Effects of some oils used in broiler rations on performance and fatty acid compositions in abdominal fat*

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SUMMARY

This study was carried out to examine how the fatty acid compositions of oils (sunflower, cotton, corn, flaxseed, soybean, olive, fish, tallow and rendering oils) were reflected in the products and their effects on the growing performance of broilers.

Trial was carried out to determine the effects of the same fat sources on the performance of the broilers and fatty acid compositions of abdominal fat with totally 414 broiler chicks. Feed consumption, body weight, feed conversion, abdominal fat/carcass yield and fatty acid levels of abdominal fat were determined.

At the end of trial, the lowest moderate body weight were found to be 1957.10 ; 1901.20 ; 2197.20 ; 2072.76 ; 2080.30 ; 1943.20 ; 1887.30 ; 2074.00 ; 2099.20 g, respectively. The lowest daily body weight increase was also observed at the group fed the fish oil (37.53 g) and the greatest daily body weight increased at the group fed the corn oil (43.85 g). The lowest feed conversion ratio 1.95 kg was observed at the group which consumed the ration containing corn oil. In samples of abdominal fats taken from broilers which consumed omega-3-rich fats, omega-3 fatty acids, showing omega-3/omage-6 fatty acids ratio significantly increased. The fat content and fatty acid composition of abdominal fat were determined. The level of fatty acid from the group consumed flax oil that was rich in omega-3 was observed the highest (15.62 %), while the lowest level (2.02 %) was found in the group administered with rendering oil. Of all groups, the highest level (52.33 %) of saturated fatty acid was obtained from the group fed ration contained tallow.

Consequently, the compositions of fatty acids from these sort of animal products presented for human consumption was seen to highly alter depending on nutrition. Especially, following consumption flax and oil, the ratio of omega-3 appeared to increase. The person who consume those might be speculated to be in low risk of being disordered by heart-vessel diseases.

KEY-WORDS : oils - energy source - broiler - growth performance - fatty acid compositions.

RÉSUMÉ

Effets de quelques huiles sur les performances et le profil d'acides gras de la graisse abdominale chez le poulet de chair. Par T. BALEVI et B. COSKUN.

Cette étude envisage les effets de quelques huiles (tournesol, coton, maïs, lin, soja, olive, poisson, suif et huile clarifiée) sur les performances et la qualité des carcasses de 414 poulets de chair.

La plus faible vitesse de croissance a été obtenue avec l'huile de poisson et la plus élevée avec l'huile de maïs. Les graisses abdominales ont été plus riches en acides gras oméga-3 avec l'huile de lin alors que le régime contenant du suif a entraîné des teneurs élevées en acides gras saturés.

La teneur en acides gras oméga-3 chez les poulets ayant consommé de l'huile de lin pourrait limiter le risque cardio-vasculaire chez le consommateur.

MOTS-CLÉS : huiles - source d'énergie - performances de croissance - composition en acides gras - poulets de chair.

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Introduction

Oils are the most important energy source of broiler rations. In order to get the optimum productivity from chickens, the protein and energy levels of ration should be high. By compensation of energy requirements of chickens with oils instead of carbonhydrats, a better performance was attained [27]. It was reported that the performance varied according to the amount of the oil [6, 23, 24]. In the study carried out by ZINCIRLIOĞLU [28] by adding tallow and vegetable oils to the rations based on corn and sorgum, in the group consuming the rations containing tallows average live weight was 1676.76 g, the feed conversion was 1.96 kg, mortality ratio was 2.44 % on day, whereas in the group consuming the ration containing vegetable oil, the values were 1586.24 g, 2.05 kg and 2.84 %, respectively.

Oils added to the rations of animals are effective on the fatty acid composition and amount of abdominal fat. Fatty acids composition of oils used in poultry rations are reflected in the animal products. The products obtained from animals fed with rations rich also in omega-3 fatty acids are rich in these acids [10, 11, 12, 17, 18, 19, 25, 26]. In a study by OLOMU and BARACOS [17], it was found that reducing the tallow added to the broiler rations and supplementing 1.5, 3, 4.5 % cotton oil instead, linoleic acid amount was 0.9, 3.2, 5.9 and 7.9 % and EPA amount 0.2, 0.4, 0.8 and 1 % and DHA amount 0.5, 0.5, 0.8 and 0.9 %, respectively.

