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Effects of dietary fat origin on the performance of broiler chickens and on the fatty acid composition of selected tissues

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ABSTRACT

Experiments were conducted to evaluate the effects of dietary fat origin on the performance and carcass fatty acid composition of broiler chickens. Sunflower and linseed oils (plant origin), fish oil (marine origin) and beef tallow (animal fat) were fed to broiler chickens at dietary levels of 40 g/kg and compared with a control diet with no added fat. Diets were formulated to be isonitrogenous (195 g/kg CP) and isoenergetic (12.4±0.2 MJ/kg). Live weight, feed intake, weight gain and feed conversion ratio for the chickens were measured. The fatty acid composition of the breast muscle and abdominal adipose tissues was also determined. Weight gain differed between the beef tallow diet and the oil diets (P<0.01). Feed conversion ratio (FCR) was not affected by fat supplementation. The fatty acid profiles for the breast muscle and abdominal fat were altered by the diets. The oil diets (plant seed and fish) increased total polyunsaturated fatty acid (PUFA) concentration in both types of tissue, while beef tallow decreased it (P<0.001). Total PUFA was, however, higher in the tissues investigated in the chicks fed plant seed oil diets (sunflower or linseed), compared to fish. Chickens fed fish oil diets showed higher concentration (P<0.001) of long chain n-3 PUFA (C22:6n-3, C22:5n-3, C20:5n-3) in the tissues investigated, compared to the others. Total monounsaturated (MUFA) and saturated (SAT) fatty acid concentrations were higher in the chickens fed the beef tallow diet.
(Keywords: dietary fats, broiler chickens, fatty acids, feed conversion, carcass)

ÖSSZEFOGLALÁS

A takarmányhoz kevert zsír minőségének hatása brojlercsirkék teljesítményére és testszöveteik zsírsavösszetételére

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Kísérleteket végeztünk annak érdekében, hogy megvizsgáljuk a takarmányhoz adott eltérő eredetű zsírok hatását a brojlercsirkék teljesítményére, ill. testszöveteik zsírsavösszetételére. Napraforgó- és lenolajat (növényi eredetű), halolajat (tengeri eredetű), valamint marhafaggyút (állati eredetű) kevertünk a csirkék takarmányához 40 g/kg mennyiségben úgy, hogy azok energia-, (12.4±0.2 MJ/kg), ill. fehérjetartalma (195 g/kg nyersfehérje) közel azonos maradjon a zsírkiegészítést nem tartalmazó kontroll csoportéval. Harminc napos hizlalási időszakot követően mértük az állatok súlygyarapodását és takarmányértékesítését valamint meghatároztuk a mellizom, ill. a hasűri zsírszövet zsírsavösszetételét. Az eltérő

zsírok etetését követően mért súlyparapodási értékek között csak a növényi olajok és a marhafaggyú összehasonlításában tapasztaltunk szignifikáns különbséget (P<0.001). A takarmányértékesítésben eltérések nem mutatkoztak. Jelentős különbségek voltak ugyanakkor a csirkék mellizomzatában és a hasűri zsírszövetben deponált lipidek zsírsavösszetételében. A növényi olajok és a halolaj növelte (P<0.001), a marhafaggyú ugyanakkor csökkentette (P<0.001) a többszörösen telítetlen zsírsavak (PUFA) összes koncentrációját a kontrollhoz viszonyítva. A PUFA összmennyisége azonban magasabbnak mutatkozott a vizsgált szövetekben a növényi olajok takarmányozását követően mint a halolaj etetésekor. A hosszú szénláncú n-3 zsírsavak (C22:6n-3, C22:5n-3, C20:5n-3) mennyisége jelentősen megnövekedett a halolaj takarmányozását követően, főként az izomszövetben. Az összes egyszeresen telítetlen (MUFA) és telített zsírsavak koncentrációja a marhafaggyú etetése után bizonyult legnagyobbnak.
(Kulcsszavak: takarmányzsírok, brojlercsirke, zsírsavak, takarmányértékesítés, testösszetétel)

INTRODUCTION

The supplementation of broiler diets with small quantities of fats and oils is a long-standing practice for improving the consistency and palatability of mash (*Summers and Leeson, 1979*), increasing the energy density of broiler meat, and stimulating growth and the utilisation of food and energy (*Rand et al., 1958; Dam et al., 1959; Carew and Hill, 1964; Vermeersch and Vanschoubroek, 1968*).

