Journal of Animal and Veterinary Advances 11 (20): 3697-3704, 2012
ISSN: 1680-5593

Effects of Apricot Kernel Oil on Selected Performance and Blood Parameters and Meat Fatty Acid Composition of Broilers

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Abstract: This study investigates the effects of apricot kernel oil on selected performance, blood and carcass parameters and meat fatty acid composition of broilers. A total of 80, 1 day old, Ross 308 male broiler chicks were used in the study and the animals were fed in individual cages. The group fed with soybean oil supplemented ration was the control group. Ensuring groups are fed with isocaloric rations, equivalent amounts of soybean oil were removed from the rations and substituted with corresponding 5, 10 and 15 g kg^{-1} apricot kernel oils. The groups supplemented with these amounts of apricot kernel oil were the treatment groups. At the end of the 42 day long experiment, no statistically significant differences were observed among groups with respect to performance and carcass parameters ($p>0.05$). The lowest plasma acid phosphatase level was identified in the treatment group supplemented with 5 g kg^{-1} apricot kernel oil and the highest level was identified in the treatment group supplemented with 10 g kg^{-1} apricot kernel oil ($p<0.05$). Apricot kernel oil supplementation in broiler rations significantly increased the proportions of C15:0 pentadecanoic acid, C17:0 heptadecanoic (margaric) acid, C17:1 heptadecanoic (margoleic) acid ($p<0.05$), C18:3 linolenic acid ($p<0.001$) and C20:1 eicosanoic acid ($p<0.05$). The experiment results indicated that apricot kernel oil supplementation in broiler rations does not generate any negative effects on animal performance and can be beneficial for human nutrition since it has effects on fatty acid composition of animals.

Key words: Broiler, apricot kernel oil, meat fatty acid, performance parameters, blood parameters

INTRODUCTION

Apricot (*Prunus armeniaca* L.) is a fruit is classified under the *Prunus* species of Prunoidae subfamily of the Rosaceae family of the Rosales group (Asthma, 2000). With an annual apricot production amount of 695.364 tonnes, Turkey is among the leading apricot producers in the world. Based on the calculations of Asthma (2000) and Gezer and Dikilitas (2002), out of a total of 695.000 tonnes of apricot, about 45.000 tonnes $year^{-1}$ (6.5%) is utilized as apricot seed and about 9,000 tonnes $year^{-1}$ (20%) of this amount is utilized as kernel. The oil content of apricot kernels ranges between 40.23 and 53.19% (Kamel and Kakuda, 1992; Turan *et al*., 2007). Hence, according to the data of, apricot kernel oil production potential of Turkey is about 4.000-5.000 tonnes $year^{-1}$.

The shells of apricot seeds are generally utilized as fuel while kernel is mostly exported to European countries. Apricot kernels are used in the production of oils, benzaldehyde, cosmetics, active carbon and aroma perfume (Haciseferogullari *et al*., 2007). Gandhi *et al*. (1997) stated that apricot kernel oil is non-toxic and can be the seeds and for that reason nutritional utilization is possible. Apricot kernel oils contain about 60-70.9% oleic acid (C18:1 omega 9), 20-30% linoleic acid (C18:2 omega 6), 4.0-4.5% palmitic acid (C16:0), 1-1.24% stearic acid (C18:0), 0.08-0.13% linolenic acid (C18:3 omega 3), 0.10-0.12% arachidic acid (C20:0), 0.11% ecosenoic acid (Ozkal *et al*., 2006; Turan *et al*., 2007; Ramadan *et al*., 2011). Apricot kernel oil has about 93% unsaturated fatty acids (ΣMUFA 71.68%, ΣPUFA 22.05%) and about 6% saturated fatty acids (ΣSFA) (Turan *et al*., 2007). The total amount of essential fatty acid in apricot kernel oil is 48.93 g/100 g (Tian and Zhan, 2011) and the total amount of tocopherol is 50.76±6.59 mg/100 g (Turan *et al*., 2007). The oil contains 11.8 mg/100 g campesterol, 9.8 mg/100 g stigmasterol and 177.0 mg/100 g sitostreol (Alpaslan and Hayta, 2006). β-carotene content of the oil is 61.05 μg g^{-1}, total antioxidant capacity is 0.86-1.33 mM Fe^{+2}/L and total polyphenol content ranges between 0.88-1.30 mM gallic acid/L (Popa *et al*., 2011). These polyphenol compounds in the oil have antioxidant properties and protect the polyunsaturated fatty acids against oxidation (Popa *et al*., 2011). Acid number in apricot kernel oil is reported as 1.56, FFA as (%) 0.87, saponification number as 191, iodine value as 105, hydroxyl value as 6.3 and unsaponifiables as (%) 0.56 (Kamel and Kakuda, 1992).