This research was carried out to find out of the fatty acid compositions of oils added to the chicken rations as an energy source, and to examine the effects of these oils on broiler performances, and reflection of the fatty acid compositions in abdominal fat.

Materials and methods

In this study a total of 414 Peterson x Avian commercial hybrid broiler chicks of 1-day-old were used. These animals were divided into 9 groups including 46 chicks in each. Diets of trial groups were prepared by adding 5 % of each of followings sunflower oil (as control), cotton oil, corn oil, flaxseed oil, soybean oil, olive oil, fish oil, tallow and rendering oil by means of mixer. Composition of diets is shown in Table I. At present study, the fatty acid composition of oils were determined first. Chickens were selected based on their body weights in a close range as much as possible. Feed and water were supplied for *ad libitum* throughout the 49-days experimental period.

Experimental period was 49 days. On the first day of trial, the feed to each group were weighted. After 14, 28, 42 and 49 days, all chicks were weighted by an electronic scale and feed intake values were determined by weighing the rest of feed at the same days and feed conversion rates were determined.

Broilers were sent to slaughtered on day 49 of the trial. Following chilling of carcass in cold water, the abdominal fats were extracted easily. Abdominal fats and carcass of all animals were weighted separately. By this way, carcass and abdominal fat ratio of each broiler was determined.

Ingredients		Composition %
Corn		20.00
Wheat		37.70
Soybean meal		29.00
Fish meal		5.50
Oil		5.00
Limestone		1.50
Dicalcium phosphate		0.50
Salt		0.25
Vitamins[1]		0.25
Minerals[1]		0.10
Antioksidant		0.10
Coccidiostat		0.10
ME *	(kcal/kg)	3200
Dry matter	%	92.65
Crude protein	%	22.75
Ether extract	%	6.20
Crude fiber	%	5.80
Ash	%	8.40
Calcium	%	1.10
Phosphor	%	0.61

* : This value was found to with calculation

[1] : Provided Per kilogram of diet : vitamin A, 12.000 IU ; cholecalciferal, 1.200 ICU ; vitamin E, 35 mg ; vitamin K_3, 5 mg ; vitamin B_1,3 mg ; vitamin B_2, 7 mg ; niacin, 20 mg ; Ca-d-panthotenate, 10 mg ; vitamin B_6, 5 mg ; vitamin B_{12}, 0.015 mg ; folic acid, 1 mg ; D-Biotin, 0.045 mg ; Choline chloride, 125 mg ; vitamin C, 50 mg ; charophyll red, 25 mg ; charophyll yellow 5 mg ; Mn, 80 mg ; Fe, 30 mg ; Zn, 60 mg ; Cu, 5 mg ; I, 2 mg ; Co, 0.4 mg ; Se, 0.015 mg.

TABLE I. — Ingredients and chemical composition of ration.

Crude nutrient in feeds were analysed by the methods of Weende analysis method [2].

On the last day of the trial, abdominal fats from chickens chosen randomly from each group were collected. They were mixed to obtain a homogenous mixture. Their oil fractions were determined by using ether extraction method [2]. These oil samples were estherized [5] and the concentration of the long-chained fatty acids in the abdominal fat were determined. Finally only one trial of analysis for each group were carried out from the extracted material. Thus, a total of 9 analysis were made from 9 groups. Qualitative determination of fatty acid methyl esters of samples were made by comparing the relative capturing timings obtained from fatty acid methyl ester standards provided from NUCHEK PREP INC. and ALLTELIX (Illinois, USA).

Gas Chromatoraphic Analysis Procedure : After methylising, the fatty acids were analysed by flame ioniser detector (FID), Varian (Model 3700) Gas Chromatography. In the analysis process, 6-feet-long stainless steel column, of which outside diameter 1.8 inch and inside 0.085 inch, silanized with 2.5 % DMES covered with 28 % DEGS liquid phase and filled with 80/100 mesh Chromosorb W AW, was used. The temperature of column was adjusted to 180°C and the temperature of injector and detector was adjusted to 220°C. Nitrogen was used as carrier gas and of which flow speed

was adjusted to 20 ml/minute. Gas flow speed used were adjusted as H_2=30 ml/minute and dry air = 300 ml/minute. The percentage area calculations of peaks in chromatograms were obtained from varian (CSD 111) integrator.