In recent studies the fatty acid composition of broiler carcass has been customised for high concentration of essential polyunsaturated fatty acids (PUFA; especially n-3 fatty acids), through supplementing diets with fish oil (*Ackman et al., 1988; Hulan et al., 1989; Chanmugam et al., 1992*), and plant seed oils (*Phetteplace and Watkins, 1989; Farrel and Gibson, 1990; Sim, 1990; Olomu and Baracos, 1991; Yau et al., 1991, and Chanmugam et al., 1992*).

Results from these studies indicate that the degree of influence of a dietary fat on carcass fatty acid composition depends on its origin. When fed to chickens fish oil (marine origin), rich in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), results in a high degree of enhancement for these fatty acids in the carcass (*Hulan et al., 1988; Ackman et al., 1988 and Hulan et al., 1989*). On the other hand, oils of plant origin are rich in polyunsaturated fatty acids (PUFA) but differ in their predominant essential fatty acids. As a result they enhance carcass PUFA content while varying in their influence on the overall carcass fatty acid composition when fed to chickens (*Miller and Robisch, 1969; Hawrysh et al., 1980; Salmon et al., 1981; Chanmugam et al., 1992*).

Thus, this study was conducted to evaluate the effect on broiler carcass fatty acid composition of feeding selected oils and fat of different origin. Their effect on performance was also evaluated.

MATERIALS AND METHODS

Source of test oils and fat

Sunflower oil (Floriol brand) was purchased at a local supermarket while fish oil and linseed oil (Limi brand) were obtained from a local pharmacy in Keszthely, Hungary. Beef tallow was obtained from ZALAHÚS Ltd. (Zalaegerszeg, Hungary). All products were stored at 4°C prior to mixing.

Birds and diets

A total of 200 one-day-old Ross cockerel chicks were obtained from a commercial hatchery (HEROSS Hatcheries Co., Ócsa, Hungary). The chicks were randomly assigned to cages (20 per cage) in batteries with raised floors, and were fed a common basal broiler starter diet from 1 to 10 days. On day 11 the chicks were individually weighed, randomly reassigned to cages (10 per cage) and fed the experimental diets (control diet with no added fat, or with 40 g/kg sunflower, fish or linseed oil or beef tallow).

The diets were isonitrogenous (195 g/kg CP) and isoenergetic (12.4±0.2MJ/kg). Adequate amounts of vitamins, minerals and essential amino acids were provided, in accordance with the 1994 recommendations of the National Research Council (NRC). The composition and calculated nutrient composition of the treatment diets is shown in *Table 1*.

Table 1

Composition and calculated nutrient content of experimental diets fed to chicks

Ingredients and composition (2)	**Experimental diets (1)**				
	Control (3)	Sunflower oil (4)	Fish oil (5)	Linseed oil (6)	Beef tallow (7)
	(g/kg)				
Yellow corn (8)	510.0	106.0	106.0	106.0	106.0
Wheat (9)	167.0	400.0	400.0	400.0	400.0
Barley (10)	-	152.0	152.0	152.0	152.0
Soybean meal (11)	268.0	247.0	247.0	247.0	247.0
Fishmeal (12)	20.0	20.0	20.0	20.0	20.0
Added fat/oil (13)	-	40.0	40.0	40.0	40.0
Vitamin/mineral premix*(14)	35.0	35.0	35.0	35.0	35.0
Total (15)	*1000.0*	*1000.0*	*1000.0*	*1000.0*	1000.0
Calculated nutrient content (16)					
ME (MJ/kg)	12.1	12.5	12.4	12.5	12.2
Crude protein, g/kg (17)	195.0	195.0	195.0	195.0	195.0
Crude fibre, g/kg (18)	35.0	40.0	40.0	40.0	40.0
Lysine, g/kg	10.2	9.9	9.9	9.9	9.9
Methionine, g/kg	3.3	3.0	3.0	3.0	3.0
Methionine+cystine, g/kg	6.5	6.2	6.2	6.2	6.2