Besides its fatty acid profile, apricot kernel oil contains a range of biologically active substances such as β-carotene, tocopherols, phenolic compounds and provitamin A. These biologically active substances have an important role in healing of wounds, increasing body resistance to toxins as well as preventing and fighting cancer (Popa *et al*., 2011). Yigit *et al*. (2009) observed that the methanol extract in sweet apricot kernel has antibacterial effect against Gram-positive bacteria *Staphlococus aureus* while the methanol extract in bitter apricot kernel has antibacterial effect against the Gram negative bacteria *Escherichia coli* and *Candida albicans*. Tian and Zhan (2011) reported that apricot kernel oil is a natural antioxidant source and for that reason, it can be used as a functional nutritional compound in potential applications due to its health benefits. Furthermore, as a natural, free-radical neutralizer, it performs superior than ascorbic acid. Mono and Polyunsaturated Fatty Acids (MUFAs and PUFAs) have an important role in human nutrition and health. The nutrients rich in these compounds help decreasing total cholesterol levels and blood pressure in humans (Turan *et al*., 2007). The goal of this study is identification of usage potentials of the valuable nutrient of apricot kernel oil (with its perfect content of MUFA and biologically active substances) in broiler rations and identification of potential for functional chicken meat production.

MATERIALS AND METHODS

Experimental design and birds: In terms of animal material, 1 day old, Ross 308 male broiler chicks were used in the experiment. The experiment was conducted in a randomized block design. At the beginning of the experiment, 4 treatment groups were formed each consisting of 20 chicks with similar initial live body weights. Chicks were put into individual cages. The first group was the control group which was supplemented with soybean oil. The other groups were the treatment groups which were given isocaloric rations with 5, 10 or 15 g kg^{-1} apricot kernel oil supplementations instead of soybean oil. The experiment duration was 42 days. The compositions of the standard and treatment rations used in the experiment are shown in Table 1. Temperature of the experiment room was set to 33°C in the 1st week, 30°C in the 2nd week, 27°C in the 3rd week and 24°C in the 4th week and kept at 24°C until the end of the experiment. Relative humidity was kept around 60-65%. Daily, clean water was provided throughout the experiment. Feeding was performed in three phases (0-10th day starter period, 11-21 days grower period, 22-42 days finisher period, Table 1). Feed consumption of chicks were recorded on daily basis and weekly consumptions were calculated based on the sum of daily consumption values. Live body weight gain of chicks were monitored by weekly measurements, feed efficiency ratios were obtained by dividing cumulative weekly feed consumption values (g) by cumulative weekly live body weight gains (g). At the end of the experiment, the 42 days old chicks were prepared for slaughter. The feathers of the slaughtered chicks were plucked-off mechanically using a batch feather-picking machine, the internal organs were taken out and the livers were weighed. Subsequently, hot carcass weights were taken and after storage at +4°C for 24 h, cold carcass weights were recorded, abdominal fats were removed and abdominal fat weights were obtained.