Data obtained was subjected to analysis of variance using one way ANOVA procedures [22].

Results

Results of ration the analysis used in this trial and the ingredients of ration are shown in Table I and the Fatty acid composition of different oils are in Table II. Feed consumption and feed conversion ratios and increases in weight gain are shown in Table III, and Live weights of broilers in different periods in Table IV. The weight of carcass and abdominal fat and the ratio between them are shown in Table V and Fatty acid compositions of abdominal fat in Table VI.

Discussion

This research was carried out to find out of the fatty acid compositions of oils added to the chicken rations as an energy source, and to examine the effects of these oils on broiler performances, and reflection of the fatty acid compositions in abdominal fat.

The fatty acid compositions of oils used in this study was determined by gas chromatography and shown in Table II. These compositions had significant differences as seen in Table II. Tallow contained 50 % saturated fatty acids, whereas saturated fatty acids ratio in vegetable oils was below 25 %.

When the cotton oil values in the same table were analysed, it was seen that, among the fatty acids, linoleic acid had the largest amount with 55.2 % and oleic and palmitic acid amounts were seen 20.24 and 20.94 %, respectively. The amount of other fatty acids in cotton oil was found to be below 1 %. These values are between the limits for cotton oil reported by KLING and HAVES [16]. In another study [18], maximum linoleic acid content for cotton oil was reported as 50.5 %, oleic acid content 18.3 % and palmitic acid content 27.3 % depending of low amounts of linolenic acid in cotton oil, omega-3/omega-6 ratio was quite small.

Of the fatty acid, the largest amount in corn oil was linoleic acid (45.61 %). However compared to cotton oil, oleic acid content was larger and palmitic acid content was lower. This proportions are coherent with other studies in literature [1]. By analysing the same table, linolenic acid (an omega-3 fatty acid) content was seen very low (1.04 %). AKGÜL [1] reported that linolenic acid amount in corn oil was below 2 %. PADLEY *et al*., [18] reported this value to be 1 % and ATTEH *et al*. [7] 0.44 %.

Among the all kinds of oils, the largest linolenic acid content was in flaxseed oil with a ratio of 51.23 %. Again, among the oil used in the trial, total PUFA in flaxseed oil was 70.35 % (the highest ratio) and total saturated fatty acids content was 9.60 % (the lowest ratio). Depending on amount of linolenic acid, omega-3/omega-6 fatty acids ratio was found to be 2.68. In another study by OLOMU and BARACOS [17], linolenic acid content in flaxseed oil was found to be the highest among the fatty acids with a ratio of 51 %. Omega-3/omega-6 fatty acids was determined as 3.27. PADLEY *et al*., [18] reported linolenic acid content as 59.8 % and omega-3/omega-6 fatty acids as 4.15.

Following flaxseed oil, soybean oil contained the largest amount of linolenic acid (7.25 %) PADLEY *et al*., [18] reported this value to be 7.5 % and ATTEH *et al*., [7] to be 9 %. As seen in Table II, saturated fatty acids ratio in soybean oil was quite low. This result is similar to the others in literature [6, 7, 9] omega-3/omega-6 fatty acids ratio in soybean oil was defined to be 0.13 which is very close to 0.14 reported by PADLEY *et al*. [18].

By comparison with the other oils used in the trial, olive oil had the largest oleic acid content (73.13 %) (Table II). Additionally, linoleic acid content was at the lowest level (2.16 %). Oleic acid content of olive oil was lower than 78.1 % reported by PADLEY *et al*., [18] and between the range (65-85 %) reported by AKGÜL [1]. While linoleic acid content was below figures in the literature [1, 16, 18], there was not any differences between the other fatty acids. The total amount of omega-3 and omega-6 fatty acids was quite low depending on high amount of oleic acid.

As seen in Table II, the fatty acid with the highest amount in sunflower oil was linoleic acid (68.13 %). This was followed by the amount of oleic acid with 18.37 %. Omega-3/omega-6 fatty acids ratio was assumed as zero, since omega-3 fatty acid content was 0.02 %. In a study by PADLEY *et al*., [18], linoleic acid content was found to be 68.17 % and oleic acid content to be 17.8 %. These values are very close to those obtained in this study. In another report [1], linoleic acid content was claimed to be between 44-75 % and oleic acid 14-42 %.

