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DIETARY INCLUSION OF GRAPE SEED OIL IN FUNCTIONAL BROILER MEAT PRODUCTION

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Abstract

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The purpose of this study is to explore the effects of grape seed oil on growth performance, some blood parameters and fatty acid composition in broiler meat. In order to formulate isocaloric ratios, the corresponding amounts of soy oil were excluded from the rations accordingly with the addition of 0, 5, 10 and 15 g grape seed oil per kg. Four treatment groups were formed each consisting of 20 birds with similar initial body weights. Feed and water were given *ad libitum*. At the end of the experiment, no statistically significant difference was identified among the groups with respect to body weight gain, feed consumption and blood parameters ($P>0.05$). Feed conversion rate was improved in the group supplemented with 15g/kg grape seed oil ($P<0.05$). Grape seed oil inclusion was determined to be quadratically significant for carcass yield ($P<0.05$). The use of grape seed oil in the ration significantly increased the levels of C17:1 heptadecanoic acid, C18:3 linoleic acid and C20:1 eicosenoic acid in the meat which is known to have health-promoting effects for humans ($P<0.05$). The results have shown that nutritional composition of diets could affect the fatty acid composition of broiler meat. Hence, the findings of the study support the potential use of grape seed oil in functional broiler meat production for human nutrition, particularly for those with cardiovascular diseases.

Key words: broiler, grape seed oil, performance, blood parameters, meat fatty acid composition

Subscripts: grape seed oil, functional broiler meat

Introduction

Grape (*Vitisvinifira*) is one of the mostly produced fruits in the world with an annual world production is about 68 million tons (FAO STAT, 2008). About 80% of this amount is used in wine production and about 10 million tons of grape residues are obtained from the process. A significant part of the grape residue is comprised by grape seed which amounts to 38-52% on dry matter basis (Maier, 2009). The oil content of grape seed ranges between 13-20% (Nerantzis and Tataridis, 2006). Hence, the annual world grape seed oil production potential is approximately 700 thousand tons.

Grape seed oil is natural oil obtained from the seed of *Vitisvinifira* (Wren, 2002). Compared to other oily seeds, grape seed oil is rich in terms of unsaturated fatty acids such as oleic and linoleic acid (Barron et al., 1988). The unsaturated fatty acids like oleic and linoleic acid are essential for human metabolism. Humans lack the enzymes required for the synthesis of these fatty acids. Therefore, these fatty acids should be provided with daily nutrition (Baydar and Akkurt, 2001). The proportion of unsaturated fatty acids in grape seed oil is over 86% (Baydar and Akkurt, 2001). The researchers have reported that grape seed oil has strong antioxidant properties (Bloom, 2009; Poiana and Ark, 2009). In Japan, the use of grape seed oil as a natural food additive has been approved and the oil is used as an antioxidant for the conservation of food (Nakamura, 2003). Grape seed oil has plenty of antioxidant substances that lower cholesterol level. Accordingly, it has an increasing effect on good cholesterol (HDL) and decreasing effect on bad cholesterol (LDL) Nerantzis and Tataridis (2006). Ozgan et al. (2009) have stated that around 2% grape seed oil supplementation has the potential for low

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cholesterol-functional egg production. The average concentration of total tocopherol (Vitamin E) in oil is around 454 mg/kg. It has been reported that grape seed oil can be used as an edible vegetable oil and considered as an important means for decreasing wine production costs (Baydar and Akkurt, 2001). Grape seed oil has also a high concentration of flavonoids. The most available of those is proanthocyanidins (Wren, 2002). This nutrient has similar effects of vitamin C and works in synergy with vitamin C. Some researchers have stated that grape seed oil helps vitamin C to enter the body's cells, thus strengthening cell membranes, and protecting cells from oxidative damage of free radicals (Anonymous, 2007). Grape seed oil is also used in treating several liver diseases. This property is attributed to its high content of vitamin E, which is an antioxidant preventing damage to liver (Mahaswari and Rao, 2005). Another study has suggested that the natural compounds in grape seed oil provide defense against the evolution of colorectal cancer (Bloom, 2009).

