.95
Canola oil	-	2.00	4.00	6.00
Soybean oil	2.00	-	-	-
Full fat soybean	2.00	2.00	2.00	2.00
DCP	1.32	1.32	1.32	1.32
Salt	0.40	0.40	0.29	0.29
Vit.+Min.	0.20	0.20	0.20	0.20
D-L Methionine 99	0.12	0.12	0.12	0.12
Antioxidant	0.20	0.20	0.20	0.20
Nutrients determined with analysis				
Dry matter (%)	87.06	87.46	87.57	86.45
Crude Protein (%)	16.46	16.88	16.28	16.80
Ether Extract (%)	11.67	11.08	11.57	12.35
Crude ash (%)	10.93	9.84	11.42	10.69
ME, kcal/kg**	2739	2739	2861	2886

*Each kilogram of feed: 12.000.000IU Vitamin A, 2.500.00IU Vitamin D3, 30.000mg Vitamin E, 34.000mg Vitamin K, 3.000mg Vitamin B1, 6.000mg Vitamin B2, 30.000mg Nicotinamide, 10.000mg Cal.-D-Palm, 5.000mg Vitamin B6, 15mg Vitamin B12, 1.000mg Folic Acid, 50mg D-Biotin, 300.000mg Cholin, 50.000mg Vitamin C, 80.000mg Manganese (Mn), 60.000mg Iron (Fe), 60.000mg Zinc (Zn), 5.000mg Copper (Cu), 2.000mg Iodine (I), 500mg Cobalt (Co), 150mg Selenium (Se), 1000mg Antioksidan, 2500mg kantaksantin, 500mg Apo-ester includes.

**: Calculated analysis.

group was stored for 24 hours at room temperature. The feed conversion ratio was expressed as the kilogram of feed consumed per kilogram of egg produced. Another 12 egg samples were randomly collected from each experimental group every month in order to assess egg quality parameters. Egg quality parameters were shape index, shell strength, shell thickness, albumen index, yolk index, yolk colour (Yolk Colour Fan, the CIE standard colorimetric system, F. Hoffman-La Roche Ltd., Basel, Switzerland) and Haugh unit and they were calculated using following formulas as summarized by Ergün *et al.* (1987). Egg quality parameters were assessed using the following formulas:

Shape index (100) = [(egg width (cm)/egg length (cm)] x 100

Shell strength (kg/cm x cm) determined by using a machine with a spiral pressure system; Shell thickness (mm) was determined in 3 different parts (upper and lower ends and middle) using a micrometre;

albumen index (%) = [(albumen height (mm) / average of albumen length (mm) and albumen width (mm)]x100;

yolk index (%) = [(yolk height (mm) / yolk diameter (mm)] x 100

yolk colour was determined using commercially available yolk colour fan according to the CIE standard colorimetric system;

Haugh unit = 100 x log (H+7.57-1.7 x $W^{0.37}$),

where H = albumen height (mm) and W = egg weight (g) (Card and Nesheim, 1972).

Lipid oxidation was assessed on the basis of the MDA (Malondialdehit) formed during refrigerated storage. MDA was the compound used as an index of lipid peroxidation (Botsoglou *et al.*, 2005). To determine the total of TBARS values 18 eggs were taken from each group at the end of the experiment and after stored 0, 21 and 42 days at +4°C, samples were analyzed according to the method of Kilic and Richards (2003). In this method, yolk sample (2g) was mixed with 12mL TCA (ethanol dissolved in 3ml of 7.5% TCA, 0.1% EDTA, 0.1% Propil galat). The mixture was vortexed for 15-20 seconds and filtered through Whatman filter paper. Following filtration, a 3mL aliquot was transferred to another tube and mixed with 3mL 0.02M of thiobarbituric acid (TBA) and the mixture was incubated for 40 minutes at 100°C. After incubation, the mixture was allowed to cool under tap water. After the mixture was centrifuged at 2000 rpm for 5 min, absorbance values were read at a wavelength of 530 with spectrophotometry. TBARS value was calculated by the following equation:

TBARS = [(absorbance / k (0.06) x 2/1000) x 6.8) x 1000 / sample weight)

