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Research Article

Effects of Various Dietary Fat Sources on Performance and Body Fatty Acid Composition of Broiler Chickens

Mehmet A. AZMAN*, İbrahim H. ÇERÇİ, Nurgül BİRBEN
Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine,
Fırat University, 23169, Elazığ - TURKEY
*E-mail: mazman@firat.edu.tr

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Abstract: The objective of this study was to investigate the effects of different dietary fat sources including soybean oil (SO), poultry grease (BG) or beef tallow (BT) used as fat source on growth performance and fatty acids composition of abdominal fat, thigh skin, breast and thigh muscle of broiler chickens.

Three hundred 21-day-old broilers were randomly assigned to 3 groups and were fed corn–soy based grower diets containing 6% of the respective dietary fat source between 21 and 41 days.

Final body weight was not significantly (P > 0.05) affected by dietary fat sources. Daily weight gain and daily feed intake was significantly (P > 0.01) higher in the beef tallow group compared to the other groups. The feed conversion ratio of the poultry grease group was better compared to the other groups. In the soybean oil supplemented group, the amount of long-chain polyunsaturated fatty acids was significantly higher in thigh skins, breast muscle and abdominal fat pad. In the thigh and breast muscle of the poultry grease fed group oleic acid content was significantly higher, and beef tallow caused increased accumulation of saturated fatty acid in thigh skins and abdominal fat pad.

In conclusion, feeding of broilers with specific mixtures of fatty acids may substantially alter fatty acid composition of the carcass, soybean oil caused marked changes in the fatty acids patterns by significantly increasing polyunsaturated fatty acids (PUFA) mainly linoleic acid in skin, abdominal fat and breast muscle, and thus better carcass quality of SO groups. Feed conversion ratio of the poultry grease group was better compared to the other groups, and in birds fed with BT daily weight gain and daily feed intake were higher than in the other groups. Supplemental BT to the grower diets has no detrimental effects on growth performance.

Key Words: Fat sources, lipid composition, growth performance, broiler.

Etlik Piliç Rasyonlarına Katılan Değişik Yağların Performans ve Karkas Yağ Asidi Kompozisyonu Üzerine Etkisi

Özet: Bu çalışmada, etlik piliç karma yemlerine katılan farklı yağların piliçlerde büyüme performansı ve karın yağı, but derisi, but ve göğüs kası yağ asitleri üzerine etkisinin belirlenmesi amaçlanmıştır. Yağ kaynağı olarak soya yağı (SO), tavuk yağı (PG) ve sığır iç yağı (BT) kullanılmıştır.

Yirmibir günlük yaşta 3 gruba ayrılan toplam 300 adet etlik piliç, mısır ve soya küspesine dayalı etlik piliç büyütme yemlerine % 6 oranında denemeye esas olan yağlar katıldı ve 21 günden 41 günlük yaşa kadar yedirildi.

Deneme sonu canlı ağırlık ortalamalarında gruplar arasında istatistiki olarak farklılık görülmezken, sığır iç yağı tüketen grupta günlük canlı ağırlık artışı ve günlük yem tüketimi diğer gruplara göre daha fazla tespit edilmiş, en iyi yemden yararlanma oranı da tavuk yağı katılan rasyon grubunda görülmüştür. Soya yağı katılan yemleri tüketen grupta but derisi, göğüs kası ve karın yağında uzun zincirli doymamış yağ asitlerinin, tavuk yağı tüketen grupta dokularda oleik asit, iç yağ tüketen grupta ise but derisi ve karın yağında doymamış yağ asitleri birikiminin daha fazla olduğu gözlendi.

Sonuç olarak, etlik piliç rasyonlarına katılan yağların karkas yağ asitleri kompozisyonunu değiştirdiği, soya yağı katılan yemi tüketen gruplarda uzun zincirli doymamış yağ asitlerinin PUFA (çoğunlukla linoleik asit) deri, karın yağı ve göğüs kasında daha fazla birikmesi nedeniyle karkas kalitesinin arttığı söylenebilir. Tavuk yağı katılan grupta yemden yararlanma oranının diğer gruplardan daha iyi olduğu, sığır iç yağı tüketen grupta günlük yem tüketimi ve günlük canlı ağırlık artışının yüksek olduğu tespit edilmiştir. Piliç büyütme yemlerine sığır iç yağı katılmasının büyüme performansı üzerine olumsuz etki yapmadığı söylenebilir.

