

# Effect of dietary fat on fatty acid composition of lipids from breast muscle and abdominal fat of broiler chickens

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## ABSTRACT

Fatty acid (FA) composition of adipose tissue and breast muscle was determined in broiler chickens fed from 8 day of life till slaughter on wheat-soyabean meal diets supplemented with different fats. The following fats and fat sources were used: beef tallow, lard, soya oil, rape seed oil or mixtures of tallow and soya oil, linseed seed and lard or rape seed and lard. The dietary fatty acids (FA) profile affected FA profile of lipids and the proportion of n-6/n-3 PUFA in broilers. The supplementation of diet with beef tallow caused the highest surplus n-6 over n-3 PUFA in adipose and breast muscle (11.9 and 10.3, respectively). The proportion of n-6/n-3 PUFA in adipose tissue and breast muscle of birds fed on diet supplemented with the mixture of full-fat linseed and lard (1.2 and 1.6, respectively) was the closest to the proportion of these fatty acids recommended for humans.

**KEY WORDS:** dietary fat, fatty acids, breast muscle, abdominal fat, broiler chickens

## INTRODUCTION

The energy density of broiler chickens diets is high and reaches 12.5-13.4 MJ of metabolizable energy (ME) per kg of diet. In Polish conditions the main cereal used in broiler diets is wheat, of relatively low ME value, so the including fodder fat or full-fat seeds is necessary to optimize energy level of diets. The composition of fatty acid (FA) in feed influences the composition of lipids in avian eggs and meat (Leskanich and Noble, 1997). Recent dietary recommendations pertaining to the consumption of dietary fat in humans have stressed the importance of lowering the proportion of saturated to unsaturated FA and the proportion of long chain n-6/n-3 polyunsaturated fatty acids (n-6/n-3 PUFA), as it may have beneficial effects on human health.

The aim of the study was to compare the effects of fodder fats of animal or plant origin and full-fat rape and linseed seeds added to balanced diets on fatty acid composition of lipids in broiler meat and fat tissues.

## MATERIAL AND METHODS

Three experiments were conducted on 140 broiler chickens. There were Hybro females (Experiment 1), ISA 215 cockerels (Experiment 2) and Cobb 500 females (Experiment 3). All birds were fed similar low fat diet for the first 7 days of life, then they were randomly allocated to groups of 20, kept in individual balance cages and fed *ad libitum* pelleted Starter type diets differing in supplementary fat (Table 1). Birds in Experiment 1 were fed diets 1 and 2 containing full-fat seeds, in Experiment 2 diets 3, 4 and 5, and in Experiment 3 diets 6 and 7 containing supplementary fats of animal or plant origin. Twelve randomly chosen birds from each group were killed by decapitation at 21 (Experiment 1), 35 (Experiment 2) or 29 (Experiment 3) day of life. Samples of 10 g of left breast muscle (*M. pectoralis major*) and abdominal fat pads were collected from each bird. Samples of meat and fat from 4 birds were pooled by tissue type, packed in polyethylene bags and kept in -18°C prior to analysis. The tissues were homogenized and total lipids extracts of tissue samples were prepared by the method of Folch et al. (1957). The fatty acid methyl esters were separated and measured on Hewlett-Packard 5890 gas chromatograph with flame ionization detection according to Rotenberg and Andersen (1980) and Paterson and Amado (1997).

## RESULTS

The experimental diets contained relatively high proportion of added fat, which made about 80% of total fat (Table 1). The proportion of fatty acids (FA) in diet depended mainly on the type of added fat, the diets supplemented with beef tallow or lard were richest in saturated fatty acids (SFA). The most polyunsaturated fatty acids (PUFA) contained the diet supplemented with soya oil, followed by diets with linseed and lard and rape seed oil. The content of PUFA was relatively low in diets supplemented with fats of animal origin. The diets supplemented with soya oil and/or tallow were characterized by surplus of PUFA n-6 over PUFA n-3 (6.8 to 7.9); the proportion of these FA in the diet with linseed and lard was 0.9 (Table 2).