Table 1: Composition of experimental diets in starter, grower and finisher period (g kg^{-1})

Ingredients	Starte (1-10 days)	Grower (11-21 days)	Finisher (22-42 days)
Corn	417.40	401.70	507.20
Soya bean meal 46HP (%)	266.90	259.40	242.70
Barley	-	89.60	35.20
Wheat shorts	100.00	-	-
Corn gluten meal 55HP (%)	68.00	60.00	40.00
Soybean oil (5, 10, 15)	44.60	71.80	69.60
Poultry offal meal (52.5HP %)	40.00	45.00	55.00
Meat-bone meal (32-33HP %)	38.00	51.20	26.80
Lysine	4.10	3.40	2.50
DCP 18 P (%)	3.30	-	5.10
Vitamin premix*	3.00	3.00	2.00
Methionine (Alimet)	2.50	2.60	2.50
Trace mineral premix**	2.00	2.00	1.50
Organic acid (Ginex)	2.00	2.00	2.00
Biomas	2.00	1.50	1.00
Sodium carbonate	1.70	2.90	3.20
Salt	1.70	1.00	1.00
Coccidiostat (Clinacox)	1.00	1.00	-
Avatec	-	-	0.60
Enzyme (Optimase-M)	1.00	1.00	1.00
Mycosorb	1.00	1.00	1.00
Total	1000.00	1000.00	1000.00
Calculated analyses (%)			
Crude protein	24.46	23.70	21.78
Metablizable energy (kcal kg^{-1})	3167.38	3314.34	3358.11

*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

Biochemical analyses in blood plasma: At the end of the experiment, 5 animals with live body weights closest to group average were kept and not sent to slaughther house. Bronchial veins were cut in laboratory and blood samples were collected in pre-numbered test tubes with heparin and immediately centrifuged. The blood samples were kept at refrigerator at +4°C for 24 h and then were

subjected to biochemical analyses (glucose, cholesterol, triglyceride, VLDL (Very Low Density Lipoprotein) acid phosphatase). The following commercial kits were used for the analyses: CHOD-PAP (for cholesterol), GPO-PAP (for triglyceride), GOD-PAP (for glucose) and ACN-ACP (for alcalin phosphatase). All blood analyses were performed by modular DPP device (Roche-Germany) at Çukurova University Faculty of Medicine, Central Laboratory.

Fatty acid composition of apricot kernel oil: The apricot kernel oil used in the experiment was obtained by cold press method and supplied from DEKA Dis Tic. Sti in Adana. GC-MS (Gas Chromatography and Mass Spectrometry) analyses were conducted at Cukurova University, Faculty of Fisheries for the determination of chemical composition and active substance content of the oil. Fatty acid composition of the apricot kernel oil used in the study is shown in Table 2.

Composition of the apricot kernel oil: Composition of the apricot kernel oil used in the study including amount of free fatty acid, peroxide value and amount of unsaponifiable matter is shown in Table 3.

Determination of free fatty acid amount: About 5 g sample was taken from the oil obtained by extraction and the sample was dissolved in 1/1 ethyl alcohol/diethyl ether solution. After adding phenolphthalein indicator, the solution was titrated in 0, 1 N ethanol KOH until it turned pink. The results were calculated in terms of porcentage oleic acid (TS 342, 2003).

Determination of peroxide value: About 0, 5-1 g sample of extracted oil was taken to a stoppered conical flask. After adding accurately weighed 10 mL chloroform, 15 mL glacial acetic acid and 1 mL saturated potassium iodide (KI) solution, the mixture was shaken for 1 min. The solution was allowed to stand in the dark for 5 min. Then, 75 mL distilled water was added and the solution was titrated with 0.01 N sodium thiosulphate +1 mL 1% starch solution until it became colourless. The results were calculated as mili-equivalent O_2/kg oil (TS EN ISO 3960, 2006).

Table 2: Main fatty acid compounds of apricot kernel oil

Fatty acid	Type	Proportion (%)
C 16:0 Palmitic acid	Saturated fatty acid	5.37
C 16:1 Palmitoleic acid	Saturated fatty acid	0.66
C 17:0 Heptadecanoic (Margaric) acid	Saturated fatty acid	0.04
C 17:1 Heptadesenoic (Margoleic) acid	Mono unsaturated fatty acid	0.11
C 18:0 Stearic acid	Saturated fatty acid	1.21
C 18:1 (n9) Oleic acid	Mono unsaturated fatty acid	67.52
C 18:2 (n6) Linoleic acid	Poly unsaturated fatty acid	24.96
C 18:3 (n3) Linolenic acid	Poly unsaturated fatty acid	0.06
C 20:0 Arachidic acid	Saturated fatty acid	0.08