*Provides per kilogram of diet (*A táp 1 kg-ra vonatkozóan tartalmaz*): vitamin A, 15,999 IU; vitamin D3, 3299.8 IU; vitamin K3, 10.2 mg; vitamin B1, 5.0 mg; vitamin B2, 15.2 mg; pantothenic acid, 20.2 mg; vitamin B6, 4.0 mg; vitamin B12, 0.06 mg; nicotinic acid, 50.3 mg; folic acid, 5.0 mg; biotin, 0.4 mg; choline chloride, 600 mg; Zn, 100 mg; I, 4.1 mg; Se, 0.2 mg; Mn, 100 mg; Cu, 16.2 mg; Fe, 20.3 mg. Benduramycin, 715.00 mg

1. táblázat: A csirkékkel etetett kísérleti takarmány összetétele és számított táplálóanyag tartalma

Kísérleti tápok(1), Alapanyag és összetétel(2), Kontroll(3), Napraforgóolaj(4), Halolaj(5), Lenolaj(6), Faggyú(7), Kukorica(8), Búza(9), Árpa (10), Szójadara(11), Halliszt(12), Addott zsír(13), Vitamin és ásvány premix(14), Összesen(15), Számított táplálóanyag tartalom(16), Nyersfehérje(17), Nyersrost(18)

The birds were raised within a controlled environment at 20 to 25°C. Additional heating was used during the initial 2-week brooding period. Lighting was provided 24 hours a day. The chicks were given free access to water and feed.

A completely randomised design was used. The design involved 4 dietary replicates per treatment.

Measurements and sample collection

The body weight of the chickens in each replicate was recorded at 11, 27 and 41 days of age. Feed consumption was determined by weighing residual feed. Mortality was recorded daily. Feed utilisation was calculated as total feed consumed divided by live weight.

Samples for chemical analysis were collected when the chickens were 42 days old. Six chickens per treatment were weighed and slaughtered, and breast muscle and abdominal fat tissue samples were obtained and stored in a deep freezer at -20°C.

Chemical analysis

Total lipid was extracted from the tissue samples by the method of *Folch et al.* (1957). Four-gramme samples of tissue were homogenised with 80 ml of a 2:1 (v/v) mixture of chloroform-methanol, after which 4 ml 0.88% NaCl was added; the liquid was mixed and left to stand for 2 hours to allow phase separation. The chloroform-methanol extract was evaporated to dryness in a water bath at 50°C under N_2 flow. The lipid extracts were then converted to fatty acid methyl esters by using boron-trifluoride-methylation solution (catalogue no. 3-3021). The resultant fatty acid methyl esters were separated and analysed by gas liquid chromatography, in accordance with *Husvéth et al.* (1982), by means of an automated gas liquid chromatograph (Chrom 42), equipped with dual flame ionisation detector and a 1.8 m × 3 mm internal diameter packed glass column containing 100/120 Chromosorb WAW coated with 10% SP 2330. An isothermic oven temperature of 180°C was maintained throughout the analysis procedure. The injector and detector temperatures were 225 and 245°C respectively. Nitrogen at a flow rate of 20 ml/min was used as the carrier gas. Conditions were chosen to separate fatty acids of carbon chain length 12 to 24. The fatty acids were identified by comparison of retention times with known external standard mixtures (PUFA-2: catalogue no. 1081), quantified by a Shimadzu C-RGA integrator and the results expressed as percentage distribution of fatty acid methyl esters. All the chemicals used for the gas chromatography analysis procedure were obtained from Supelco Inc. (Bellefonte, PA, U.S.A.).

Statistical analysis

The experiment was based on a completely randomised design, the experimental unit being the pen average for each performance variable. The data were analysed by means of one-way ANOVA. When analysis of variance indicated a significant treatment the means were compared by multiple range tests. Significance was accepted at the 5% confidence level. The data are expressed as means ± standard error of the mean (SEM).

RESULTS AND DISCUSSION

Fatty acid composition of supplemental fats

The fatty acid profiles of the test oils and fat show that the sunflower oil and linseed oils (plant seed oil) used in this study are rich in linoleic acid, C18:2n-6 and linolenic acid,

C18:3n-3, respectively. Fish oil and beef tallow (animal fat) have high concentrations of long-chain n-3 PUFA (eicosapentaenoic acid, EPA and docosahexaenoic acid, DHA) and saturated fatty acids (SAT), respectively (*Table 2*). These data are consistent with those obtained in other studies (*Herald and Kinsella,* 1986*; Phetteplace and Watkins,* 1989; *and Olomu and Baracos,* 1991). Since the fatty acid composition of broiler chicken carcass may be influenced considerably by that of the diet (*Miller and Robish,* 1969*; Hargis and Elswyk,* 1993), it is expected that diets containing oils and fat of different origin will influence carcass fatty acid composition, reflecting their predominant fatty acids.