The increased awareness in consumers in the recent years and the emphasis on the direct relationship between nutrition and health has lead to a growing interest in functional foods. Functional food is defined as the food in normal food form but not in the form of capsules, tablet or pills, which, in addition to its basic nutritional impact has beneficial effects on one or more functions of the human organism, thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases **(**Siró et al., 2008).Functional food materials can be obtained by the recovery of nutrients from the residues and other solid wine wastes. Among these, the substances ß-glucan and antioxidant in grape seed oil reduce the risks of chronic diseases and have other physical benefits (Nerantzis and Tataridis, 2006). Therefore, the present study was conducted to evaluate grape seed oil in broiler nutrition and its potential to affect fatty acid profile of broiler meat to improve nutritional value and functionality for consumers.

Materials and Methods

The experiment was carried out according to in a complete randomized design using one-day-old, Ross 308 male broiler chicks. At the beginning of the experiment, four treatment groups were formed each consisting of 20 birds with similar initial body weights. The first group was assigned as the control group and subjected to nutrition with ration without grape seed oil. The other groups were subjected given rations including grape seed oil. In order to formulate the rations to be isocaloric, the corresponding amounts of soy oil were excluded from the rations accordingly with the addition of 0, 5, 10 and 15 g grape seed oil per kg diet. The experiment lasted 42 days and the broilers were housed in individual cages. The experimental chicks were given starter feed (HP: 24.46%, ME: 3167 kcal/kg) between the 1st and 10th day, grower feed (HP: 23.70%, ME: 3314 kcal/kg), between the 11th and 21st day and finisher feed (HP: 21.78%, ME: 3358 kcal/kg) between the 22nd and 42nd day. The experimental grape seed oil is a cold-pressed grape seed oil obtained from red grape and is supplied from DEKA Foreign Trade Co. in Adana Province. The chemical composition of the grape seed oil used in the experiment was determined by GC-MS and presented in Table 1. The compounds of the standard and treatment rations used in the experiment are given in Table 2.

The experimental room temperature was set as 33°C in the first week. In the subsequent two weeks, the temperature was decreased at a rate of 3°C gradually. The temperature which

Table 1
Main fatty acid compounds of grape seed oil

Fatty Acid	Type	Proportion, %
C 14:0 Miristic Acid	Saturated Fatty Acid	0.04
C 16:0 Palmitic Acid	Saturated Fatty Acid	7.81
C 16:1 Palmitoleic Acid	Saturated Fatty Acid	0.11
C 17:0 Heptadecanoic (Margaric) Acid	Saturated Fatty Acid	0.07
C 18:0 Stearic Acid	Saturated Fatty Acid	5.08
C 18:1 n9 Oleic Acid	Mono Unsaturated Fatty Acid	22.91
C 18:2 n6 Linoleic Acid	Poly Unsaturated Fatty Acid	62.9
C 18:3 n3 Linolenic Acid	Poly Unsaturated Fatty Acid	0.24
C 20:0 Arasidic Acid	Saturated Fatty Acid	0.16
C 20:1 Eicosenoic Acid	Unsaturated Fatty Acid	0.17
C 20:4 n6 Arachidonic Acid	Unsaturated Fatty Acid	0.12
C 20:5 n3 Eicosapentaenoic Acid	Unsaturated Fatty Acid	0.12
C 22:0 Behenic Acid	Unsaturated Fatty Acid	0.12

Table 2
Ingredient and nutrieint composition of broiler chick starter, grower and finesher diets used in the experiment, g/kg