Table 3: Chemical composition of apricot kernel oil

Analyses	Proportion
Free Fatty Acid (% oleic acid)	0.69
Peroxide value (mili-equivalent O_2 kg^{-1} oil)	4.31
Unsaponifiable matter amount (%)	0.36

Determination of unsaponifiable matter amount: The total amount of soluble substances in oil which are not soluble in water after saponification but only soluble in the solvent used in the analyses is called unsaponifiable matter. The main principle in extraction is saponification of oil with alcoholic alkali (KOH solution with 2 N ethanol), extraction of soap with an appropriate solvent (diethyl ether) and evaporation of the extract until a dry mass is obtained. The results were calculated as percentage (TS 4963, 2009).

Analysis of meat fatty acid: Meat samples were taken from 3 animals in each group also subjected to blood analyses. The samples were taken from thigh (without skin) and meat fatty acid profiles were determined by GCMS.

Lipid extraction method: The procedure used for lipid extraction was based on that of Bligh and Dyer. 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. The homogenate was filtered using Whatman fitler study (185 mm) and filtrate was collected and transferred to a separatory funnel for phase separation. The lower fraction was collected and filtered and the filtrate was transferred to a rotary evaporator for evaporation. The resulting lipid sample was pipetted into a small tube for fatty acid analysis.

Fatty acid analysis: Lipid samples were converted to their constituent Fatty Acid Methyl Esters (FAMEs) by the method of Ichihara *et al.* (1996). Each lipid sample (20 mg), in duplicate was diluted in 4 mL of n-heptane and then mixed with 4 mL of 2 mol L^{-1} potassium hydroxide in methanol in a clear tube with a screw cap. In addition, 20 mg lipid was taken in tubes and 4 mL heptanes and 2 mL KOH were added to each tube (number of tube was 2). The mixture was shaken in vortex for 10 sec and centrifuged at 4000 rpm for 10 min. The top layer was taken for FAME analysis (Ozogul *et al*., 2009).

Analysis of FAMEs was performed using a Clarus 500 gas chromatograph with an autosampler (Perkin Emler, Shelton, CT, USA), equipped with a flame ionisation

detector and a fused silica capillary column (30 m×0.32 mm i.d., 0.25 μm; SGE Analytical Science Pty Ltd. Melbourne, Australia). The oven temperaure was held at 140°C for 5 min then increased to 200°C at 1°C min^{-1}. The injector and detector temperatures were set ay 220 and 280°C, respectively. The carrier gas (hellium) was controlled at 110316.11 Pa. The split ratio used was 1:50. Faty acids were identified by comparing the retention times of FAMEs against a Standard 37-component FAME mixture (Sigma-Aldrich Chemie GmbH, Munich, Germany). Two replicate analyses were performed and results were expressed as gas chromatographic area (%, mean±Standard deviation) Ozogul *et al*. (2009).

Statistical analysis: The statistical analyses of data obtained in the experiment were conducted by SAS (1987) 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).

RESULTS

The effects of different amounts of apricot kernel oil supplementation in broiler rations on 0-21 and 0-42 days performance parameters are shown in Table 4. No statistically significant differences ($p>0.05$) were observed in treatment groups with respect to body weight gain, feed consumption and feed efficiency ratio. However, at the end of the experiment, apricot kernel oil supplementation in broiler ration resulted numerically higher live body weight gain and feed consumption in the treatment groups compared to those of the control group. The best numerical feed efficiency ratio was recorded in the treatment group supplemented with 5 g kg^{-1} apricot kernel oil.

Findings on slaughter and carcass parameters at the end of the experiment are shown in Table 5. No statistically significant differences ($p>0.05$) were observed in the treatment groups with respect to hot carcass weight, cold carcass weight, carcass yield, abdominal fat weight, abdominal fat ratio (%) and liver weight. However, at the end of the experiment, numerically higher hot and cold carcass weight values were recorded in the treatment groups compared to those of the control group. This can be explained by the higher live body weights in the treatment groups at the end of the experiment.