A wide spectrum has been observed from 12 carbon fatty acids to 22 carbon fatty acids when the fatty acid compound of fish oil was analysed. In the study by PHETTEPLACE and WATKINS [20], fish oil compound was reported to display a wide spread like seen in this study. This result was also reached in another study by HUANG *et al*., [13]. But there were differences in fatty acid concentrations between the results obtained in this study and those in the literature. This was probably because of the species of fish from which oils were extracted.

It is found out that there were significant differences between the fatty acid compositions of tallow and rendering oil used in this trial as sources of tallow. In the studies related to this subject [3, 9, 15, 17, 23] only tallow was used and analysed under the name of tallow. Leading some differences between the fatty acid compositions in reported works [3, 17, 23]. As seen in Table II, saturated fatty acids content of tallow was found to be 53.74 % and of rendering oil to be 46.68 %. MUFA content of tallow was observed 40.38 % and PUFA content was 5.89 %. This data in rendering oil were 28.39 % and 24.94 %, respectively.

Fatty acids also show a wide spectrum like, as in fish oil since various organs and tissues are processed in rendering oil (Table II).

Fatty Acids	OILS								
	Sunflow Oil	Cotton Oil	Corn Oil	Flax. Oil	Soybean Oil	Olive Oil	Fish Oil	Tallo - w Oil	Rendr Oil
12:0	-	0.41	0.09	0.40	0.04	-	4.65	-	0.68
14:0	0.08	0.61	0.26	0.01	0.02	0.04	10.86	2.83	13.67
16:0	8.01	20.94	17.00	6.48	11.44	19.24	19.27	26.78	28.27
16:1	0.10	0.02	-	0.48	0.04	1.13	11.11	3.54	-
16:2	-	-	-	-	-	-	-	1.21	-
18:0	4.29	2.30	2.67	2.28	3.43	3.19	8.30	23.29	4.07
18:1	18.37	20.24	32.64	19.45	21.42	73.13	22.21	36.76	25.74
18:2	68.13	55.20	45.61	19.12	54.26	2.16	3.96	3.57	17.09
18:3	0.02	-	1.04	51.23	7.25	0.17	4.52	1.05	4.47
20:0	0.12	0.31	0.50	-	0.96	0.76	2.08	0.85	-
20:1	0.09	-	0.20	0.14	1.16	0.20	-	0.08	2.66
22:0	0.33	-	-	0.44	-	-	0.30	-	-
20:2	-	-	-	-	-	-	0.35	-	1.07
20:3	-	-	-	-	-	-	2.93	0.07	0.93
20:4	-	-	-	-	-	-	8.33	-	1.12
20:5	-	-	-	-	-	-	0.48	-	0.27
22:4	-	-	-	-	-	-	0.65	-	-
24:0	0.48	-	-	-	-	-	-	-	-
Σ Saturated	13.30	24.56	20.52	9.60	15.88	23.23	45.46	53.74	46.68
Σ MUFA	18.56	20.25	32.84	20.06	22.62	74.46	33.32	40.38	28.39
Σ PUFA	68.15	55.20	46.65	70.35	61.51	2.32	21.22	5.89	24.94
Σ ω-3	0.02	0.00	1.04	51.23	7.25	0.17	8.58	1.12	5.67
Σ ω-6	68.13	55.20	45.61	19.12	54.26	2.16	12.64	3.57	19.27
ω-3/ω-6	0.00	0.00	0.02	2.68	0.13	0.08	0.68	0.31	0.29

TABLE II. — Fatty acids compositions oils used to supplement rations, %.

As seen in Table III, while the lowest feed consumption was observed with 78.03 g in the group consuming the ration with fish oil, the highest consumption was attained with 93.3 g in the group consuming ration with tallow. However feed consumption found was 81.15 g in group fed sunflower oil (control group). On a study [8] in which oils were compared, the feed consumption of the tallow in a ration containing sunflower oil was found to be slightly higher than the group which consuming tallow. Because of the low energy level of tallow, feed consumption increased in group fed tallow.