Compounds	Starter diet (1st-10th day)				Grower diet (11th-21st day)				Finesher diet (22nd-42nd day)			
Corn	417.41				401.67				507.22			
Soya bean meal, 46HP%	266.85				259.43				242.7			
Barley	-				89.55				35.22			
Wheat Shorts	100				-				-			
Corn Gluten Meal, 55HP%	67.95				60				40			
Oil	44.62				71.79				69.64			
Grape Seed Oil, g/kg	0	5	10	15	0	5	10	15	0	5	10	15
Soya Oil, g/kg	15	10	5	0	15	10	5	0	15	10	5	0
Poultry offal meal, 52.5HP%	40				45				55			
Meat-Bone Meal, 32-33HP%	37.96				51.18				26.82			
Lysine	4.07				3.43				2.46			
DCP, 18 P%	3.27				-				5.11			
Vitamin premix*	3				3				2			
Methionine (Alimet)	2.49				2.56				2.47			
Trace mineral premix**	2				2				1.5			
Organic acid	2				2				2			
Biomos	2				1.5				1			
Sodium Carbonate	1.7				2.86				3.24			
Salt	1.68				1.02				1.02			
Coccidiostat	1				1				-			
Enzyme	1				1				1			
Toxin binder	1				1				1			
Total	1000				1000				1000			
Chemical Analyses, %												
Dry Matter	88.04				88.41				88.03			
Metabolizable Energy, kcal/kg	3167.38				3314.34				3358.11			
Crude Protein	24.46				23.7				21.78			
Crude Fat	8.23				11				10.7			
Crude fiber	2.97				3.18				3.07			
Crude Ash	6.16				6.4				5.78			
Lysine	1.52				1.43				1.29			
Methionine	0.63				0.62				0.58			
Cystine	0.4				0.38				0.36			
Methionine + Cystine	1.04				1				0.94			
Arginine	1.53				1.48				1.37			
Triptophan	0.24				0.23				0.22			
Calcium	1.1				1.17				0.91			
Phytate Phosphorus	0.48				0.48				0.45			

*in each 2 kg composition ; 12 000 000 IU Vitamin A, 3 500 000 IU Vitamin D_3, 100 g Vitamin E, 3 g Vitamin K_3, 2.5 g Vitamin B_1, 6 g Vitamin B_2, 25 g Niacin, 12 g Ca-D-Pantotenat, 4 g Vitamin B_6, 15 mg Vitamin B_{12}, 1.5 g Folic Acid, 150 mg D-Biotin, 100 g Vitamin C, 450 g Colin Chloride

** in each 1 kg composition; 100 mg Manganese, 25 g Iron, 65 g Zinc, 15 g Copper, 0.25 g Cobalt, 1 g Iodine, 0.2 g Selenium.

was set as 24°C was kept constant until the end of the experiment. The relative humidity in the experiment room ranged between 50-60%. Daily fresh and clean water was provided throughout the experiment. Feed consumption of the chicks was recorded on a daily basis and the weekly values were obtained by summing up daily consumption amounts. Body weight gains of the chicks were identified by weekly weight measurements, and feed conversion rates were calculated by dividing weekly feed consumption amounts by weekly body weight gains. At the end of the experiment, the 42-day-old chicks were prepared for slaughter. In the one hour period before the slaughter, the feeds of the chicks were removed. A normal slaughter procedure was performed, blood samples of the five chicks weighing around the group average were taken as representing animal of each group, bleeding, the birds were plucked-off mechanically using a batch heather-picking machine then eviscerated and livers were weighed. Subsequently, hot carcass weights were taken and after storage at +4 °C for 24 h, cold carcass weights were recorded and abdominal fats were removed and weighed. The blood samples of representive birds from each group were taken then centrifuged, blood plasma were obtained and stored at -25°C for biochemical analysis (glucose, cholesterol, triglycerides, very low density lipoprotein, acid phosphatase). Commercial kits were used for the mentioned parameters, namely; CHOD-PAP for cholesterol, GPO-PAP for triglycerides, GOD-PAP for glucose and ACN-ACP for alkaline phosphatase. All analyses were conducted using modular DPP auto analyzer (Roche-Germany). From the three of five representative birds meat samples were obtained from the thigh without skins and were subjected to GCMS analysis for fatty acid profile determination.

Analytical Techniques

Lipid extraction method

For lipid extraction, the procedure based by Bligh and Dyer (1959) was employed. About 10 g of samples of chicken meat without skin was homogenised with 120 mL of methanol/chloroform (1:2 v/v) in a T25 Ultraturrax (Ika-Werke, Staufen, Germany) for 2 min. Whatman filter paper (185 mm) was used for filtering the homogenate. Then, filtrate was collected and transferred to a separatory funnel for phase separation. After the collection of the lower fraction, it was filtered and the obtained filtrate was transferred to a rotary evaporator for evaporation. The remainder lipid sample was then subjected to fatty acid analysis after being pipetted into a small tube.