Anahtar Sözcükler: Yağ kaynakları, yağ kompozisyonu, büyüme performansı, etlik piliç.

Introduction

Fats are frequently included in broiler diets to increase the energy density. Several experiments have shown that an increase in energy concentration produces a decrease in feed intake but does not negatively affect daily gain, resulting in an improvement in feed efficiency (1,2). It is well documented that n-3 fatty acids are essential for human growth and development and may play an important role in the prevention and treatment of coronary arterial disease, hypertension, diabetes, arthritis, depression, other inflammatory and autoimmune disorders and cancer (3,4).

Dietary fatty acids (FA) are absorbed and deposited in tissues in monogastric animals without significant modification (2,5). Deaton et al. (6) reported that body fat increases with the amount of dietary tallow (composed essentially of saturated fatty acids). However, some studies have reported opposite results. Zollitsch et al. (7) observed that unsaturated vegetable oils produce lower fecal energy losses and consequently, higher metabolizable energy value (ME) than animals fats. Low fat utilization at 1 wk of age in the young chickens has been attributed to limited bile salt secretion and low lipase activity (8). Improved bile salt secretion and lipase activity with age in young chickens resulted in increased fat utilization at 3 wk by making their digestive systems fully functional to digest dietary lipids (9).

The present study was undertaken to determine the effects of different dietary fat sources on broiler performance and tissue fatty acid composition by supplementation of broiler diets with soybean oil, poultry grease and beef tallow. Poultry grease was included in this study since it is increasingly being used in chicken diets.

Materials and Methods

Three hundred 21-day-old male broiler chicks (Ross 308 strain) were randomly assigned to 12 litter pens. There were 3 diets; each was fed to 4 replicate pens of 25 poults each. A bird density of 13 birds per square meter was provided. Feed and water were supplied ad libitum. A light/dark cycle of 23:1 h and a room temperature of 22-25 °C were maintained throughout the 41 d experimental period.

Birds were fed with isocaloric and isonitrogenous grower diets (3.195 kcal/kg ME, 22% crude protein) containing 6% of three different dietary fat sources: soybean oil (SO), poultry grease (PG) or beef tallow (BT). The experimental diets are presented in Table 1. Beef tallow and poultry grease were obtained from different local slaughterhouses.

Chicks were weighed at 21 and 41 days and feed consumption in each pen was recorded on the same days. Feed conversion ratio (FCR) was calculated at each period (g feed/ g gain). Animals in each group were closely monitored and daily mortalities (MR) were noted.

On day 41, 6 chicks from each treatment group were slaughtered. Following chilling of the carcass in cold water, abdominal fat, and thigh muscles including skin and breast meat without skin were dissected and collected. The samples were frozen and stored at –20 °C until further processing. They were mixed to obtain a homogeneous mixture. Total lipids from tissues and feeds were extracted by standard procedures following homogenization in a suitable excess of chloroform/ methanol (2:1) as described by Christie (10). The fatty acids were analyzed by gas chromatography, with a Unicam (Model 610) fitted with a capillary column system (SGE, BPX70 fused capillary column).

The fatty acid profiles of the three fat sources are given in Table 2. Soybean oil (SO) contained 51.42% PUFA (polyunsaturated fatty acids), predominantly linoleic acid, and beef tallow (BT) included 45.52% SFA (saturated fatty acids), predominatly palmitic and stearic acids, and poultry grease (PG) contained 40.77% MUFA (monounsaturated fatty acids), mainly oleic acid. In this table, the lowest SFA ratio was 19.79% in the SO, while the highest SFA amount was 45.52% in the BT. It was also found that the highest MUFA level was 40.77% in the PG, and lowest MUFA amount was 22.54% in the SO. The highest PUFA level was 51.42% in the SO and the lowest level was 18.93% in the BT.

Data collected were subjected to analysis of variance, and where significant differences were observed means were further subjected to Duncan's multiple range test. SPSS for Windows (10.1) was utilized for statistical analysis (11).

Results

Table 3 shows the growth performances (body weight, weight gain, feed intake and feed conversion ratio) of the birds according to the dietary fat sources.