Concentrations of selected metabolites determined in biochemical analyses of blood samples taken on 42nd day (end of experiment) from 5 animals in each group with live

Table 4: Effects of apricot kernel oil supplementation in rations on live body weight gain, cumulative feed consumption (g/chick) and feed efficiency ratio of broilers

	Live Body Weight gain (BWG g)		Feed Consumption (FC g)		Feed Efficiency (FC/BWG)	
Treatment groups	0-21 days	0-42 days	0-21 days	0-42 days	0-21 days	0-42 days
Control group	615.5200	2199.3600	971.89	3777.9400	1.5900	1.7200
Apricot kernel oil (5 g kg^{-1})	651.8000	2330.8000	1015.00	3918.8100	1.5600	1.6900
Apricot kernel oil (10 g kg^{-1})	630.8400	2223.0600	1004.95	3852.1100	1.6100	1.7400
Apricot kernel oil (15 g kg^{-1})	616.6400	2268.3300	970.63	3834.4400	1.5800	1.7000
SEM	9.3300	30.6600	11.74	42.2600	0.0100	0.0100
Significance level (= p)	0.4769	0.4477	0.4083	0.7036	0.7919	0.3333
[+]Effect						
L	-	-	-	-	-	-
Q	-	-	-	-	-	-
C	-	-	-	-	-	-

Table 5: Effects of apricot kernel oil supplementation in rations on carcass parameters of broilers

	Parameters					
Treatment groups	Hot carcass (g/broiler)	Cold carcass (g/broiler)	Carcass yield (%)	Abdominal fat (g/broiler)	Abdominal fat (%)	Liver weight (g)
Control group	1539.54	1530.15	69.8300	30.4700	1.98	44.3300
Apricot kernel oil (5 g kg^{-1})	1605.83	1577.67	69.7100	35.1700	2.18	42.9100
Apricot kernel oil (10 g kg^{-1})	1608.00	1584.24	69.2400	31.8900	2.00	44.2900
Apricot kernel oil (15 g kg^{-1})	1552.30	1537.90	68.7700	33.3500	2.12	42.5000
SEM	28.4400	28.03	0.2400	1.5800	0.08	0.8300
Significance level (= P)	0.75210	0.8600	0.3526	0.7778	0.8432	0.7814
[+]Effect						
L	-	-	-	-	-	-
Q	-	-	-	-	-	-
C	-	-	-	-	-	-

SEM: Standard Eerror of difference between Means

body weights closest to group average are given in Table 6. No statistically significant differences ($p>0.05$) were observed in the treatment groups with respect to glucose, cholesterol, triglyceride and VLDL levels. On the other hand, plasma acid phosphatase concentration was significantly affected from the treatments (Cubic effect, $p<0.05$). The lowest plasma acid phosphatase level was recorded in the treatment group supplemented with 5 g kg^{-1} apricot kernel oil and the highest plasma acid phosphatase level was recorded in the treatment group supplemented with 10 g kg^{-1} apricot kernel oil.

Thigh meat fatty acid profiles of the treatment groups are presented in Table 7. C15:0 pentadecanoic acid, C17:0 heptadecanoic (margaric) acid, C17:1 heptadecanoic (margoleic) acid ($p<0.05$), C18:3 linolenic acid ($p<0.001$) and C20:1 eicosanoic acid were significantly ($p<0.05$) affected from the treatments. The proportions of C15:0 pentadecanoic acid and C17:0 heptadecanoic (margaric) acid were observed to increase in the treatment groups ($p<0.05$, linear). Supplementations of 5 and 10 g kg^{-1} apricot kernel oil in the rations increased the proportions of pentadecanoic acid and heptadecanoic acid whereas supplementation of 15 g kg^{-1} apricot kernel oil in the rations decreased the proportions of these acids ($p<0.05$, quadratic).

The proportion of monounsaturated fatty acid C17:1 heptadecanoic (margoleic) acid was observed to increase in the treatment groups ($p<0.05$, linear). The highest heptadecanoic (margoleic) acid value was recorded in the treatment group supplemented with 5 g kg^{-1} apricot kernel oil and a decrease was observed in the treatment group supplemented with 10 g kg^{-1} apricot kernel oil ($p<0.05$, quadratic). A slight increase in heptadecanoic (margoleic) acid value was recorded in the treatment group supplemented with 15 g kg^{-1} apricot kernel oil ($p<0.05$, cubic). However, these values were still higher ($p<0.05$) than those of the control group.