Fatty acids and blood analysis: Fatty acids were analyzed by gas chromatography at the Food Engineering Department of Atatürk University (IUPAC, 1976). For analysis of the yolk fatty acid, yolk samples were extracted and analyzed as reported by Aksu and Kaya (2002). Fat (0.15 to 0.20g) extracted by the ether method from each sample (total of two), was saponified with 5 ml NaOH with methanol in a water bath for 10 minutes. Previously, at this mixture 5mL BF3-methanol was added and the extract was refluxed for 2 minutes. After adding 5mL heptane to the mixture, it was boiled again for 1 minute. The content of this mixture was transferred into 25mL volumetric flasks and the volume was adjusted with saturated NaCl to 25ml. 1mL of the heptane phase from upper layer of the volumetric flasks was used to determine the fatty acids composition. Fatty acids were analyzed with gas chromatography (Agilent 6890N, Hewlett Packard, Palo Alto, CA) with a capillary column (supel covax 10, 60m x 0.25 mm ID). The chromatographic conditions were: detector temperature 280°C; injector temperature 200°C; initial column temperature 100°C for 8 min, programmed to increase at a rate of 5°C per five minutes up to 200°C and then at 4°C per minute up to the final temperature of 250°C. The helium carrier gas flow was set at 1.2mL/min, hydrogen at 30mL/min and air at 300mL/min. Injection of the 1-µL samples was performed with a split ratio of 20:1. Identification of individual fatty acids was based on comparisons of retention times of unknown peaks to authentic fatty acid methyl ester standards.

To determine the serum and egg lipid profile blood was taken from 5 hens and 5 eggs for each group, samples were analyzed according to method of (Hara and Radin, 1978).

Statistical analysis: Differences between groups were analyzed with one-way analysis of variance (ANOVA) by using the statistical package SPSS for Windows (1999), version 10.0. Significant means were subjected to a multiple comparison test (Duncan) at alpha = 0.01 and 0.05 level.

RESULTS

Canola oil prevents the accumulation of bad cholesterol (LDL) by enriching the monounsaturated fatty acid (oleic acid) content. It also contains 61% unsaturated fatty acids which are heart-friendly acids; this rate is second only to that of olive oil. Because of these properties, canola oil plays an important role in maintaining cardiovascular health (Denekbasi and Karayücel, 2010). When data from Table 2 was examined, it was observed that egg production, weight of egg and feed intake decreased compared to the control ($p<0.05$), although feed conversion did not affect by supplementing the canola oil.

Table 2: Feed conversion rates and daily feed intake, egg production, egg weight of trial groups (%)

Groups	EP	EW	FC	FCR
Control	84.75[a]	67.19[a]	127.16[a]	1.50
2.0%	81.03[a]	65.19[b]	127.18[a]	1.56
4.0%	76.64[ab]	61.48[c]	111.77[b]	1.45
6.0%	70.98[b]	61.68[c]	109.52[b]	1.54
SEM	2.76	0.57	3.15	0.06

a,b,c: Means with different superscripts each column differs significantly P<0.05.
EP: Egg Production, EW: Egg Weight, FC: Feed Consumption, FCR: Feed Conversion Ratio.

Table 3: The effects of canola oil on egg shell quality of laying hens

Groups	Control	2.0%	4.0%	6.0%	SEM
Quality criteria					
SI(%)	74.50	73.39	74.75	74.22	0.86
BS (kg/cm^2)	2.17	1.56	2.00	1.82	0.17
ST(mm)	0.39	0.38	0.38	0.38	0.01
SW(g)	7.85	7.91	7.60	7.67	0.17
YC	8.11[a]	6.61[ab]	6.61[ab]	6.56[ab]	0.12
YI(%)	38.36	39.71	41.23	40.89	0.41
FI(%)	7.97[b]	9.08[a]	8.47[b]	9.12[a]	0.39
HU	79.04[b]	82.79[ab]	81.12[ab]	83.36[a]	1.50

a,b,c: Means with different superscripts each column differs significantly P<0.05.
SI: Shape index; BS: Breaking Strength; ST: Shell Thickness; SW: Shell Weight; YC: Yolk Colour; YI: Yellow Index; FI:Flow Index; HU: Haugh Unit.

Table 4: TBARS values in egg of groups (MDA ng/g)

	21 Day	42 Day
Control	7.53[c]	15.49
2.0%	13.60[ab]	14.23
4.0%	14.78[ab]	14.52
6.0%	16.68[a]	16.74
SEM	1.57	1.65

a,b,c: Means with different superscripts each column differs significantly P<0.05.

When data from Table 3 was examined, it was seen that there were no differences among groups for the parameters examined, with the exception of the yellow colour of the egg and egg yolk index.

Data related to TBARS is presented in Table 4 TBARS values were determined on days 21 and 42nd. On day 21st, the TBARS values in the canola-supplemented group increased. Compared with the TBARS values of the control group on day 42th, those of the group supplemented with 6.0% canola oil numerically increased, although this change was not significant statistically (p>0.05).