Fattyacidanalysis

The method of Ichihara et al. (1996) was employed for the conversion of lipid samples to their constituent fatty acid methylesters (FAMEs). 4 mL of n-heptane was used for the dilution of each lipid sample (20 mg), in duplicate. Subsequently, the lipid samples were mixed with 4 mL of 2 mol L-1 potassium hydroxide in methanol in a clear tube with a screwcap. In addition, 20 mg lipid samples were taken in two tubes which were then supplemented with 4 ml heptanes and 2 ml KOH. The mixtures were shaken in vortex for 10 s and centrifuged at 4000 rpm for 10 min. Top layers were taken and subjected to FAME analysis (Ozogul, 2009).

FAME analysis was conducted by a Clarus 500 gas chromatograph with an autosampler (Perkin Emler, Shelton, CT, USA), equipped with a flame ionisation detector and a fused silicacapillary column (30 m x 0.32 mm i.d., 0.25 µm; SGE Analytical Science Pty Ltd, Melbourne, Australia). The oven temperature was set at 140°C for 5 min which was the nincreased to 200°C at 1°C min^{-1}. The injector and detector temperatures were set at 220 and 280°C respectively. The carrie rgas (hellium) was controlled at 110 316.11Pa. 1:50 split ratio was employed in the analysis. The identification of fatty acids was realized through the comparison of the retention times of FAME sagainst a Standard 37-component FAME mixture (Sigma-Aldrich Chemie GmbH, Munich, Germany). Two rounds of replicate analyses were conducted and results (%, mean ± stadard deviation) were expressed as gaschromatographic area (Ozogul, 2009).

The statistical analyses of data obtained in the experiment were conducted by SAS (2010) package software using Orthogonal Polynomials Method and data were subjected to analysis of variance by defining the contrasts (linear, quadratic and cubic) effects (Bek and Efe, 1988) (Tables 1 and 2).

Results and Discussion

Feed Consumption and Feed Conversion Rate

At the end of the experiment, feed consumption was not affected by the inclusion of grape seed oil to the diets (Table 3). However, higher ($P<0.05$) feed consumption was observed in the group fed with the ration containing 5 and 10g/kg grape seed oil compared to the control group. This higher amount of feed consumption could be attributed to the appetite stimulating effect of the phenolic compounds such as tannin and proanthocyanidin etc. in the composition of 5 and 10g/kg grape seed oil. Treutter (2008) reported that the ratios of the phenolic compounds proanthocyanidin, catechin and epicatechin in grape seed oil were 0.41, 0.22 and 0.07 µg/ml, respectively. In rat experiments with grape seed oil, it was observed that the oil has no toxic effect and has a digestibility rate above 97% (Karslý, 1983). Best (2006) has identified the effects of animal fat and grape seed oil supplemented pig rations on feed consumption as 0.84 FU/day and 0.82 FU/day.

Davies et al. (2009) have reported that the additives of 50, 100 and 150 mg/kg grape seed extracts per body weight in horse rations had no effect on total feed consumption. The findings of Ozgan et al. (2009) have similarly revealed that grape seed oil supplementation in laying hen rations did not have any significant effects on feed consumption. Bloom (2009) has stated that grape seed oil can be utilized as an inexpensive feed material. In our study, grape seed oil supplementation did not have any negative effects on feed consumption and performance of the treatment groups, which indicates that the oil is acceptable without stimulating effects on feed intake. However, in contrary to our study, Wren et al., (2002), fed male and female rats with grape seed oil supplementations at the rates of 0, 0.5, 1 and 2.0% for a duration of 90 days they found that grape seed oil supplementation especially at a rate of 2% has significantly increased feed consumption among male rates.

