Effect of dietary fat type on fatty acids profile of muscles and liver in female and male broiler (Ross-308)

H. A. Mohammed†, E. Horniaková

Department of Animal Nutrition, Faculty of Agrobiology and Food Resources, Slovak University of Agriculture in Nitra, Slovakia

SUMMARY

Fat feeding, through saturated fat (SF) and unsaturated fat (USF) in broiler reflects on the composition of muscles meat and liver. The objective of this study to find the reflection of the dietary type fat on fatty acids profile in main carcass muscles and liver for both sex of broiler strain (Ross-308). The experiment was done on one-day old (two genders) of 50 birds in four groups C, T1, T2 and T3. The fattening was 42 days in length, consisting of pre-starter (7 days), starter (9 days), grower (17 days) and finisher (5 days) periods. Treatments were C group (5% packed fat), and T1 (2.5 % packed fat +2.5% sunflower oil), T2 (2.5% packed fat +2.5% rapeseed oil), T3 (2.5% packed fat +1.25 rapeseed +1.25% sunflower oil). There were significant differences ($P<0.01$) among groups about percentage saturated fatty acids (SFA) and unsaturated fatty acids (USFA) in breast, thigh muscles and liver. The general result pointed to in female breast muscle, best value were in group T3 for UFA/SFA, PUFA/MUFA and MUFA/ SFA are 1.62, 0.019 and 1.59 respectively, for male breast best value for the same data were in C (1.06), T2 (0.02) and C (1.06) respectively. In female high for the same parameter, best value were in T1 (1.15), T2 (0.008) and T1 (1.148) respectively, for male were in T1 (0.92), T3 (0.023) and C (0.92) respectively. For liver parameters best value found for female in C (1.04), T3 (0.024), and C (1.030), while for liver male were in T3 (1.69), T2 (0.02) and T3 (1.66) respectively.

Keywords: broiler meat, n-3/n-6 fatty acids, human health

INTRODUCTION

Potentially one of the most important fields of study in animal nutrition is fat feeding and fatty acid composition of product. This information is mainly of value because of an imbalance in the human dietary intake of various types of fatty acids (Simopoulus, 1989). There is much interest in the relative merits of

† Corresponding author e-mail: mohammedhassan335@gmail.com

monounsaturated, n-6 polyunsaturated and n-3 polyunsaturated fatty acids (PUFA) in human nutrition and their role in protecting the human body against cardiovascular related diseases (Wiseman, 1997). Several sources of information suggest that man evolved on a diet with a ratio of n-6 to n-3 fatty acids of ~1, whereas today this ratio is ~10:1 to 20-25:1 (Simopoulus, 1991). This suggests that Western diets are deficient in n-3 fatty acids compared with the diet on which humans evolved and their genetic parameters were established. It is thus important for human health to increase the consumption of n-3 fatty acids. Dietary fatty acids are absorbed by monogastric animals and deposited in their tissues without significant modification. There is, therefore, considerable potential for the manipulation of the fatty acid profiles of poultry tissue by dietary means, thus to increase the supply of n-3 PUFA suitable for human consumption.

Ajuyah et al. (1991) and Barlow et al. (1990) showed that the use of linseed oil or whole linseed in poultry diets resulted in tissue enrichment of n-3 PUFA (C20:5n-3 and C22:6n-3) derived from C18:3n-3 by desideration. Hulan et al. (1989) indicated that marine oils and fish meal containing residual lipid increased the C20 and C22 n-3 PUFA concentration of poultry tissue. Poultry meat, as is the case in the rest of the meat of farm animals is composed of carbohydrates, fats, vitamins, enzymes, minerals and water. The value of poultry meat from the biological standpoint is very high, and is determined by the relationship between proteins with high nutrient value to lowland protein value, in poultry 1:13, in cattle 1:4.3. This is reflected in the representation of proteins (Mahmoud, 1988). Interest in dietary fat and coronary heart disease CHD was centered primarily on SFA and PSFA until 1985, when Banni and Martin (1998) reported, that MSFA, namely oleic acid, were as effective as PUFA in reducing plasma total and low density levels LDL cholesterol. These observations coincided with the relatively low incidence of CHD observed among populations consuming the so-called “Mediterranean diet,” which is characterized by a high intake of fat but primarily from olive oil (Abbey et al., 1993).