Table 1. Composition of the experimental diets, %.

Corn	53.40
Soybean meal	33.40
Fish meal	4.00
Fat[1] / SO/PG/ BT	6.00
Limestone	1.50
Dicalcium phosphate	0.80
Sodium chloride	0.25
Vitamin premix[2]	0.15
Mineral premix[2]	0.20
DL- Methionin	0.20
Antioxidant[3]	0.10
Calculated nutrient content[4]	
ME, kcal/kg	3.195
CP, %	22.00
Calcium	1.00
Total phosphorus	0.59

[1] Diet containing fat source: SO: soybean oil; PG: poultry grease; BT: beef tallow,

[2] Vitamin and mineral premix provided per kilogram of diet: vitamin A, 12.000 IU; cholecalciferol, 1500 IU; vitamin E, 30 mg; vitamin K_3, 5 mg; vitamin B_1, 3 mg; vitamin B_2, 6 mg; vitamin B_6, 5 mg; vitamin B_{12}, 30 µg; Ca D- pantothenate, 10 mg; folic acid, 0.75 mg; D-biotin, 0.08 mg; Mn, 80 mg; Zn, 60 mg; Fe, 40 mg; Cu, 5 mg; Se, 0.15 mg; Co, 0.1 mg; I, 0.4 mg.

[3] Ethoxyquin.

[4] Based on NRC (1994) feed composition tables (12).

Table 2. Fatty acid composition of the dietary fat sources, % total fatty acids.

Fatty acid	SO	PG	BT
C14:0	-	-	0.68
C16:0	16.44	22.99	22.35
C16:1	2.28	0.98	-
C18:0	3.35	8.62	22.49
C18.1	20.26	39.79	33.82
C18:2	48.57	33.82	16.06
C18:3	2.85	-	2.87
Total	93.76	96.20	98.28
Undetected	6.24	3.80	1.72
Σ SFA[1]	19.79	31.61	45.52
Σ MUFA[2]	22.54	40.77	33.82
Σ PUFA[3]	51.42	23.82	18.93

SO: soybean oil; PG: poultry grease; BT: beef tallow.

[1] SFA: saturated fatty acids.

[2] MUFA: monounsaturated fatty acids.

[3] PUFA: polyunsaturated fatty acids.

Final body weight did not statistically differ between groups. Although daily weight gain (21 to 41 days) was also markedly improved by the inclusion of BT in the diets ($P < 0.01$), daily weight gain of poults fed with SO or PG were not different during these periods. Furthermore, when BT was included in the diets, significant increases in feed intake compared to SO and PG diets ($P < 0.01$) were observed. Feed conversion ratio (FCR) was better in the group of poults fed on PG ($P < 0.01$).

SFA were the predominant fatty acids in all tissues, but they were particularly concentrated in breast muscles and in abdominal fat of the PG and BT groups ($P < 0.05$) (Table 4). Their contents in thigh skins were higher in chicks fed with BT diets than in birds fed with SO and PG diets ($P < 0.05$). This peculiarity was probably due to high quantity of palmitic acid (C16:0), which is the main SFA, found in tissues, although the fluctuations of this fatty acid were not significantly different between groups. The proportion of SFA in abdominal fat was higher in birds fed with BT and PG diets than in SO groups ($P < 0.01$) because of significantly higher contents of myristic acid (C14:0) ($P < 0.01$) and palmitic acid ($P < 0.05$) in these 2 groups. The lowest contents of myristic and palmitic acids were obtained in the SO group. In thigh skin and breast muscles, the proportion of total SFA and of palmitic acid did not significantly differ between groups. The highest content of stearic acid (C18:0) was recorded in thigh muscle of the SO group (Table 4).

The main MUFA found in broiler tissues was oleic acid (C18:1), which was particularly concentrated in thigh muscles in the SO and BT groups ($P < 0.05$). The content of palmitoleic acid (C16:1) increased in thigh skin, thigh muscles and breast muscles of birds fed with BT ($P < 0.01$). Soybean oil diet induced significant increases in C16:1 in abdominal fat ($P < 0.05$). Total MUFA and oleic acid percentages were low in breast muscle ($P < 0.01$) of birds fed with SO diets (Table 5).