In abdominal fat of broilers SFA content was highest in group fed on the diet with tallow, followed by group fed on diets with tallow/soya oil and lard, lowest in group fed on the diet with rape seed oil. Most PUFA contained abdominal fat

TABLE 1

Composition of diets, g/kg

Component	Diet no						
	1	2	3	4	5	6	7
Wheat	459	455	636	636	636	614	612
Maize	100	100	-	-	-	-	-
Soyabean oilmeal	290	284	253	253	253	276	277
Linseed	80	-	-	-	-	-	-
Rape seed	-	100	-	-	-	-	-
Lard	30	20	-	-	-	75	-
Beef tallow	-	-	52	-	75	-	-
Soyabean oil	-	-	23	75	-	-	-
Rape seed oil	-	-	-	-	-	-	76
Remaining*	41	41	35	35	35	35	35
Crude fat	79	79	95	95	92	96	88

\* limestone, dicalcium phosphate, NaCl, mineral-vitamin premix, feed enzyme (Avizyme 1300), L-lysine, DL-methionine

TABLE 2

Fatty acid composition of experimental diets, in % of total FA (\*calculated from the composition of the feed ingredients)

Fatty acids	Diet no/source of added fat						
	1 linseed lard	2 rape seed lard	3* tallow soya oil	4* soya oil	5* tallow	6* lard	7* rape seed oil
Σ SFA	23.5	18.8	42.5	16.2	54.5	50.5	8.8
Σ MUFA	30.8	50.2	31.5	23.2	35.3	39.4	56.0
Σ PUFA	45.7	31.0	26.0	60.6	10.2	10.1	35.2
C18:2 n-6	21.5	24.5	23.0	53.9	8.8	7.8	26.7
C18:3 n-3	24.1	5.8	3.0	6.8	1.3	1.7	7.8
Σn-6/Σn-3 PUFA	0.9	4.2	7.7	7.9	6.8	4.6	3.4

SFA – saturated FA; MUFA – monounsaturated FA; PUFA – polyunsaturated FA

in group fed on the diet with soya oil, least in group fed on the diet with tallow. The proportion of PUFA n-6 to PUFA n-3 in the group fed on the diet with linseed and lard was 1.2, in the group fed on the diet containing tallow was 11.9 (Table 3).

Lipids of breast muscle contained most SFA in group fed on the diet with tallow, followed by group fed on diets with tallow/soya oil. The content of PUFA

was highest in group fed on the diet with soya oil, lowest in group fed on the diet with tallow. The proportion of PUFA n-6 to PUFA n-3 in the group fed diet with linseed and lard was 1.6, in the group fed on the diet containing tallow 1.3 (Table 4).

TABLE 3

Fatty acid composition (% total FA) of lipids from abdominal fat of broilers fed diets with various supplemental fat

Fatty acids	Group no/source of added fat						
	1 linseed lard	2 rape seed lard	3 tallow soya oil	4 soya oil	5 tallow	6 lard	7 rape seed oil
Σ SFA	25.0	23.7	31.9	24.2	33.7	30.0	18.2
Σ MUFA	45.4	54.8	49.5	45.0	56.9	55.8	58.4
Σ PUFA	29.5	21.5	18.6	40.8	9.4	14.2	23.4
C18:2 n-6	15.7	17.4	16.1	35.2	8.2	12.4	17.9
C18:3 n-3	12.8	3.3	1.8	4.5	0.7	1.4	5.1
C20:4 n-6 (AA)	0.2	0.3	0.1	0.2	-	0.2	0.2
C20:5n-3 (EPA)	0.2	0.1	-	-	-	-	0.07
Σn-6/Σn-3 PUFA	1.2	5.2	9.3	7.9	11.9	9.0	3.5

TABLE 4

Fatty acid composition (% total FA) of lipids from breast muscle of broilers fed diets with various supplemental fat

Fatty acids	Group no/source of added fat						
	1 linseed lard	2 rape seed lard	3 tallow soya oil	4 soya oil	5 tallow	6 lard	7 rape seed oil
Σ SFA	29.5	27.6	34.3	32.1	34.9	31.4	22.8
Σ MUFA	35.7	40.5	36.9	27.1	46.1	49.4	47.8
Σ PUFA	34.8	31.9	28.7	40.8	18.9	19.2	29.4
C18:2 n-6	16.0	17.9	17.7	28.1	11.9	13.3	16.6
C18:3 n-3	7.0	2.1	1.1	2.2	0.5	2.2	3.6
C20:4 n-6 (AA)	2.2	4.8	4.3	4.6	2.8	3.2	4.0
C20:5n-3 (EPA)	1.9	0.7	0.4	0.2	0.4	0.4	0.6
C22:6n-3(DHA)	2.4	2.0	0.9	0.7	0.5	0.7	1.7
Σn-6/Σn-3 PUFA	1.6	4.7	8.4	9.0	10.3	8.4	2.8