The feed conversion rates obtained at the end of the experiment (Table 4) reveal that the group supplemented with 15g/kg grape seed oil has achieved the best feed conversion rate. This result is a reflection of higher body weight gain but lesser feed consumption. This improvement in feed conversion rate was determined to be significant in terms of cubic effect (P<0.05).

Body Weight Gain

The results with respect to body weight obtained in the experiment showed that (Table 5) body weight gain was not affected by dietary inclusion of grape seed oil, but numerically the highest body weight gain was detected in the group fed with the diet containing 15 g/kg grape seed oil. López-Ferrer et al. (1999) have concluded that grape seed oil inclusion used as an alternative of fish oil did not have any significant effects on broiler performance. Wren et al. (2002) reported no significant

Table 3
The effects of grape seed oil inclusion to diets on cumulative feed consumption (g/chicken) of broilers

Treatment groups		Weeks of study					
		1	2	3	4	5	6
Control Group		125.10	453.26	971.89	1726.5	2678.94	3777.94
Grape Seed Oil, 5g/kg		129.40	456.15	964.68	1724.68	2690.56	3836.53
Grape Seed Oil, 10g/kg		139.25	490.25	1018.6	1798.55	2759.00	3827.00
Grape Seed Oil, 15g/kg		112.16	397.63	927.67	1659.47	2600.79	3742.43
SED		2.63	7.11	11.65	19.43	29.16	38.92
Significance Level (=P)		0.0045	0.0002	0.0551	0.0967	0.2999	0.812
*Effect	L	-	*	-	-	-	-
	Q	*	*	-	-	-	-
	C	-	*	*	-	-	-

SED: Standard Error of Difference between Means Effect: L; Linear, Q; Quadratic, C; Cubic
*: P<0.05

Table 4
The effects of grape seed oil inclusion to diets on feed conversion rate (g feed consumption/g weight gain) of broilers

Treatment groups		Weeks					
		1	2	3	4	5	6
Control Group		1.50	1.57	1.59	1.64	1.66	1.72
Grape Seed Oil, 5g/kg		1.46	1.52	1.57	1.63	1.68	1.71
Grape Seed Oil, 10g/kg		1.44	1.54	1.61	1.67	1.71	1.77
Grape Seed Oil, 15g/kg		1.64	1.55	1.52	1.58	1.61	1.67
SED		0.07	0.02	0.01	0.01	0.01	0.01
Significance Level (=P)		0.7635	0.9453	0.3261	0.1007	0.0385	0.0468
*Effect	L	-	-	-	-	-	-
	Q	-	-	-	-	*	-
	C	-	-	-	-	-	*

SED: Standard Error of Difference between Means Effect: L; Linear, Q; Quadratic, C; Cubic
*: P<0.05

relationship between dietary inclusion of grape seed oil and body weight gain in rats. On the other hand, Best (2006) observed that animal fat and grape seed oil improved body weight of pigs as about 440 g and 407 g, respectively. Furthermore, dietary use of grape seed oil is reported to reduce pig production costs at a rate of 9% compared to animal fat. On the other hand, grape residue inclusion up to 30 g/kg did not have any contribution on growth performance of the broilers (Goñi et al., 2007). The study of Ozgan et al. (2009) revealed that feeding diet containing grape seed oil did not have any significant contribution to body weight gain. The findings of these studies are in agreement with our findings concerning body weight gain and it could therefore be concluded that dietary inclusion of 5, 10, 15 g/kg grape seed oil did not improve e statistically, but induce a small increase in broiler body weight.

Carcass Parameters

As indicated by Table 6, the carcass parameters obtained at the end of the experiment were not affected by the treatments. However, numerically the heaviest carcass weight was detected in the group fed with 15 g/kg grape seed oil supplementation. This could be attributed to the higher body weights of the chickens in this group obtained at the end of the experiment. The difference among the groups in terms of carcass yield was quadratically significant (P<0.05). While carcass yield decreased in the groups fed with 5 and 10 g/kg grape seed oil supplementation, carcass yield of the group fed with 15 g/kg grape seed oil supplementation was similar to that of the control group.