The egg yolk and serum lipid profile values are presented in Table 5 and 6. The egg yolk lipid profile was not different among treatment groups examined in terms of hydrocarbons, although hydrocarbons in serum lipid profile increased in containing canola oil groups. The triacylglycerols in the group containing 6.0% canola oil was lower than the control group. No statistical differences were observed among groups for free fatty acids, although free fatty acids were identified as being higher in the 6.0% canola oil group compared to the control group. Identified blood serum and egg yolk cholesterol in egg yolks the canola oil containing groups was observed to be higher than the control group. The amount of canola oil in the treatment groups was also observed to be lower than in the other as well as groups the blood serum level.

The amounts of egg yolk fatty acid are presented in Table 7. The lowest amount of oleic acid was determined in the control group (36.05%), while the highest amount was in the group with 6.0% canola oil (43.51%). Conversely, the highest amount of linoleic and alpha-linoleic acid (20.43 and 0.93%, respectively) were found in the control group, the lowest amount of linoleic and alpha-linoleic acid were also found in the group with 6.0% canola oil. No statistical differences were observed among groups for EPA and DHA, as well as total Saturated Fatty Acids (SFA) among the groups. Polyunsaturated Fatty Acids (PUFA) in the groups with canola oil decreased (P<0.05) compared to the control. Monounsaturated Fatty Acids (MUFA) decreased in the control, while it increased in the groups with increasing levels of canola oil.

DISCUSSION

In a study with Cobb laying hens (Cherian, 2008), it was determined that supplementation of n-3 fatty acid-rich oil into the diet decreased the weight of eggs compared to the un-supplemented group (control). Another study (Mazalli *et al*., 2004a) was the effects of different feed oils on the performance in laying hens were investigated, determined that Polyunsaturated Fatty Acids (PUFA) decreased the weight and size of eggs and regulated the concentration of plasma estradiol by reducing estrogenic activity. In another study where the different levels of locally produced canola seeds were used in the diet of laying hens (Agah *et al*., 2010), it was observed that feed intake, egg production and the weight of eggs decreased in parallel with an increase in the level of canola seed. The cause of decrease in egg weight is the lack of linoleic acid in the diet (Rasaulpour *et al*., 2011; Nobakht *et al*., 2011). In a similar study (Grobas *et al*., 2001) the effects of different levels of tallow, olive oil, soy oil and flax seed oil on the performance of laying hens were investigated and it was reported that all supplementations decreased feed intake compared to the control; the weight of eggs numerically increased in the soy oil supplemented group; egg production was higher in the experimental group with the exception of the soy oil supplemented group; feed conversion was not affected from supplementation. The data obtained from the present study were consistent with some research findings that reported a decrease for weight of egg (Cherian, 2008; Mazalli *et al*., 2004a; Nobakht *et al*., 2011), egg

Table 5: The egg yolk lipid profile (%)

Groups	HC	TAG	FFA	Col	M-DAG	PL
Control	9.21	65.48^{a}	3.88	15.26^{b}	5.17	1.00
2%	9.54	63.41^{b}	3.99	16.56^{a}	5.44	1.05
4%	9.40	64.48^{ab}	3.23	17.09^{a}	5.00	0.81
6%	9.00	63.91^{b}	3.35	17.71^{a}	5.23	0.80
SEM	0.30	0.43	0.24	0.39	0.26	0.09

a,b,c: Means with different superscripts each column differs significantly P<0.05.
HC: Hydrocarbons; TAG: Triachyleglyserol; FFA: Free Fatty Acids; Col: Cholesterol; M-DAG: Mono-Diaçilgliserol; PL: Polar Lipids

Table 6: The blood serum lipid profile (%)

Groups	HC	TAG	FFA	Col	M-DAG	PL
Control	16.97^{c}	46.45^{a}	4.35^{bc}	20.00^{ab}	2.33^{a}	9.90^{b}
2%	22.13^{b}	39.29^{b}	3.81^{c}	20.61^{a}	1.78^{b}	12.04^{a}
4%	24.10^{b}	37.54^{b}	5.56^{ab}	19.21^{bc}	1.69^{b}	11.91^{a}
6%	27.32^{a}	34.90^{c}	6.03^{a}	18.64^{c}	1.74^{b}	11.37^{ab}
SEM	0.95	0.87	0.42	0.33	0.16	0.52

a,b,c: Means with different superscripts each columns differ significantly P<0.05.
HC: Hydrocarbons; TAG: Triachyleglyserol; FFA: Free Fatty Acids; Col: Cholesterol; M-DAG: Mono-Diaçilgliserol; PL: Polar Lipids