Polyunsaturated fatty acids (mainly linoleic acid, C18:2) were concentrated in thigh skin, abdominal fat and breast muscle in the SO group, ($P < 0.05$), and in thigh muscle in the PG group, ($P < 0.05$). Except in thigh muscle, SO diet provoked sustained increases in total PUFA in all tissues due to rises in linoleic acid contents ($P < 0.01$). On the other hand, the lowest percentages of total PUFA and linoleic acid were obtained in all tissues of the BT group (Table 6). In broilers fed with added SO,

Table 3. Effects of dietary treatment on body weight, body weight gain, feed intake, and feed conversion ratio (FCR) and mortality rate of broiler chicks.

Variable	SO	PG	BT	P
Body weight, g (21 days)	609.5 ± 80.7	596.8 ± 76.7	614.8 ± 81.2	NS
Final body weight, g (41 days)	2067.1 ± 248.0	2038.8 ± 262.7	2102.8 ± 246.8	NS
Daily weight gain, g / day	72.1 ± 0.73[b]	72.1 ± 0.61[b]	74.4 ± 0.38[a]	**
Feed intake, g / day	119.8 ± 0.92[b]	113.5 ± 1.45[c]	133.3 ± 1.10[a]	**
FCR, (g feed: g gain)	1.67 ± 0.03[b]	1.58 ± 0.07[c]	1.80 ± 0.04[a]	**
Mortality rate, %	3.0	3.0	3.1	NS

[a, b, c]: Means in lines with no common superscript are significantly different (P < 0.05).
** P < 0.01 Results were expressed as means ± standard errors, NS: not significant.
SO: soybean oil, PG: poultry grease, BT: beef tallow.

Table 4. Saturated fatty acid composition in each tissue lipids of the broilers fed with SO, PG or BT diets, % total fatty acid.

Tissues	Saturated Fatty Acids (SFA)			
Thigh skin	C14:0	C16:0	C18:0	Total
SO	0.43 ± 0.03	29.77 ± 3.50	1.52 ± 0.03[c]	32.88 ± 3.43
PG	-	33.15 ± 1.78	4.80 ± 0.29[a]	37.94 ± 1.94
BT	1.96 ± 0.10	38.60 ± 6.13	3.86 ± 0.15[b]	44.81 ± 6.45
P	-	NS	**	NS
Abdominal fat				
SO	0.98 ± 0.05[c]	26.29 ± 2.13[b]	4.99 ± 0.71	32.26 ± 0.03[b]
PG	2.04 ± 0.25[b]	38.21 ± 0.57[a]	4.13 ± 0.57	44.38 ± 1.20[a]
BT	2.93 ± 0.36[a]	36.68 ± 4.84[a]	5.91 ± 1.14	45.52 ± 4.33[a]
P	**	*	NS	**
Thigh muscles				
SO	1.71 ± 0.05[b]	33.63 ± 0.40[a]	4.71 ± 1.33	42.14 ± 1.75[a]
PG	0.79 ± 0.05[c]	22.90 ± 3.41[c]	3.01 ± 1.54	27.72 ± 2.91[c]
BT	2.32 ± 0.29[a]	28.18 ± 1.68[b]	3.38 ± 0.18	34.00 ± 0.83[b]
P	**	**	NS	**
Breast muscles				
SO	0.44 ± 0.04[c]	39.92 ± 6.53	3.22 ± 0.75[b]	43.58 ± 5.63
PG	3.65 ± 0.53[a]	41.51 ± 5.93	5.77 ± 0.17[a]	50.92 ± 4.85
BT	2.07 ± 0.14[b]	43.50 ± 3.02	2.45 ± 0.60[b]	48.02 ± 3.41
P	**	NS	**	NS

[a, b, c]: Values in the same column and same tissue with no common superscript differ significantly.
* P < 0.05 ** P < 0.01 NS: not significant
SO: soybean oil, PG: poultry grease, BT: beef tallow.

fatty acid analysis of the skin, abdominal fat and breast muscles indicated that the level of linoleic acid (C18:2 n-6) was higher in these tissues than in those fed with other treatment lipids. The proportions of unsaturated fatty acids (C18:1 and C18:2) in thigh muscles were significantly increased by the inclusion of PG in the diet (Table 7).