Table 6: Effects of apricot kernel oil supplementation in rations on selected blood parameters of broilers

	Parameters (mg dL^{-1})				
Treatment groups	Glucose	Cholesterol	Triglyceride	VLDL	Acid phosphatase
Control group	205.7500	110.00	28.5000	5.7500	6.5300
Apricot kernel oil (5 g kg^{-1})	204.8600	119.43	30.8600	6.2900	5.7300
Apricot kernel oil (10 g kg^{-1})	188.8800	122.38	28.6300	5.6300	8.3800
Apricot kernel oil (15 g kg^{-1})	206.8800	118.75	23.3800	4.6300	7.1000
SEM	7.5800	3.09	1.7300	0.3400	0.3200
Significance level (= p)	0.7747	0.4663	0.4322	0.3398	0.0485
***Effect**					
L	-	-	-	-	-
Q	-	-	-	-	-
C	-	-	-	-	*

SEM: Standard Error of difference between Means

Table 7: Effects of apricot kernel oil supplementation in rations on meat fatty acid composition of broilers

	Treatment groups								
							*Effect		
Proportions of fatty acids in broiler meats (%)	Control group	Apricot kernel oil (5 g kg^{-1})	Apricot kernel oil (10 g kg^{-1})	Apricot kernel oil (15 g kg^{-1})	SEM	Significance level (= p)	L	Q	C
C 10:0 Capric acid	0.010	0.010	0.025	0.013	0.0045	0.4701	-	-	-
C 12:0 Lauric acid	0.016	0.016	0.020	0.020	0.0014	0.5957	-	-	-
C 14:0 Myristic acid	0.283	0.306	0.310	0.293	0.0053	0.1891	-	*	-
C 14:1 Myristoleic acid	0.040	0.046	0.046	0.053	0.0024	0.2290	-	-	-
C 15:0 Pentadecanoic acid	0.050	0.063	0.070	0.060	0.0020	0.0172	*	*	-
C 16:0 Palmitic acid	15.453	15.570	15.220	15.623	0.1007	0.3750	-	-	-
C 16:1 Palmitoleic acid	2.123	2.286	2.136	2.410	0.1092	0.6445	-	-	-
C 17:0 Heptadecanoic (Margaric) acid	0.120	0.150	0.203	0.156	0.0096	0.0337	*	*	-
C 17:1 Heptadecanoic (Margoleic) acid	0.096	0.126	0.120	0.123	0.0030	0.0107	*	*	*
C 18:0 stearic acid	4.715	4.706	4.996	4.606	0.2316	0.8776	-	-	-
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 Arachidic acid	0.056	0.063	0.073	0.083	0.0036	0.0592	*	-	-
C 20:1 Eicosanoic acid	0.176	0.173	0.213	0.236	0.0085	0.0345	*	-	-
C 20:2 Eicosadienoic 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	0.123	0.0061	0.2522	-	-	
C 20:3n 3 Eicosatrienoic acid	0.420	0.320	0.403	0.300	0.0192	0.0651	-	-	*
C 20:5n 3 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	0.1699	-	-	-
C 24:0 Lignoceroic acid	0.056	0.053	0.056	0.050	0.0040	0.8849	-	-	-

SED: Standard Error of Difference between means; Effect: L: Linear; Q: Quadratic; C: Cubic; *$p<0.05$

The highest increase in the proportion of polyunsaturated fatty acid C18:3 linolenic acid was recorded in the treatment group supplemented with 5 g kg^{-1} apricot kernel oil ($p<0.05$, quadratic). The proportions of linolenic acid were observed to decrease with increasing amounts of apricot kernel oil ($p<0.05$, cubic). However, these values were still higher than those of the control group. The proportion of monounsaturated fatty acid C20:1 eicosanoic (margoleic) acid was found to increase with increasing amounts of apricot kernel oil ($p<0.05$, linear).