Table 7: The effects of canola oil on egg yolk fatty acid composition of laying hens (%)

Fatty acids	Control	2.0%	4.0%	6.0%	SEM
$C_{14:0}$ (Miristic Acid)	024^{b}	0.31^{a}	0.28^{ab}	0.25^{b}	0.305
$C_{16:1\ \omega7}$(Palmitoleic Acid)	2.13^{ab}	2.34^{a}	1.96^{b}	1.18^{c}	0.102
$C_{18:1\ \omega9}$(Oleic Acid)	36.05^{b}	42.94^{a}	42.14^{a}	43.51^{a}	0.528
$C_{18:2\ \omega6}$(Linoleic Acid)	20.43^{a}	13.90^{b}	14.10^{b}	14.12^{b}	0.792
$C_{18:3\ \omega3}$(alpha-Linolenic Acid)	0.93^{a}	0.51^{c}	0.68^{b}	0.71^{b}	0.051
$C_{20:5\ \omega3}$ (EPA)	0.04	0.03	0.02	0.02	0.006
$C_{22:5\ \omega3}$ (DPA)	0.10	0.10	0.13	0.11	0.014
$C_{22:6\ \omega3}$(DHA)	0.93^{c}	0.84^{c}	1.15^{b}	1.55^{a}	0.051
ΣSFA	34.55	33.88	34.59	33.46	1.033
ΣMUFA	40.02^{b}	47.58^{a}	46.21^{a}	46.67^{a}	0.541
ΣPUFA	24.68^{a}	17.61^{b}	18.31^{b}	19.00^{b}	0.948
Σω6	22.69^{a}	16.12^{b}	16.34^{b}	16.61^{b}	0.859
Σω3	1.99^{b}	1.49^{c}	1.98^{b}	2.39^{a}	0.097

a,b,c: Means with different superscripts each column differs significantly P<0.05.

production (Agah *et al*., 2010), feed intake (Çelebi and Utlu, 2006; Shafey *et al*., 2003) and feed conversion (Grobas *et al*., 2001; Lelis *et al*., 2009; Balevi and Coskun, 2000) when canola oil was supplemented into laying hens. Conversel, the finding of the current study were in contrast with some research findings indicating that performance parameters improved with the supplementation of different feed oils (Küçükersan *et al*., 2010). Alternatively, some researchers (Rasoulpour *et al*., 2001; Shahriar *et al*., 2002; Lelis *et al*., 2009; Ceylan *et al*., 2011) reported that types of feed oils did not affect feed intake, egg production and feed conversion, although saturated oils supplementation decreased feed intake (Grobas *et al*., 2001). Variation among results can be ascribed to the differences in the conditions of the studies. It is well known that the feed intake of poultry varies depending on several factors such as metabolizable energy levels of diets, age, body weight and breeding (Küçükersan *et al*., 2010).

The yellow colour of the eggs in the experimental groups decreased compared to the control (P<0.05) as this was similar among the groups. This difference is thought to be related to the amount of xanthophylls in the ration (An *et al*., 2010). The findings of the present study were in agreement with the findings of Ceylan *et al*. (2011). The egg yolk index increased in the present study (Table 3). In a study where solid and liquid oil and their mixtures were used in laying hens diets it was observed that these oils did not affect the egg quality parameters (Rasaulpour *et al*., 2001).Conversely, Mazalli *et al*. (2004a) reported that the diameter of the egg yellow reduced due to reduction in plasma estradiol level when n-3 PUFA level increased the in diet. In previous studies where the effects of different feed oils on performance and egg quality in laying hens were investigated (Ceylan *et al*., 2011; Cherian, 2008) it was observed that the supplementation of different feed oils into laying hens improved the yellow color and yolk index of egg. Data from current study for yellow colour and yolk index of the eggs was in agreement with the findings of the last researchers mentioned above.

Given the numerous double bonds between the carbon atoms of polyunsaturated fatty acids, they are more rapidly oxidized than then monounsaturated fatty acids (Barroeta, 2007). On day 21 of the experiment in the current study, the egg yolk TBARS values significantly

increased in the canola oil-supplemented group compared to TBARS values of the control group (P<0.05). The n-3 PUFA is highly susceptible to peroxidation, especially in egg yolk which contains a great deal of lipids (An *et al*., 2010). An *et al*. (2010) reported that the MDA content of egg yolk substantially increased due to the replacement of CO (corn oil) with FO (fish oil) in the broiler breeder diet at the end of the 8th week of the experiment. Cherian *et al*. (2007) observed that combination yellow grease, conjugated linolic acid+yellow grease (CLA-YG), yellow grease+conjugated linoleic acid+fish oil (YG-CLA-FO), yellow grease+fish oil (YG-FO) in the rations of laying hens was higher in YC-CLA than all the other treatments accumulation of TBARS during storage. Cherian *et al*. (2007) reported that diet and storage reduced the tocopherol content of eggs.