Feed conversion ratios were found to be between 1.95 and 2.26 kg (Table III). These results show similarity with some other works' results [10, 14, 25]. While the lowest weight gain was observed with 37.53 g in the group consuming the ration with fish oil, the highest weight gain was attained with 43.85 g in the group consuming ration corn oil. However weight gain was observed 38.94 g in control group. In the end of the trial, live weights averages of groups were between 1887.3 and 2197.2 g (Table IV). These values were in similar with some other studies' findings [4, 23]. On a study by done

Groups	DURING EXPERIMENT		
	DFC, g	FCG, kg	GLW, g
Sunflower Oil	81.15	2.08	38.94
Cotton Oil	83.89	2.22	37.82
Corn Oil	85.61	1.95	43.85
Flaxseed Oil	82.10	1.99	41.31
Soybean Oil	84.38	2.04	41.41
Olive Oil	80.53	2.08	38.68
Fish Oil	78.03	2.08	37.53
Tallow	93.30	2.26	41.33
Rendering Oil	84.07	2.01	41.83

DFC : Daily feed consumption ; FCG : Feed quantity consumed to gain 1 kg body weight
GLW : Gain in live weight

TABLE III. — Increases in weight gain, feed consumption and feed conversion ratios.

Groups	DAYS				
	1	14	28	42	49
	x ± Sx	x ± Sx	x ± Sx	x ± Sx	x ± Sx
Sunflower Oil	49.10	328.70 ± 4.86	887.50 ± 18.09 cd	1585.80 ± 34.75 cd	1957.10 ± 51.01 bc
Cotton Oil	47.94	309.84 ± 8.58	906.67 ± 18.37 bcd	1691.30 ± 35.47 abc	1901.20 ± 54.43 c
Corn Oil	48.66	303.66 ± 10.49	989.77 ± 22.01 a	1808.20 ± 41.86 a	2197.20 ± 53.93 a
Flaxseed Oil	48.52	318.21 ± 5.48	929.55 ± 15.19 abc	1706.00 ± 31.96 ab	2072.76 ± 51.96 ab
Soybean Oil	51.04	331.31 ± 5.28	938.64 ± 14.54 abc	1741.80 ± 30.51 ab	2080.30 ± 45.14 ab
Olive Oil	48.14	313.39 ± 5.54	952.38 ± 15.61 ab	1638.80 ± 41.97 bcd	1943.20 ± 59.76 bc
Fish Oil	48.38	321.93 ± 4.91	784.61 ± 22.27	1542.70 ± 50.02 d	1887.30 ± 72.28 c
Tallow	48.75	323.14 ± 5.70	880.71 ± 17.35 cd	1770.50 ± 30.75 a	2074.00 ± 45.36 ab
Rendr. Yağı	49.48	369.66 ± 6.99	869.21 ± 27.69 d	1716.70 ± 40.35 ab	2099.20 ± 52.16 ab

a, b, c, d : Means within columns with no common superscrips differ significantly [P < 0.05]

TABLE IV. — Live weights of broilers in different days, g.

FRITSCHE *et al* [12], it was determined that the average live weights of chickens consuming ration with fish oil were higher than that of groups consuming the ration with flaxseed, corn, canola and lard oil.