DISCUSSION

In the study, proportions of palmitic acid (C16:0), palmitoleic acid (C16:1), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2) and arachidic acid (C20:0) in apricot kernel oil were identified, respectively as 5.37, 0.66, 1.21, 67.52, 24.96 and 0.08%. These findings are in agreement with the findings of the studies of Ozkal *et al.* (2006), Turan *et al.* (2007) and Ramadan *et al.* (2011) on apricot kernel oil. The proportion of unsaponifiable matter in apricot kernel oil was identified as 0.36% in this study. This value is lower than the value of 0.56% obtained by Kamel and Kakuda (1992). However, it is in agreement with the values (0.10-1.00%) identified by Rafique *et al.* (1986). Hussain *et al.* (2011) reported peroxide values in bitter and sweet apricot kernel oil as 4.9 and 5.0 meq kg^{-1}, respectively. These reported peroxide values are higher than the values obtained in this study.

Replacing equivalent amounts of soybean oil with 5, 10 and 15 g kg^{-1} apricot kernel oil in starter, grower and finisher rations did not have any significant effects on performance parameters of broilers. In their study on rat rations, Gandhi *et al.* (1997) substituted 10% apricot kernel oil supplementation with 10% peanut oil supplementation and they reported that no statistically significant differences occured in feed consumption, feed efficiency rate and growth rate. Ozturk (2004) substituted sunflower oil supplementation by 33.3% rape seed oil supplementation in broiler rations. Although, a significant improvement ($p<0.01$) was recorded in live body weight at the 3rd week, this was not sustained by the end of the experiment. Ozturk (2004) also used higher proportions of supplementations. He found that 66.7 and 100% rape seed oil supplementation numerically improved live body weight in the treatment groups at the end of the experiment compared to the control group. However, the differences between 66.7 and 100% rape seed oil supplemented groups and the control group as well as the differences between 66.7 and 100% rape seed oil supplementation and 33.3% rape seed oil supplementation were not statistically significant. ($p>0.05$). The same researcher also reported that increased proportions of rape seed oil supplementations in broiler rations did not have any significant effects on feed consumption and feed efficiency rate. Aacona *et al.* (2008) stated that rape seed oil and chia seed oil supplementation in broiler rations did not have any significant effects on live body weight gain and feed efficiency rate of broilers. Hajati *et al.* (2011) reported that pumpkin seed oil did not have any significant effects on growth performance of broilers but when used at higher proportions, it negatively affected performance. Similarly, Al-Khalifa *et al.* (2012) found that gradually increased fish oil supplementations in broiler rations did not have any significant effects on live body weight gain. The findings of these researchers are in agreement with the findings of this study. It can be concluded that apricot kernel oil rich in unsaturated fats does not have any effects on growth parameters of broilers.

In this study, apricot kernel oil supplementation in rations did not generate any significant effects on carcass parameters of broilers. The numerical differences in hot and cold carcass weights are attributed to the differences in live body weights at the end of the experiment. Ozturk (2004) reported that substitution of sunflower oil with gradually increased supplementations of rape seed oil (33.3, 66.7 and 100%) did not have any significant effects on carcass yield and abdominal fat ratio ($p>0.05$). Azona found that use of unsaturated fat rich flaxseed, rape seed and chia seed oils rich in broiler rations did not have any significant effects on carcass yield. Similarly, Hajati *et al.* (2011) explained that pumpkin seed oil did not have significant effects on carcass composition and abdominal fat ratio of broilers. The findings of these researchers are in agreement with the findings of this study.

Plasma acid phosphatase level was significantly affected by apricot kernel oil supplementation in broiler rations (Cubic effect, $p<0.05$). The change in plasma acid phosphatase level can be attributed to the strong antioxidant content of apricot kernel oil. In agreement with the findings of this study, the deficiency of the antioxidant vitamin E in broilers was reported to affect plasma acid phosphatase level (Dundar and Aslan, 1999). However, plasma glucose, glucose, cholesterol, triglyceride and VLDL levels were not significantly affected by apricot kernel oil supplementation. Similarly, Gandhi *et al.* (1997) reported that 10% apricot kernel oil supplementation in rat rations did not have any significant effects on blood cholesterol, glucose and triglyceride levels. Kutlu *et al.* (2009) claimed that apricot kernel oil supplementation in rat rations significantly increased Catalase (CAT) and Glutathione Peroxidase (GPx) enzyme activities and significantly improved liver antioxidant function. Similarly, Zhang *et al.* (2011) reported that apricot kernel oil supplementation in rat