Consumed monogenic fatty acids were observed efficiently reduced the blood serum cholesterol level. Rape seed oil reduced the serum cholesterol level due to the rich monogene (Salamatdoustnobar *et al*., 2009). In a study carried out by the addition at different levels of canola oil on the rations of Iranian domestic turkeys, Salamatdoustnobar *et al*. (2009), reported that an increased amount of canola oil in the diet caused a decrease in the serum cholesterol and HDL levels. In the same study, serum triacylglycerol levels between the groups was not found to be significant. Mazalli *et al*. (2004b) reported that addition in the different levels oil the layer hens rations were in groups consumed canola oil and sunflower oil with vitamin E of the lowest cholesterol levels. Küçükersan *et al*. (2010) reported that addition in different levels of sunflower oil, fish oil, soybean oil and hazelnut oil the layer hens rations were not efficiently on the egg yolk cholesterol levels. Increase in the amount of egg yolk cholesterol decreased lipogenezis with fatty acids, although the cholesterol level increased in the liver. Therefore, it is increased in the egg yolk (Rowghani *et al*., 2007). In a study added control, 1.0% calcium soaps of fatty acids, 3.0% and 5.0% canola oil (Rowghani *et al*., 2007) egg yolk cholesterol levels have been identified as 12.07, 12.57, 12.28, 12.30 mg/g, respectively. Differences between studies on egg yolk cholesterol is thought to be related to the genetic structure of chickens with on the factors connected to ration.

A study carried out with breeding- broilers (Cherian, 2008), observed that high or low levels of n-3 PUFA in diets did not affect the egg yolk fatty acid profile (PUFA, MUFA and SFA). It was reported that the egg yolk fatty acid profile would be related to the age and breed of animals (Cherian, 2008; Grobas *et al*., 2001). In a similar study (Grobas *et al*., 2001) the effects of different levels of tallow oil, olive oil, soy oil, flax seed oil on performance of laying hens was investigated. It was observed that the egg yolk MUFA level was higher in the groups with tallow oil and olive oil (P<0.05); as well as egg yolk PUFA level in the groups with soy oil and flax seed oil (P<0.05). In the same study, the amounts of docosapentanoik acid (DPA, $C_{22:5\ n-3}$) and dokosahexanoik acid (DHA, $C_{22:6\ n-3}$) were increased in the groups supplemented with feed oils compared to the control (P<0.05). An increase in the PUFA of egg yolk ascribed to the high level of linoleic acid in soy and flax oil (Grobas *et al*., 2001; Shakeel *et al*., 2010). In the current study, it was determined that the amounts docosapentanoik acid (DPA, $C_{22:5\ n-3}$) and dokosahexanoik acid (DHA, $C_{22:6\ n-3}$) were highest in the group with 6% canola oil (1.55%) and lowest in the control (0.93%) (Table 7). Ceylan *et al*. (2011) reported that the highest amount of (DHA, $C_{22:6\ n-3}$) was in the group with flax seed oil. In another study where different feed oils were used at a 3.0% level in laying hens (Pita *et al*., 2010), it was determined that the amount of PUFA was higher in the groups with flax oil (23.66%) and soy oil (24.06%) and it was lower in the group with canola oil (17.32%). Milinsk *et al*. (2003) reported that supplementation of canola oil increased the amount of oleic acid compared to other feed oil resources (soy oil, flax oil, sunflower oil) and the control (P<0.01); while the amount is similar between the groups with sunflower oil and the control. In the same study, it was also observed that the lipid concentration of egg yolk was highest (39.8%) in the group with canola oil and lowest in the group with sunflower oil (30.4%). In another study (Güçlü *et al*., 2008), were the effects of different feed oil resources on performance and egg quality in laying quail were investigated, the highest oleic acid level was determined in the group with rape seed oil due to the presence of high oleic acid level in rape seed oil (73.2%). In the current study, a high amount of MUFA and a low amount of PUFA were observed in the experimental group. This can be ascribed to the differences in the fatty acid profile of canola oil. Data from the current study for the amounts of PUFA and MUFA of egg yolk was in agreement with those the finding of certain researchers (Milinsk *et al*., 2003; Pita *et al*., 2010; Grobas *et al*., 2001; Güçlü *et al*., 2008).

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