While the lowest carcass weight was 1228.1 g in the group fed by ration containing fish oil, the highest carcass weight was 1469.7 g in the group fed by ration with corn oil (Table V), and the difference between these data was found to be statistically significant ($P < 0.05$). In a trial executed by SONAIYA [26], broilers were fed by high and low level energy rations and the carcass weights were found to be between 1585 and 1778 g when fed at high temperatures (21-30°C) while the corresponding values were found to be between 1641 and 1936 when fed at 21°C. It was observed that the weight of abdominal fat obtained from broilers varied between 24.98 and 33.21 (Table V). Abdominal fat amount was the lowest in the control group and the highest in the group fed rendering oil. There was not statistically significant difference between the groups with respect to abdominal fat ($P > 0.05$). While these results are lower than the values found in some other studies [21, 26]. TUNCER *et al* [27] reported that fed rations containing the corn, sunflower, fish oil and tallow in varying proportions, the abdominal fat weights of groups were between 33.4 and 55.7 g, and abdominal fat/live weight ratios were between 1.8 and 2.9 at the end of 56 days old. In another study [21], it was reported that the abdominal fat weights of broilers consuming the mixture of tallow and vegetable oil varied between 34.9 and 41.0. The data on fatty acids composition in abdominal fat were given in Table VI. As seen, the lowest saturated fatty acid ratio was 22.14 % in the group fed by ration containing soybean oil, while the highest saturated fatty acid amount was 52.33 % in the group fed tallow. It also was found that, the highest MUFA level was 51.05 % in the abdominal tissues of the broilers that consumed ration with olive oil which is rich in MUFA (74.46 %) and the highest PUFA level was 38.08 % in the group fed by ration containing flaxseed oil rich in PUFA (70.35 %). While the omega-3/omega-6 ratio was the lowest in the group fed cotton oil (0.07), and the highest in the group consumed olive oil (0.82). The reason for the high ratio in the olive oil group is the result of the low omega-6 content of abdominal fat (5.50 %). Omega-3/omega-6 ratio was estimated as 0.11.

The linolenic acid level in the abdominal fat tissues of the broilers fed by rations containing flaxseed oil which is rich in linolenic acid was found to be 11.86 %, saturated fat level

Groups	Live weight, G	Carcass weight, g	Abdominal fat weight, g	The ratio of abdominal fat to carcass
	x ± Sx	x ± Sx	x ± Sx	%
Sunflower Oil	1957.10 ± 51.01 c	1341.80 ± 37.25 abcd	24.98 ± 1.33	1.83
Cotton Oil	1901.20 ± 54.43 c	1295.70 ± 42.14 cd	25.86 ± 1.58	1.96
Corn Oil	2197.20 ± 53.93 a	1469.70 ± 42.06 a	27.38 ±1.38	1.83
Flaxseed Oil	2072.76 ± 51.96 ab	1461.31 ± 42.20 a	29.83 ± 1.83	2.00
Soybean Oil	2080.30 ± 45.14 ab	1385.20 ± 39.19 abc	26.79 ± 1.86	1.90
Olive Oil	1943.20 ± 59.76 bc	1332.30 ± 49.95 bcd	27.60 ± 1.94	2.03
Fish Oil	1887.30 ± 72.28 ab	1228.10 ± 64.22 d	27.93 ± 1.61	2.22
Tallow	2074.00 ± 45.36 ab	1450.10 ± 39.62 ab	30.87 ± 2.01	2.08
Rendr. Yağı	2099.20 ± 52.15 ab	1466.20 ± 43.64 a	33.21 ± 2.30	2.21

a, b, c, d : Means within columns with no common superscrips differ significantly [$P < 0.05$]

TABLE V. — The weight of carcasses and abdominal fat, g.

	OİLS								
Fatty Acids	Sunflow Oil	Cotton Oil	Corn Oil	Flax. Oil	Soybean Oil	Olive Oil	Fish Oil	Tallow Oil.	Rendr Oil
12:0	0.02	1.07	1.41	0.48	0.04	0.06	0.53	0.09	0.06
14:0	1.35	1.79	1.31	4.29	0.93	1.94	4.88	5.59	3.78
16:0	26.45	20.47	16.58	17.09	17.91	26.90	16.61	34.22	28.04
16:1	9.19	4.86	5.21	1.33	6.07	7.69	9.96	15.73	0.83
16:2	-	0.76	-	-	0.81	2.40	2.05	1.52	0.84
18:0	0.56	5.98	4.81	6.51	3.26	7.64	4.54	12.43	6.20
18:1	28.67	28.10	28.41	27.96	31.39	41.64	31.84	21.79	44.43
18:2	27.08	33.01	37.32	21.05	33.66	2.43	21.15	2.78	11.60
18:3	1.49	1.40	1.75	11.86	3.24	2.59	1.13	1.31	1.24
20:0	2.78	0.05	0.01	2.58	-	0.02	1.90	-	-
20:1	0.41	0.52	0.53	1.69	0.82	1.72	1.21	1.43	0.64
21:0	-	-	-	-	-	-	0.36	-	-
20:2	0.29	0.54	0.42	1.04	0.45	1.06	0.11	1.43	0.57
20:3	0.76	0.48	0.54	2.20	0.19	1.17	0.33	0.82	0.12
20:4	0.20	0.52	0.78	0.38	0.63	2.01	0.40	-	0.99
20:5	0.75	0.45	0.40	1.56	0.54	0.75	3.00	0.86	0.66
22:4	-	-	0.54	-	0.06	-	-	-	-
∑ Doymuş	31.16	29.36	24.11	30.95	22.14	36.56	28.82	52.33	38.08
∑ MUFA	38.27	33.48	34.15	30.98	38.28	51.05	43.01	38.95	45.90
∑ PUFA	30.57	37.16	41.75	38.08	39.58	12.40	28.17	8.72	16.02
∑ ω-3	3.00	2.33	3.23	15.62	4.03	4.51	4.46	2.99	2.02
∑ ω-6	27.57	34.07	38.52	22.46	34.74	5.50	21.66	4.21	13.16
ω-3/ω-6	0.11	0.07	0.08	0.70	0.12	0.82	0.21	0.71	0.15