The fatty acid profile of the different tissues reflected dietary fatty acid profiles. MUSFA were higher in abdominal fat, whereas PUSFA were higher in muscle fat. These results suggest that PSFA produced lower abdominal fat deposition than SFA or MUSFA. Wiseman (1984) reported that if diets containing PUFA result in more fat absorption, it could be presumed that USFA may lead to higher energy absorption than diets containing SFA. Thus, the primary measure for lowering cholesterol and other secondary risk factors in the bloodstream is to stabilize the artery walls and, thereby, decrease the metabolic demand for increased production of these risk factors in the liver. Therefore, it is not surprising that Dr. Rath’s Cellular Health recommendations

help to stabilize the artery walls and, at the same time, help to decrease blood levels of cholesterol and other risk factors naturally (Rath, 1993).

The aim of our study was to compare the effect of type of fat on fatty acids profile in breast and thigh muscles as well as liver in both gender of broiler (Ross308).

MATERIAL AND METHODS

Birds and management

Broiler chickens were kept under the Ross recommended procedure. Water and rations were distributed *ad libitum* and uniform light was provided 24 hours daily. The temperatures of the house and vaccination programmed were applied as suggested by the company Microclimate indicators in the range of temperature and humidity were measured and recorded three times a day, at 7.00 am, 12.00 and 17.00 pm. Measurement indicated in the zone of animals, in the height from the floor, where the largest part of the body of animals.

Experimental intervention

Birds were assigned randomly to 1 of 5 dietary treatments. At the first group (C) added only 5% packed fat in their feed mixtures, in the second group (T1) added (2.5% sunflower oil + 2.5% Packed fat), in third group (T2) added (2.5% rapeseed oil +2.5% Packed fat), and in the fourth group (T3) added(2.5% Packed fat + 1.25% sunflower oil +1.25% rapeseed oil).

All other feed ingredients, mineral feed premixes and additives will be used in the same batch in all groups in the production of each type of complete feed mixtures.

Fatty acids methyl esters (FAME) determination

We obtained 5g of the sample of each main muscles parts as well as liver for determination of fatty acid by petroleum ether then trans-methylated with methanol HCl. The FAME were analysed by Agilent 6890N (Agilent Technologies, USA) gas chromatography equipped with flame ionization detector (FID) and fitted with a fused silica capillary column (30m x0.53mm i. d. and µm of RTX 225). ISO/ TS 17764-2 (2002) standard method was applied. Column temperature was programmed at 8^{o}C /min from 96 to 200^{o}C. Injected and detector temperatures were 240 and 250^{o}C, respectively. The carrier gases were hydrogen (45 ml/min) and air (30 ml.min^{-1}; 20% V/V O_2). The makeup gas was helium (25ml.min^{-1}). The split used was 1:100. Peak areas were determined by Agilent Chem Station (Agilent Technologies, USA) and FAME identification was done by comparison with retention times of the known

standards from Sigma (USA). Data were calculated using normalized peak area percentages of fatty acids. Fatty acids content of diet were observed in tables 1. 2, 3, 4, 5, and 6.