Table 2

Fatty acid composition of control diet, oils and beef tallow

Fatty acids (1)	**Control diet (2)**	**Sunflower oil (3)**	**Fish oil (4)**	**Linseed oil (5)**	**Beef tallow (6)**
percentage of total fatty acids (7)					
C14: 0	-	-	7.5	-	3.5
C16: 0	21.3	6.9	12.8	5.6	28.3
C16: 1n-7	-	2.5	13.3	-	7.8
C18: 0	0.7	21.9	2.0	2.2	10.7
C18: 1n-9	12.5	-	24.7	21.0	46.7
C18: 2n-6	61.2	68.7	1.9	17.6	1.0
C18: 3n-3	2.3	-	8.1	53.2	-
C20: 2n-6	-	-	4.1	-	-
C20: 4n-6	0.2	-	-	-	-
C20: 5n-3	0.1	-	9.1	-	-
C22: 4n-6	-	-	0.3	-	-
C22: 5n-3	-	-	1.4	-	-
C22: 6n-3	-	-	8.8	-	-
Others (8)	1.7	-	1.0	0.4	2.0
Saturated fatty acids (9)	22.0	9.4	22.3	7.8	42.5
Monounsaturated fatty acids(10)	12.5	21.9	38.0	21.0	54.5
Total n-6 (11)	61.4	68.7	6.4	17.6	1.0
Total n-3 (12)	2.4	-	27.4	53.2	-
Polyunsaturated fatty acids (13)	63.8	68.7	33.8	70.8	1.0

2. táblázat: A kontrol táp, olajok és a faggyú zsírsavösszetétele

Zsírsav(1), Kontroll táp(2), Napraforgóolaj(3), Halolaj(4), Lenolaj(5), Faggyú(6), Az összes zsír százalékában(7), Egyéb(8) Telített zsírsavak(9), Egyszeresen telítetlen zsírsavak(10), Összes n-6 zsírsav(11), Összes n-3 zsírsav(12), Többszörösen telítetlen szírsavak(13)

Influence of the experimental diets on live weight, growth rate, feed intake and feed conversion ratio (FCR) in the broiler chickens

Studies by *Atteh et al.* (1983) and *Sklan and Ayal* (1989) reported no differences in growth rate or FCR of broiler chickens fed various dietary fats of different origin. The inclusion of fish oil in poultry diets has also been reported to have no effect on feed intake (*Huang et al.,* 1990), live weight or FCR (*Hulan et al.,* 1989; *Phetteplace and Watkins,* 1990, *and Nash et al.,* 1995), compared to a control diet with no fat added. These observations are consistent with a number of findings made in this study. For instance, dietary fat origin did not influence (P>0.05) live weight, feed intake or FCR (*Table 3*). In addition, weight gain was not different (P<0.05) among chickens fed the various fat diets in comparison with the control. However, significantly higher (P<0.05) weight gain and a non-significant (P>0.05) improvement in FCR was observed in the chickens fed unsaturated plant seed oil (sunflower and linseed) diets compared to those fed the animal fat (beef tallow) diet. This is in agreement with the findings of *Alao and Balnave* (1984), who fed sunflower and olive oil diets to male broiler chickens and reported a faster growth rate, with a non-significant improvement in FCR, in chickens fed the sunflower oil diet. It has been suggested that terrestrial plant seed oils of high PUFA content are more effectively absorbed and utilised than the highly saturated animal fats (*Husvéth,* 1980; *Corino et al.,* 1980; *Brue and Latshaw,* 1985). In spite of the differences in growth rate, FCR was not affected, probably due to the small differences between the averages.