Table 5. Monounsaturated fatty acid composition in each tissue lipids of the broilers fed with SO, PG or BT diets, % total fatty acid.

Tissues	Monounsaturated Fatty Acids (MUFA)		
Thigh skin	C16:1	C18:1	Total
SO	1.27 ± 0.11^{b}	20.17 ± 3.82	21.44 ± 3.82
PG	1.95 ± 0.53^{b}	26.30 ± 1.50	28.25 ± 1.50
BT	4.88 ± 0.91^{a}	27.98 ± 3.00	32.86 ± 2.30
P	**	NS	NS
Abdominal fat			
SO	3.55 ± 0.39^{a}	25.56 ± 0.75	29.11 ± 0.75
PG	2.95 ± 0.07^{b}	24.79 ± 1.24	27.74 ± 1.24
BT	2.07 ± 0.07^{c}	27.99 ± 1.93	30.06 ± 1.93
P	**	NS	NS
Thigh muscles			
SO	0.77 ± 0.18^{b}	28.89 ± 1.92^{a}	29.66 ± 2.10
PG	0.42 ± 0.05^{b}	11.38 ± 2.67^{b}	12.22 ± 1.50
BT	3.38 ± 0.23^{a}	28.91 ± 1.23^{a}	32.29 ± 3.00
P	**	**	NS
Breast muscles			
SO	2.71 ± 0.67^{a}	17.32 ± 2.09	20.03 ± 2.72
PG	2.03 ± 0.05^{b}	25.71 ± 2.41	27.74 ± 2.41
BT	3.05 ± 0.14^{a}	21.56 ± 3.84	24.61 ± 3.84
P	**	NS	NS

$^{a, b, c}$: Values in the same column and same tissue with no common superscript differ significantly.
** P < 0.01 NS: not significant
SO: soybean oil, PG: poultry grease, BT: beef tallow.

Discussion

In the present study, chicks fed with diets containing SO, PG and BT showed no significant difference in body weight (BW). These results were similar to those reported by others (13,14). Pesti et al. (14) demonstrated that the average BW of chicks consuming a ration with SO was not different from those consuming a ration of animal/vegetable blend and PG. Hulan et al. (15) found no significant difference in average BW of chickens consuming a ration with PG, BT, lard and rapeseed oil. However, Balevi and Coşkun (16) reported that average BW of chickens consuming a ration with corn oil was higher than those consuming the ration with soybean oil or beef tallow. We have previously shown that weight gain was lower in broilers fed on the diets supplemented with PG than SO or BT for 5 to 21 days of age (17). In contrast, the present study indicated that daily weight gain was higher in the diet of the BT group (P < 0.01).

The highest feed intake was observed in the BT-fed group. Similarly, Scaife et al. (2), and Al-Athari and Watkins (18) have reported higher feed consumption in birds fed on dietary tallow than rapeseed oil diets. Atteh and Leeson (19) observed significant increases in food intake when tallow was supplemented in the broiler ration. Low energy level of tallow might cause increased feed consumption. If the diets containing PUFA increased fat absorption (3), it could be presumed that unsaturated fats may lead to higher energy absorption than diets containing SFA. However, Leeson and Atteh (20) have reported that poults fed diets containing SO consumed less feed than poults fed with the diets supplemented with tallow. Zollitsch et al. (7) have reported that feed consumption was not improved by a higher percentage of PUFA in the diets.

The present study indicated that PG supplemented diets caused improvement in the FCR (P < 0.01). Al-

Table 6. Polyunsaturated fatty acid composition in each tissue lipids of the broilers fed with SO, PG or BT diets, % total fatty acid.