Abdominal fat weight, % of abdominal fat and liver weight were not affected by the grape seed oil concentrations in the

Table 5
The effects of grape seed oil inclusion to diets on body weight gain (g/chicken) of broilers

Treatment groups		Weeks						
		0	1	2	3	4	5	6
Control Group		42.74	85.34	292.43	615.52	1056.41	1617.13	2199.36
Grape Seed Oil, 5g/kg		42.70	89.67	301.6	619.25	1062.57	1606.97	2246.96
Grape Seed Oil, 10g/kg		42.68	97.13	319.47	635.77	1081.92	1615.18	2169.44
Grape Seed Oil, 15g/kg		42.68	81.62	270.16	622.52	1061.99	1621.03	2251.96
SED		0.30	2.24	6.26	10.18	15.27	20.98	27.44
Significance Level (=P)		0.9999	0.0844	0.0449	0.8869	0.9287	0.9959	0.642
*Effect	L	-	-	-	-	-	-	-
	Q	-	*	*	-	-	-	-
	C	-	-	-	-	-	-	-

SED: Standard Error of Difference between Means Effect: L; Linear, Q; Quadratic, C; Cubic
*: P<0.05

Table 6
The effects of grape seed oil inclusion to diets on carcass parameters of broilers

Treatment groups		Parameters					
		Hot carcass weight, g/chicken	Cold carcass weight, g/chicken	Carcass yield, %	Abdominal fat weight, g/chicken	Abdominal fat, %	Liver weight, g
Control Group		1539.54	1530.15	69.83	30.47	1.98	44.33
Grape Seed Oil, 5g/kg		1569.00	1532.90	68.81	29.25	1.89	41.50
Grape Seed Oil, 10g/kg		1463.43	1423.86	68.07	23.71	1.65	42.00
Grape Seed Oil, 15g/kg		1554.23	1540.31	69.80	34.08	2.08	42.79
SED		34.78	34.43	0.32	1.65	0.09	0.78
Significance Level (=P)		0.7771	0.6691	0.2152	0.248	0.4282	0.5332
*Effect	L	-	-	-	-	-	-
	Q	-	-	*	-	-	-
	C	-	-	-	-	-	-

SED: Standard Error of Difference between Means Effcet: L; Linear, Q; Quadratic, C; Cubic
*:P<0.05

rations. Nevertheless, compared to those of the control group, abdominal fat weight and % of abdominal fat showed a decreasing tendency in the groups fed with 5 and 10 g/kg grape seed oil supplementation. Moreno et al. (2003) have reported that grape seed extract limited fat deposition in adipose tissue by inhibition of the fat metabolizing enzymes pancreatic, lipoprotein and hormone-sensitive lipase and controlled obesity.

Plasma Glucose, Cholesterol, Triglyceride, VLDL and Acid Phosphatase Concentrations

As revealed in Table 7, plasma glucose, cholesterol, triglyceride, VLDL and acid phosphatase concentrations were not affected by the treatments

On the other hand, Nakamura and Tonogai (2002) reported that the polyphenols in grape seed oil affected the lipid metabolism of rats by decreasing serum and liver triglyceride concentrations rather than changing the cholesterol metabolism. It has also been reported that the proanthocyanidins in grape seed oil dramatically ameliorated the incidence of atherosclerosis by preventing the formation of foam cells in arteries and decreased plasma triglyceride level in hamsters (Vinson, 2002). Maheswari and Rao (2005) have explored antihepatotoxic (antioxidant mechanism scavenging toxins and free radicals from liver) effect of grape seed oil in rats. Oral administration of grape seed oil (3.7g/kg, body weight) has been found to protect liver against carbontetrachloride (CCl_4)-induced hepatotoxicity in rats. They reported that feeding grape seed oil resulted in a significant reduction in serum aspartate aminotransferase (AST), alanineaminotransaminase (ALT), and alcaline phosphatase (ALP) levels and livermalondialdhyde (MDA) and hydroperoxides and significant improvement in glutathione, superoxide dismutase (SOD), catalase (CAT), and total protein (TP), when compared with CCl_4 damaged rats. In the study by Davies et al. (2009), 100 and 150 mg/kg grape seed oil supplementation in horse rations induced a significant drop in blood glucose concentration. Ozgan et al. (2009) suggested that dietary inclusion of 2% grape seed oil significantly increased plasma glucose concentration while decreasing plasma cholesterol level and egg yolk cholesterol level. The findings of these studies are inconsistent with our findings concerning blood parameters which might be explained by the differences in the amounts of grape seed oil supplementations and animal material.