Table 3

Live weight, feed intake, weight gain and feed conversion ratio (FCR) of chickens as influenced by experimental diets

	Experimental diets* (1)					P (7)
	Control (2)	SUN (3)	FIS (4)	LINS (5)	BT (6)	
Live weight (g/bird) (8)	1497.0±19.8	1729.0±19.4	1495.0±36.6	1607.3±29.1	1471.0±18.0	NS
Feed intake (g/bird) (9)	2407.5±14.5	2360.0±51.1	2327.5±41.9	2323.8±49.6	2313.8±48.0	NS
Weight gain (g/bird) (10)	1308.6^{ab}±15.0	1359.7^{a}±23.6	1301.4^{ab}±31.2	1418.1^{a}±35.4	1274.8^{b}±17.0	**
FCR (g:g) (11)	1.8±0.01	1.7±0.1	1.8±0.03	1.6±0.1	1.8±0.01	NS

*SUN=40 g/kg sunflower oil, FIS=40 g/kg fish oil, LINS=40 g/kg linseed oil, BT=40 g/kg beef tallow; NS P>0.05; ** P<0.01; *** P<0.001, a-e Means±SEM within rows with no common superscripts differ significantly (P<0.05) (*Az eltérő betűvel jelzett soron belüli átlagok szignifikánsan (P<0,05) különböznek*)

3. táblázat: A kísérleti tápokat fogyasztó csirkék élősúlya, takarmányfogyasztása, testtömeggyarapodása és takarmányértékesitése (FRC)

Kísérleti tápok(1), Kontroll(2), Napraforgóolaj(3), Halolaj(4), Lenolaj(5), Faggyú(6), Szignifikancia szint(7), Élőtömeg (8), Takarmányfogyasztás(9), Testtömeggyarapodás(10), Takarmányértékesítés(11)

Influence of dietary fats on tissue fatty acid composition

The fatty acid composition of the broiler carcass lipids is generally a reflection of the fatty acid profile of the diet fed (*Tables 4a, 4b, 5a, and 5b*). This is consistent with the results of a number of earlier studies (*Hulan et al.,* 1988; *Yau et al.,* 1991; *Zollitsch et al.,* 1997 *and Ochrimenko et al.,* 1997). The lipids of the breast muscle and abdominal adipose tissue in chickens fed oil diets (sunflower, linseed and fish) showed significant increases in the concentration of total PUFA. However, linoleic acid (C18:2n-6), in high concentrations in sunflower oil diets, resulted in increased levels of C18:2n-6, while the chickens fed linseed, rich in linolenic acid (C18:3n-3), showed higher C18:3n-3 deposition in both the types of tissue investigated. The fish oil diet, rich in long-chain n-3 PUFA (eicosahexaenoic acid (EPA) and docosahexaenoic acid (DHA)) resulted in increased deposition of these fatty acids in both types of chicken tissue (*Tables 4b and 5b*). The animal fat (beef tallow) diet, rich in saturated (SAT) and monounsaturated fatty acids (MUFA), increased the concentration of these acids in the abdominal adipose tissue of the chickens (*Tables 4a and 5b*). This is in contrast with the findings of *Naber and Bigger* (1989) and *Cherian et al.* (1996), who reported no change in the SAT content of adipose tissue with the feeding of a highly saturated palm oil diet to hens. The diets did not affect total saturated fatty acid deposition in the breast muscle tissue. These results also suggest that the ability of broiler chickens to alter the SAT content of the breast muscle is limited. The difference in the influence of dietary fats on SAT deposition in the breast and the abdominal adipose tissues is probably due to the difference in function of the fatty acids in these two types of tissue. The fatty acids in the fat depots of the adipose tissues have a storage function, and therefore show increased deposition of saturated fatty acids, while those of the muscle tissues serve as structural components, which limits their levels of deposition.

Table 4a

Saturated and monounsaturated fatty acid composition of breast muscle lipids of chickens as influenced by experimental diets

Fatty acid (2)	Experimental diets* (1)					P (8)
	Control (3)	SUN (4)	FIS (5)	LINS (6)	BT (7)	
	% total fatty acids (9)					
C14:O	0.5^{c}±0.01	0.4^{c}±0.02	1.0^{a}±0.04	0.4^{c}±0.03	0.8^{b}±0.04	***
C16:O	22.5±0.5	18.8±0.7	22.3±0.3	18.3±0.9	21.6±0.1	NS
C16:1n-7	3.3^{a}±0.4	1.6^{b}±0.1	2.8^{a}±.02	2.5^{a}±0.3	3.3^{a}±0.2	***
C18:O	11.6±0.2	12.3±0.3	11.2±0.3	11.5±0.2	11.1±0.3	NS
C18:1n-9	26.4^{a}±0.6	20.0^{b}±0.7	22.4^{b}±1.2	22.9^{b}±0.5	29.3^{a}±0.6	***
Saturated fatty acids (10)	34.5±0.3	32.1±0.8	34.8±0.4	29.3±1.9	33.5±0.3	NS
Monounsaturated fatty acids (11)	29.8^{a}±0.9	21.5^{b}±0.8	25.3^{b}±1.4	25.4^{b}±0.7	32.5^{a}±0.9	***