Tissues	Polyunsaturated Fatty Acid (PUFA)			
Thigh skin	C18:2	C18:3	Others[1]	Total
SO	30.11 ± 3.31^{a}	-	0.09 ± 0.02	30.20 ± 3.52^{a}
PG	20.87 ± 2.21^{b}	-	0.19 ± 0.02	21.06 ± 4.95^{ab}
BT	15.07 ± 0.67^{b}	-	1.38 ± 0.01	16.45 ± 2.55^{b}
P	**	-	NS	**
Abdominal fat				
SO	25.24 ± 1.44^{a}	0.91 ± 0.05	-	26.15 ± 0.35^{a}
PG	17.88 ± 3.27^{b}	-	-	17.88 ± 3.27^{b}
BT	16.77 ± 0.53^{b}	-	-	16.77 ± 0.53^{b}
P	**	-	-	**
Thigh muscles				
SO	13.74 ± 1.01^{b}	1.64 ± 0.33^{b}	6.35 ± 1.35	24.15 ± 1.13^{b}
PG	40.04 ± 5.74^{a}	9.10 ± 0.50^{a}	2.06 ± 1.85	51.20 ± 1.62^{a}
BT	19.61 ± 3.14^{b}	1.67 ± 0.21^{b}	0.83 ± 0.52	22.11 ± 1.73^{c}
P	**	**	NS	**
Breast muscles				
SO	30.58 ± 3.86^{a}	-	-	30.58 ± 3.86^{a}
PG	14.27 ± 1.19^{b}	-	0.48 ± 0.03	14.75 ± 0.10^{b}
BT	19.68 ± 1.67^{b}	-	0.69 ± 0.09	20.37 ± 1.24^{b}
P	**	-	-	**

$^{a, b, c}$: Values in the same column and same tissue with no common superscript differ significantly.
** P < 0.01   NS: not significant
Others[1]: C20:4, C22:4
SO: soybean oil,   PG: poultry grease,   BT: beef tallow.

Athari and Watkins (18) found no difference in the FCR of broilers fed diets containing 5% added saturated fat or SO. In contrast, Pinchasov and Nir (1) and Zollitsch et al. (7) have reported an improved gain to FCR in broilers when dietary PUFA intake increased.

The fatty acid composition of adipose tissue and body fat are determined by the relative contributions of hepatic lipogenesis and dietary fat (21). Linoleic (C18:2) and linolenic acids (C18:3) are not synthesized by the bird (1). Their presence in the body, therefore, depends on their availability in the diet (1). The present study indicates that an increase in dietary PUFA causes a reduction in the deposition of SFA and MUFA in the thigh skins. There is a close relationship in all lipid classes between dietary fatty acid composition and experimental diets of fatty acids.

Palmitic acid (C16:0) levels in thigh muscle of chicks fed with SO diets were significantly higher ($P < 0.01$). The lowest amount of oleic acid (C18:1) was detected in the chicks fed with PG group. The PUFA level in the thigh muscle lipid tissues of the broilers fed by rations containing PG was higher. Studies by Chanmugam et al. (22) indicated that supplementation by linseed or fish oil of broiler diets causes significant increases in the n-3:n-6 fatty acid ratio in thigh muscle lipids compared with controls fed with the same level of corn oil.

Breast muscle fatty acid composition was markedly affected by dietary fatty acid intake. The proportion of linoleic acid (C18:2) was significantly increased in chicks fed the SO based diets. Additionally, percentage of oleic acid (C18:1) was the highest in the group fed PG. Yau et al. (23) reported that the effect of dietary fat on the

Table 7. Distribution of fatty acids in each tissue lipids of the broilers fed with SO, PG or BT diets.