rations increased serum superoxide dismutase and glutathione peroxidase enzyme activities while decreasing malondialdehyde concentration. In contrary to the findings of this study, Ramadan *et al.* (2011) found that compared to the rats fed with alkali rations, rats supplemented with 1 g kg^{-1} CA apricot oil had significantly higher levels of plazma triglycerides, total cholesterol and LDL-C. This can be attributed to additional intake of 1 g kg^{-1} CA apricot oil in these rats compared to the group fed with alkali rations. Compared to the rats fed with hypercholesterolemic rations, the rats supplemented with 1 g kg^{-1} CA apricot oil had significantly lower levels of triglycerides, total cholesterol and LDL-C.

In this study, apricot kernel oil supplementation in broiler rations significantly increased proportions of C15:0 pentadecanoic acid, C17:0 heptadecanoic (margaric) acid, C17:1 heptadecanoic (margoleic) acid ($p<0.05$), C18:3 linolenic acid ($p<0.001$) and C20:1 eicosanoic acid ($p<0.05$) in the broilers. Klose (1980) stated that fatty acid composition of the feed materials used in poultry rations significantly affect fatty acid proportions in poultry meat. Ozturk (2004) reported that substitution of sunflower oil with rape seed oil in broiler rations increases linolenic acid (C18:3) in thigh meat and it can be successfully used for this purpose. Bayraktar *et al.* (2006) claimed that nutrition is a determinant of fatty acid composition in broiler meat and use of fish oil in broiler rations significantly increases level of Omega 3 oil in thigh meat which has important benefits for human health. Aacona *et al.* (2008) explained that flaxseed and chia seed oil supplementations in broiler rations significantly increased the proportion of linolenic acid (C18:3) in broiler meat. Salamatdoustnobar *et al.* (2008) found that canola oil supplementation in broiler rations significantly improved fatty acid composition in broiler meat. Similarly, Saleh *et al.* (2010) stated that increased proportions of fish oil supplementation in broiler rations resulted increased proportions of linolenic acid (C18:3) in broiler meat. The findings of these researchers support the findings of this study. The findings of this study showed that the use of apricot kernel oil containing 93% unsaturated fatty acid resulted an increase in the proportions of mono and polyunsaturated fatty acids in thigh meats of broilers. The composition of fats in animal nutrition, their chain length (long or short), degrees of saturation or unsaturation are important determinants for human nutrition (Klose, 1980). Hence, the results are significantly important for human health.

Karakaya and Aktumsek (1996) reported that the main components of broiler meat are 42.0% linoleic (C18:2) and 28.5% oleic (C18:1) acid. Similarly in this study, the main components of thigh meat in the treatment groups were identified, respectively as; 42.19, 41.44 and 41.98% linoleic (C18:2) and 29.00, 29.07 and 29.26% oleic (C18:1) acid. Hence, the findings of Karakaya and Aktumsek (1996) are in agreement with the findings of this study. Nevertheless, proportions of oleic acid (C18:1) in thigh meat of broilers found in this study were slightly higher compared to the findings of Karakaya and Aktumsek (1996). This can be explained by the high (67.5%) content of oleic acid (18:1) in apricot kernel oil used in this study.

CONCLUSION

The study affirmed that apricot kernel oil can successfully be used as a dietary supplementation material without any negative effects on animal performance. Furthermore, apricot kernel oil supplementation in broiler rations is found to improve fatty acid composition in broiler meat. Apricot kernel oil significantly increased the proportion of linolenic (omega 3) fatty acid in broiler meat which is essential for human nutrition. This adds a functional characteristic to the meat. However, the increase in unsaturation degree of meat resulted by dietary manipulations will increase sensitivity of broiler meet to oxidation during storage. Recently, there are growing concerns about use of synthetic antioxidants. Since, apricot kernel oil has strong antioxidant properties due to its perfect content of MUFA and PUFA and biologically active substances such as tocopherols, phytosterols, β-carotene and phenolic compounds, future studies are needed on the effects of apricot kernel oil on shelf-life of broiler meat.

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