Meat Fatty Acid Composition

The effects of grape seed oil inclusion in the rations on meat fatty acid composition of broilers are presented in Table 8. The levels of the meat fatty acids C17:1 Heptadecanoic (Margoleic) Acid, C18:3 Linolenic Acid and C20:1 Eicosenoic Acid were affected from the treatments ($P<0.05$). The mono-unsaturated fatty acid "Heptadecanoic (Margoleic) Acid" has increased (linearly) in treatment groups and reached its peak value in the group supplemented with 10 g/kg grape seed oil. Meanwhile, a decrease (quadratically) was identified in this acid in the group supplemented with 15 g/kg grape seed oil. Nevertheless, this value was still higher than that of the control group.

While the highest increase (quadratically) in the poly-unsaturated fatty acid "Linoleic Acid" was recorded in the group receiving 5 g/kg grape seed oil, a negative relationship was identified between the level of grape seed oil inclusion and meat linoleic acid concentration.

The level of the mono unsaturated fatty acid "Eicosenoic Acid" was found to increase (linearly) with increasing amounts of grape seed oil supplementations. López-Ferrer et

Table 7
The effects of grape seed oil inclusion to diets on some blood parameters of broilers

Treatment groups		Parameters				
		Plasma glucose, mg/dl	Plasma cholesterol, mg/dl	Plasma triglycerid, mg/dl	Plasma vldl, mg/dl	Plasma acid Phosphatase, mg/dl
Control Group		205.75	110.00	28.50	5.75	6.53
Grape Seed Oil, 5g/kg		202.00	120.57	30.71	6.00	6.70
Grape Seed Oil, 10g/kg		211.33	114.33	32.00	6.33	6.80
Grape Seed Oil, 15g/kg		193.88	119.88	28.38	5.63	6.88
SED		8.02	3.35	2.62	0.50	0.32
Significance Level (=P)		0.8871	0.5328	0.957	0.9698	0.9735
*Effect	L	-	-	-	-	-
	Q	-	-	-	-	-
	C	-	-	-	-	-

SED: Standard Error of Difference between Means Effect: L; Linear, Q; Quadratic, C; Cubic
*: $P<0.05$

al. (1999) have reported that supplementation of grape seed oil as an alternative to fish oil, decreased the amount of total saturated fatty acid in thigh while increasing the amount of total mono unsaturated fatty acid which is attributed to the high content of oleic acid in grape seed oil. Siró et al (2008) have stated that functional meat production can be realized either by changing the fatty acid profile in cooked and raw meat or by the supplementation of antioxidant. In the present study, the increase in the levels of the unsaturated fatty acids Heptadecanoic (Margoleic) Acid, Linolenic Acid and Eicosenoic Acid could have a significant potential in terms of functional chicken meat production. It was reported that dietary use of olive oil, which has high content of mono unsaturated fatty acids (C18:1), instead of animal fat can help reduce the risk of cardiovascular diseases and breast cancer (Vural, 2009). Meanwhile, compared to their saturated counterparts, unsaturated fatty acids are essential for the production of healthier meat and the establishment of an appropriate balance between n-6 and n-3 poly unsaturated fatty acids (Vural, 2009). By the GCMS determination of fatty acid profile, grape seed oil was found to contain 22.9% oleic acid and 62.9% linoleic acid. These proportions are in agreement with those reported by Baydar and Akkurt (2001). The increase in unsaturation level of muscle meat fatty acid composition obtained by feeding manipulations increases the sensitivity of chicken meat to oxidative degeneration (Engberg et al., 1996). This leads to losses in the taste and nutritional value of chicken meat. However, researchers have emphasized the contribution of grape seed extract on decreasing the levels of primary and secondary lipid peroxidation products in raw (Lau and King, 2003) and cooked (Rababah et al., 2006) chicken meat.