See Table 3 (*Lásd 3. táblázat*)

4a. táblázat: A mellizom telített – és egyszeresen telítetlen zsírsavai összetételének változása a kísérleti tápok etetésének hatására

Kísérleti tápok(1), Zsírsav(2), Kontroll(3), Napraforgóolaj(4), Halolaj(5), Lenolaj(6), Faggyú(7), Szignifikancia szint(8), Összes zsír százalékában(9), Telített zsírsavak(10), Egyszeresen telítetlen zsírsavak(11)

Table 4b

N-6 and n-3 PUFA composition of breast muscle lipids of chickens as influenced by experimental diets

Fatty acids (2)	Experimental diets* (1)					P (8)
	Control (3)	SUN (4)	FIS (5)	LINS (6)	BT (7)	
	% total fatty acids (9)					
C18:2n-6	15.0^{d}±0.2	24.2^{a}±0.8	10.5^{d}±0.4	17.4^{b}±0.7	14.4^{c}±0.3	***
C20:2n-6	0.6^{b}±0.1	0.9^{a}±0.1	0.2^{c}±0.01	0.2^{c}±0.03	0.3^{c}±0.04	***
C20:3n-6	1.2^{a}±0.04	1.0^{b}±0.1	0.5^{c}±0.03	0.6^{c}±0.1	0.8^{c}±0.04	***
C20:4n-6	4.9^{b}±0.4	7.0^{a}±0.3	2.2^{d}±0.1	2.5^{d}±0.2	3.8^{c}±0.3	***
C22:4n-6	1.0^{b}±0.1	1.2^{a}±0.1	0.3^{d}±0.01	0.2^{d}±0.02	0.7^{c}±0.1	***
Total n-6 (10)	23.0^{bc}±0.6	34.4^{a}±0.9	13.7^{d}±0.4	21.0^{bc}±0.7	20.1^{c}±0.4	***
C18:3n-3	0.6^{b}±0.1	0.5^{b}±0.03	1.7^{b}±0.2	10.0^{a}±1.1	0.6^{b}±0.1	***
C20:5n-3	1.0^{c}±0.04	0.6^{c}±0.1	4.2^{a}±0.5	2.7^{b}±0.2	1.3^{c}±0.1	***
C22:5n-3	1.8^{c}±0.2	1.6^{c}±0.1	4.0^{a}±0.2	3.1^{b}±0.2	1.7^{c}±0.1	***
C22:6n-3	3.4^{b}±0.2	3.3^{b}±0.2	9.9^{a}±0.4	2.6^{b}±0.1	3.5^{b}±0.2	***
Total n-3 (11)	6.8^{b}±0.4	6.0^{b}±0.3	19.8^{a}±0.9	18.3^{a}±1.0	6.9^{b}±0.3	***
Polyunsaturated fatty acid (12)	29.2^{cd}±0.6	40.3^{a}±1.0	33.5^{b}±1.1	39.3^{a}±1.4	27.0^{d}±0.7	***

See Table 3 (*Lásd 3. táblázat*)

4b. táblázat: A mellizom n-6 és n-3 többszörösen telítetlen zsírsavai összetételének változása a kísérleti tápok etetésének hatására

Kísérleti tápok(1), Zsírsav(2), Kontroll(3), Napraforgó olaj(4), Halolaj(5), Len olaj(6), Faggyú(7), Szignificancia szint(8), Összes zsír százalékában(9), Összes n-6 zsírsavak(10), Összes n-3 zsírsavak(11), Telítetlen zsírsavak(12)

Table 5a

Saturated and monounsaturated fatty acid composition of adipose tissue lipids of chickens as influenced by experimental diets