Tissues	SO	PG	BT	P
Thigh skin				
MUFA + PUFA, %	51.64 ± 4.62	49.31 ± 3.57	49.31 ± 3.46	NS
SFA : (MUFA + PUFA)	0.64 ± 0.12	0.77 ± 0.11	0.91 ± 0.26	NS
n-3, %	0.09 ± 0.02	-	0.21 ± 0.10	-
n-6, %	30.11 ± 3.31^{a}	21.06 ± 4.95^{b}	16.24 ± 2.40^{b}	**
n-6 : n-3	334.56	-	77.33	-
Abdominal fat				
MUFA + PUFA, %	55.26 ± 0.40^{a}	45.62 ± 1.93^{b}	46.83 ± 2.45^{b}	**
SFA : (MUFA + PUFA)	0.58 ± 0.05^{b}	0.97 ± 0.02^{a}	0.97 ± 0.15^{a}	**
n-3, %	0.91 ± 0.05	-	-	-
n-6, %	25.24 ± 1.44^{a}	17.88 ± 3.27^{b}	16.77 ± 0.53^{b}	**
n-6 : n-3	27.74	-	-	-
Thigh muscles				
MUFA + PUFA, %	53.81 ± 1.93^{b}	63.42 ± 1.33^{a}	54.40 ± 3.97^{b}	*
SFA : (MUFA + PUFA)	0.78 ± 0.06^{a}	0.44 ± 0.04^{b}	0.63 ± 0.07^{a}	**
n-3, %	1.64 ± 0.33^{b}	9.10 ± 0.50^{a}	1.67 ± 0.21^{b}	**
n-6, %	20.09 ± 1.25^{b}	42.02 ± 3.63^{a}	20.44 ± 2.60^{b}	**
n-6 : n-3	12.25 ± 2.00^{a}	4.62 ± 0.71^{b}	12.24 ± 0.74^{a}	**
Breast muscles				
MUFA + PUFA, %	50.61 ± 5.95	42.49 ± 3.17	44.98 ± 2.66	NS
SFA : (MUFA + PUFA)	0.86 ± 0.26	1.20 ± 0.25	1.07 ± 0.15	NS
n-3, %	-	-	-	-
n-6, %	30.58 ± 3.86^{a}	14.75 ± 1.10^{c}	20.37 ± 1.20^{b}	**
n-6 : n-3	-	-	-	-

$^{a, b, c}$: Values in the same column and same tissue with no common superscript differ significantly.
* P < 0.05 ** P < 0.01 NS: not significant
SO: soybean oil, PG: poultry grease, BT: beef tallow.

composition of breast muscle fat was less pronounced than that of abdominal fat. But Lopez-Ferrer et al. (24) showed SFA content of both the breast and thigh samples decreased, when fish oil was replaced by linseed oil, MUFA content of the meat samples did not vary with the change in diet, whereas the PUFA content increased when linseed was added to the diet.

Although the trend is to reflect that of diet, differences in gaining abdominal fat between treatments have not been as evident as in other fat depots (5,25). Birds fed with SO diets showed higher values of linoleic acid than the rest of the treatments. Palmitic acid level was higher proportion in broilers fed with the PG and BT diet. In this experiment, the highest content of linoleic acid and lowest content of palmitic acid were found in adipose tissues of broilers fed with SO. Crespo and Esteve-Garcia (21) suggested that differences in fat deposition between broilers fed different dietary fatty acid profiles are more related to different rates of lipid oxidation than lipid synthesis. This suggestion was also supported by Calabotta et al. (26) comparing chickens from high and low body weight lines. This is in good agreement with data from various authors who reported significant changes in the composition of the abdominal fat after feeding with different fat sources (14,25,27). Pinchasov and Nir (1) reported that with the increase of PUFA level in the ration, the fatty acid level in abdominal fat significantly decreases, and the same tendency was observed in MUFA as well.

The findings of Hrdinka et al. (27) showed that feeding with feed-grade PG resulted in significantly smaller abdominal fat pads compared to the other fat sources as SO, palm oil and restaurant grease. Previous reports indicate that broiler chickens fed with diets enriched with PUFA have less abdominal fat deposition than broiler chickens fed with diets containing SFA. This is of particular interest in the rearing of female broilers, because the amount of abdominal fat at slaughter age may represent >3% of the live weight (28).

This experiment has shown that much lower amounts of n-3 fatty acid were present in all tissues (Table 7). Production of flesh rich in n-6 and poor in n-3 fatty acids is expected if the animals are fed with feeds rich in grains containing n-6 fatty acids. Barlow et al. (29) suggested that the total n-3 content of the Western diet should be 3 g per day. Health and Welfare Canada (30) suggested an n-6:n-3 ratio of 4:1. In contrast, the average total n-3 consumption in Western countries is 1.7 g/day and the n-6:n-3 ratio ranges from 10 to 20:1 (29). Lopez-Ferrer et al. (24) showed that the use of linseed or fish oil in poultry diets increased the n-3 PUFA concentration of poultry tissue.

In summary, the results of the present study have shown relatively high content of PUFA in SO and high content of MUFA in PG. It is suggested that the composition of abdominal fat is significantly influenced by the dietary fat source. This is especially the case for the content of MUFA and PUFA, which is often discussed in connection with consumer demand for “healthy” foodstuffs. Fat composition in poultry meat may be substantially altered by feeding specific mixtures of fatty acids.

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