Conclusion

Dietary inclusion of grape seed oil (5 and 15 g/kg) in broiler chicks could improve feed conversion rate in contrast to the control group. The results also showed that no negative effects have been detected due to use of grape seed oil, which indicates that broilers could utilize grape seed oil easily. Due to its high content of unsaturated fatty acids, grape seed oil supple-

Table 8
The effects of grape seed oil inclusion to diets on meat fatty acid composition of broilers

Fatty acid content and associated proportions (%) in Broiler Meat	Treatment groups								
	Control Group	G. Seed Oil, 5g/kg	G. Seed Oil, 10g/kg	G. Seed Oil, 15g/kg	SED	Sig. Level (P=)	*Effect		
							L	Q	C
C 10:0 Capric Acid	0.010	0.003	0.010	0.010	0.0010	0.0519	-	-	*
C 12:0 Lauric Acid	0.016	0.013	0.016	0.013	0.0020	0.8018	-	-	-
C 14:0 Miristic Acid	0.283	0.286	0.283	0.300	0.0046	0.4112	-	-	-
C 14:1 Miristoleic Acid	0.040	0.053	0.046	0.053	0.0030	0.2579	-	-	-
C 15:0 Pentadecanoic Acid	0.050	0.053	0.056	0.063	0.0024	0.2011	*	-	-
C 16:0 Palmitic Acid	15.453	15.173	15.066	15.660	0.1182	0.2010	-	-	-
C 16:1 Palmitoleic Acid	2.123	2.616	2.460	2.366	0.1235	0.4231	-	-	-
C 17:0 Heptadecanoic (Margaric) Acid	0.120	0.133	0.143	0.170	0.0067	0.6269	*	-	-
C 17:1 Heptadesenoik (Margoleik) Acid	0.096	0.116	0.123	0.120	0.0030	0.0215	*	*	-
C 18:0 Stearic Acid	4.715	3.896	4.353	4.893	0.2597	0.3830	-	-	-
C 18:1 Oleic Acid	28.550	28.640	29.003	28.823	0.3463	0.9413	-	-	-
C 18:2 Linoleic Acid	42.003	41.770	41.356	41.343	0.3478	0.8070	-	-	-
C 18:3 Linolenic Acid	3.746	4.453	4.273	3.960	0.0369	0.0001	-	*	*
C 20:0 Arasidic Acid	0.056	0.063	0.073	0.083	0.0036	0.0592	*	-	-
C 20:1 Eicosenoic Acid	0.176	0.173	0.213	0.236	0.0085	0.0345	*	-	-
C 20:2 Eicocadienoic Acid	0.146	0.136	0.146	0.163	0.0064	0.4038	-	-	-
C 20:3n 6 Dihomo-gamma-linolenic Acid	0.116	0.093	0.110	0.122	0.0061	0.2522	-	-	-
C 20:3n 3 Eicosatrienoic Acit	0.420	0.320	0.403	0.300	0.0192	0.0651	-	-	*
C 20:5 Eicosapentaenoic Acid	0.030	0.030	0.033	0.030	0.0032	0.9325	-	-	-
C 23:0 Tricosanoic Acid	0.070	0.053	0.063	0.050	0.0038	0.1619	-	-	-
C 24:0 Lignoceric Acid	0.056	0.053	0.056	0.050	0.004	0.8849	-	-	-

SED: Standard Error of Difference between Means; Effect: L; Linear, Q; Quadratic, C; Cubic;
*:P<0.05

mentation in poultry rations increase the levels of unsaturated fatty acids in meat such as Heptadecanoic (Margoleic) Acid, Linolenic Acid and Eicosenoic Acid and hence, it can be utilized for functional meat production in broilers. In addition to those mentioned above, it is presumed that grape seed oil with its strong antioxidant activity could improve shelf-life of chicken meat in a natural way. In order to obtain further findings within this scope, comparative studies are required concerning the effects of antioxidants on chicken meat quality.

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