## DISCUSSION

Altering dietary fatty acid profile affected the fatty acid profile of structural and storage lipids of broiler chickens. The levels of the predominate fatty acid of each dietary fat were elevated in both tissues (Tables 3 and 4). However, in contrary to the findings of Yau et al. (1991) the shift in SFA /MUFA proportion in both tissues due to the intake of highly saturated fat from tallow and lard containing diets was not as great as might be expected. In the diets with tallow and lard this proportion was 1.54 and 1.28, in birds fed respective diets it was 0.59 and 0.54 in adipose tissue, 0.76 and 0.63 in breast muscle, respectively. In the diets with linseed and rape seed oil SFA/MUFA proportion was 0.8 and 0.15, in birds fed respective diets it was 0.55 and 0.31 in adipose tissue, 0.82 and 0.48 in breast muscle, respectively. It indicates on the ability of the chickens to keep this proportion relatively steady. The process of desaturation of absorbed fat is however limited and may lead only to FA with one double bond.

The deposition of linoleic (C 18:2n-6) and  $\alpha$ -linolenic (C 18:3n-3) acids in adipose and breast tissues was more correlated with their content in the feed. From dietetic standpoint not only the amount of both above mentioned FA, but also the amount of FA of 20 and more carbon in the chain of both families [especially AA (C20:4n-6), EPA (C20:5n-3) and DHA (C22:6n-3)] is important, as well as the proportion of total n-6/n-3 PUFA (Leskanich and Noble, 1997). The proportion of AA, EPA and DHA found in adipose tissue were very small or negligible, in the breast tissue they were higher. Shift in the proportion of AA/sum of EPA and DHA in breast muscle lipids responded to the proportion of their precursors, linoleic and  $\alpha$ -linolenic acid in the diet. Birds fed diet with tallow deposited fat of lowest total PUFA and  $\alpha$ -linolenic acid content, and had the low proportion of AA, EPA and DHA in breast lipids. The big surplus of linoleic over  $\alpha$ -linolenic acid in diets was reflected not only in proportion of these acids deposited in adipose and breast tissues, but also affected negatively the proportion of EPA and DHA in breast muscles and the proportion of total n-6/n-3 PUFA, which in birds fed diet with soya oil averages 7.9 and 9.0, respectively. The proportion of total n-6/n-3 PUFA in food products, fulfilling the demands of health-conscious consumers, should average from 1 to 5, so from dietetic standpoint the best fat supplement to broiler diets were the mixture of linseed and lard, followed by rape seed oil and the mixture of full-fat rape seed and lard.

The results of the experiments indicate, that animal fat, supplemented with full-fat rape and linseeds may be recommended as a source of energy in broiler chicken diets.

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## STRESZCZENIE

**Wpływ tłuszczu diety na skład kwasów tłuszczowych lipidów mięśni piersiowych i tłuszczu brzuszno kurcząt brojlerów**

Oznaczono skład kwasów tłuszczowych (FA) w tłuszczu brzuszno i mięśni piersiowo kurcząt brojlerów, żywionych od 8 dnia życia do uboju dietami pszenno-sojowymi różniącymi się rodzajem dodawanego tłuszczu. Użyto następujących tłuszczów lub źródeł tłuszczu: łój wołowy, smalec, olej sojowy, olej rzepakowy lub mieszanina łoju i oleju sojowego, nasion lnu i smalcu, nasion rzepaku i smalcu. Skład FA w dietach wpływał na profil FA oraz stosunek n-6/n-3 PUFA w lipidach kurcząt. Uzupelnianie diety lojem wołowym spowodowało największy nadmiar n-6 nad n-3 PUFA w lipidach tłuszczu brzuszno i mięśni piersiowych kurcząt (odpowiednio 11,9 i 10,3). Proporcja n-6/n-3 PUFA w lipidach tłuszczu brzuszno i mięśni piersiowych kurcząt żywionych dietą zawierającą pełnotłuste nasiona lnu i smalec wynosiła odpowiednio 1,2 i 1,6 i była najbardziej zbliżona do proporcji tych FA zalecanych w żywieniu ludzi.