Fatty acid (2)	Experimental diets* (1)					P (8)
	Control (3)	SUN (4)	FIS (5)	LINS (6)	BT (7)	
	% total fatty acids (9)					
C14:O	0.7^{c}±0.03	0.5^{c}±0.02	1.9^{a}±0.3	0.4^{c}±0.01	1.5^{b}±0.1	***
C16:O	26.1^{a}±1.1	20.6^{c}±0.8	22.5^{b}±0.9	22.4^{bc}±0.8	26.3^{a}±0.5	***
C16:1n-7	8.5^{a}±0.6	3.6^{c}±0.3	8.6^{a}±0.8	5.0^{bc}±0.3	7.2^{a}±0.4	***
C18:O	6.3^{b}±0.4	6.0^{b}±0.4	6.4^{b}±0.7	4.2^{c}±0.2	7.2^{a}±0.1	***
C18:1n-9	39.2^{b}±0.5	31.7^{e}±1.2	36.3^{c}±1.4	35.0^{cd}±0.6	42.2^{a}±0.7	***
Saturated fatty acid (10)	33.1^{b}±1.2	27.1^{d}±0.8	30.8^{c}±1.0	27.0^{d}±0.9	35.4^{a}±0.4	***
Monounsaturated fatty acids (11)	47.6^{ab}±0.7	35.3^{d}±1.4	44.9^{b}±1.8	40.0^{c}±0.9	50.0^{a}±0.5	***

See Table 3 (*Lásd 3. táblázat*)

5a. táblázat: A hasüreg zsír telített – és egyszeresen telítetlen zsírsavösszetételének változása a kísérleti tápok etetésének hatására

Kísérleti tápok(1), Zsírsav(2),Kontroll(3), Napraforgóolaj(4), Halolaj(5), Lenolaj(6), Faggyú(7), Szignificancia szint(8), Összes zsír százalékában(9), Telített zsírsavak(10), Egyszeresen telítetlen zsírsavak(11)

Table 5b

N-6 and n-3 PUFA composition of adipose tissue lipids of chickens as influenced by experimental diets

Fatty acids (2)	Experimental diets* (1)					P (8)
	Control (3)	SUN (4)	FIS (5)	LINS (6)	BT (7)	
	% total fatty acids (9)					
C18:2n-6	17.0^{b}±0.8	36.6^{a}±1.9	18.6^{b}±2.8	15.4^{bc}±0.9	12.3^{c}±0.3	***
C20:2n-6	0.0^{b}	0.0^{b}	0.03^{a}±0.02	0.0^{b}	0.0^{b}	***
C20:3n-6	0.0	0.0	0.0	0.0	0.0	NS
C20:4n-6	0.0^{b}	0.0^{b}	0.3^{a}±0.1	0.0^{b}	0.0^{b}	***
C22:4n-6	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	***
Total n-6 (10)	17.2^{b}±0.8	36.6^{a}±1.9	18.5^{b}±2.7	15.4^{bc}±0.9	12.3^{c}±0.3	***
C18:3n-3	1.3^{cd}±0.3	0.5^{d}±0.02	4.1^{b}±0.8	17.6^{a}±0.8	0.7^{d}±0.03	***
C20:5n-3	0.0^{b}	0.0^{b}	0.6^{a}±0.1	0.0^{b}	0.0^{b}	***
C22:5n-3	0.0^{a}	0.0^{a}	0.1^{a}±0.1	0.0^{a}	0.0^{b}	***
C22:6n-3	0.0	0.0	0.0	0.0	0.0	NS
Total n-3 (11)	1.3^{c}±0.3	0.5^{c}±0.02	4.9^{b}±1.0	17.6^{a}±0.8	0.7^{c}±0.03	***
Polyunsaturated fatty acids (12)	18.5^{d}±1.0	37.1^{a}±1.9	23.5^{c}±2.2	33.0^{b}±1.6	13.0^{e}±0.3	***

See Table 3 (*Lásd 3. táblázat*)

5b. táblázat: A hasüreg zsír n-6 és n-3 többszörösen telítetlen zsírsavösszetételének változása a kísérleti tápok etetésének hatására

Kísérleti tápok(1), Zsírsav(2), Kontroll(3), Napraforgóolaj(4), Halolaj(5), Lenolaj(6), Faggyú(7), Szignificancia szint(8), Összes zsír százalékában(9), Összes n-6 zsírsavak(10), Összes n-3 zsírsavak(11), Telítetlen zsírsavak(12)

CONCLUSIONS

It may be concluded from the results of this study that the origin of dietary fats significantly influences the fatty acid composition of broiler chicken carcasses, reflecting the predominant fatty acid of the diet, while exercising no influence on performance in chickens.

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