TABLE VI. — Fatty acids compositions of abdominal fat, %.

30.95 %, MUFA 30.98 %, PUFA 38.08 %, and omega-3 fatty acids level 15.62 %. Olive oil, which is rich in oleic acid, also led to high oleic acid accumulation in abdominal fat in the same manner. The same situation should be valid for other fatty acids, too. In a study' by HULAN *et al* [14], broilers were fed by rations containing 7.5, 15 and 30 % fish meal, and 2.1 % and 4.2 % fish oil and a control ration without any fish meal or oil. At the end of the trial, while the total omega-3 fatty acid amount in thigh and breast of control group was 3.7 %, total PUFA was 29.3 %, and omega-6 fatty acids were 25.6 %, the corresponding values in the group fed by ration containing 30 % fish meal were 8.2, 28.7, 13.4 % and in the group fed by ration containing 2.1 % fish oil were 7.7, 27.7 and 20.1 %, in the group fed by ration containing 4.2 % fish oil were 11.6, 29.2 and 17.6 %, respectively. There were statistical differences between the control group and all the other groups. It was determined that the omega-3 fatty acids level was 8.58 % and omega-6 fatty acids level was 12.64 % in fish oil. These fatty acids in abdominal fats obtained from the groups fed by ration containing fish oil were 4.46 and 21.66 %, respectively, and omega-3/omega-6 ratio was 0.21. Omega-3 amount was higher than in that of other groups except the flaxseed oil and olive oil groups. While the saturated fatty acid ratio was 30.95 % in the abdominal fat of the broilers consumed rations with flaxseed oil containing 70.35 % PUFA, the corresponding value was 36.56 % in the group fed by rations with olive oil containing 2.32 % PUFA. PINCHASOV and NIR [21] reported that with the increasing of PUFA level in ration, fatty acid level in abdominal fat significantly decreased, and the same tendency was observed in MUFA as well. Table VI shows that in the abdominal fats of broilers fed by rations containing corn, flaxseed and fish oil, omega-3/omega-6 fatty acid ratio was 0.08, 0.70 and 0.21, and total PUFAs were 41.75, 38.08 and 28.17 %. In another study [10], corresponding values in broilers fed by rations containing 5 % corn, flaxseed and fish oil, the ratios mentioned above were 0.04, 1.06, 0.65 and PUFAs were 40.38, 44.82 and 26.15 % in thigh of broilers.

Omega-3 fatty acids in abdominal fats obtained from the groups fed by ration containing flaxseed, fish and soybean oil were 15.62, 4.46 and 4.03 % resp., and omega-6 fatty acids were 22.46, 21.66 and 34.74 % resp. Similarly, in another study [26], investigation of fatty acids in the abdominal fat were made and omega-3 fatty acid percentages were found as 26.78, 8.02 and 3.19 % ; while omega-6 fatty acids were 22.25, 16.93 and 42.92 %.

In conclusion, it can be said that compositions of fatty acids from animal products that produced for human consumption could be changed depending on nutritional conditions ; to decrease the risk of heart-vessel disease, the composition of fatty acids added to poultry rations are of importance and to use flaxseed and fish oil in poultry rations would subsequently effect human health in a positive manner by increasing omega-3 fatty acid quantities in animal product.

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