Table 1: Fatty acid composition of diets during pre-starter and starter periods

Fatty acids	Groups			
	C	T1	T2	T3
% of crud fat in pre-starter period				
Lauric / C12: 0	0.12±005 ^{b}	0.11±0.01^{b}	0.12±0.01^{b}	0.08±0.003^{a}
Myristic/C14:0	1.04±0.01^{c}	0.77±0.01^{b}	0.99±0.02^{b}	1.01±0.01^{b}
Palmatic/C16:0	38.03±0.30^{c}	34.88±0.44^{b}	36.12±0.81^{bc}	30.14±1.70 ^{a}
Palmitolic/C16:7	8.27±0.28 ^{a}	10.97±0.10^{b}	8.66±0.67 ^{a}	9.13±0.51 ^{a}
Stearic/C18:9	42.31±0.22^{b}	14.24±0.64^{a}	42.38±0.17^{b}	42.00±0.09^{b}
Oleic/C18:9	8.51±0.17 ^{a}	11.16±0.94^{b}	9.29±0.29 ^{a}	8.96±0.69 ^{a}
Linoleic/C18:6	17.43±2.01	14.72±0.12	16.83±1.72	17.57±0.46
Linolenic/ C18:6,9	0.02±0.01 ^{a}	0.10±0.01 ^{a}	0.75±0.08^{b}	0.80±0.04^{b}
Arachidic/C20:0	0.47±0.03	0.51±0.01	0.57±0.15	0.52±0.01
Arachidonic/C20:5,8,11,14	0.10±0.01 ^{b}	0.09±0.01 ^{b}	0.06±0.02 ^{b}	0.001±0.04^{a}
Behenic/C22:0	0.92±0.01^{b}	0.97±0.04^{b}	0.85±0.03^{a}	0.85±0.03^{a}
% of crude fat in starter period				
Lauric / C12: 0	0.16±0.004^{b}	0.14±0.01^{b}	0.15±0.01^{b}	0.11±0.003^{a}
Myristic/C14:0	0.96±0.01^{c}	0.68±0.01^{b}	0.90±0.02^{bc}	0.92±0.01^{a}
Palmatic/C16:0	29.45±0.30 ^{c}	26.30±0.44 ^{b}	27.53±0.81^{bc}	21.55±1.70 ^{a}
Palmitolic/C16:7	8.58±0.28 ^{a}	11.26±0.10^{b}	8.96±0.67 ^{a}	9.43±0.51 ^{a}
Stearic/C18:9	26.69±0.22^{b}	25.62±0.64^{a}	26.73±0.17^{b}	26.38±0.09^{b}
Oleic/C18:9	17.77±0.17^{a}	20.42±0.94^{b}	18.54±0.29^{a}	18.22±0.69^{a}
Linoleic/C18:6	32.78±2.01	30.07±0.12	32.18±1.71	32.92±0.46
Linolenic/ C18:6,9	0.52±0.004^{a}	0.59±0.01 ^{a}	1.24±0.08 ^{b}	1.29±0.04 ^{b}
Arachidic/C20:0	0.38±0.03	0.42±0.005	0.50±0.19	0.44±0.005
Arachidonic/C20:5,8,11,14	0.12±0.005^{b}	0.11±0.005^{b}	0.08±0.03 ^{b}	0.03±0.03 ^{a}
Behenic/C22:0	0.35±0.01^{b}	0.40±0.03^{b}	0.29±0.03^{a}	0.24±0.02^{a}

Table 2: Calculation of different profiles of the fatty acids in experimental groups of pre-starter diet period

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	81.73	34.33	0.42	34.21	0.12	0.004	0.42
T1	77.60	37.04	0.48	36.85	0.19	0.005	0.47
T2	79.92	35.59	0.45	34.78	0.81	0.023	0.44
T3	73.51	36.46	0.50	35.66	0.80	0.022	0.49

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

Table 3: Calculation of different profiles of the fatty acids in experimental groups of starter diet period

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	56.87	59.77	1.05	59.13	0.64	0.011	1.040
T1	52.74	62.45	1.18	61.75	0.7	0.011	1.171
T2	55.05	61	1.11	59.68	1.32	0.022	1.084
T3	48.61	61.89	1.27	60.57	1.32	0.022	1.246

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

Table 4: Fatty acid composition of diets during grower and finisher periods

Fatty acids	Groups			
	C	T1	T2	T3
% of crud fat in pre-starter period				
Lauric / C12: 0	0.11±0.02^{a}	0.12±0.01^{b}	0.12±0.01^{b}	0.09±0.002^{a}
Myristic/C14:0	0.74±0.01^{c}	0.46±0.01^{a}	0.69±0.02^{b}	0.70±0.01^{b}
Palmatic/C16:0	12.44±0.30^{c}	36.29±0.44^{b}	37.53±0.81^{bc}	31.55±1.70^{a}
Palmitolic/C16:7	9.28±0.28^{a}	11.96±0.67^{b}	9.66±0.67^{a}	10.13±0.51^{a}
Stearic/C18:9	45.19±0.22^{b}	44.122±0.64^{a}	45.24±0.17^{b}	44.88±0.09^{b}
Oleic/C18:9	7.64±0.17^{a}	10.30±0.94^{b}	8.42±0.29^{a}	8.10±0.69^{a}
Linoleic/C18:6	13.10±1.84	11.90±0.12	14.01±1.72	14.75±0.46
Linolenic/ C18:6,9	0.02±0.004^{a}	0.10±0.01^{a}	0.75±0.08^{b}	0.79±0.04^{b}
Arachidic/C20:0	0.49±0.04	0.52±0.005	0.58±0.14	0.54±0.01
Arachidonic/C20:5,8,11,14	0.12±0.03^{b}	0.12±0.01^{b}	0.09±0.03^{ab}	0.04±0.03^{a}
Behenic/C22:0	0.37±0.08^{ab}	0.45±0.04^{b}	0.33±0.03^{a}	0.28±0.02^{a}
% of crude fat in starter period				
Lauric / C12: 0	0.16±0.004^{b}	0.14±0.01^{b}	0.15±0.01^{b}	0.11±0.003^{a}
Myristic/C14:0	0.75±0.01^{c}	0.47±0.01^{a}	0.70±0.02^{b}	0.71±0.01^{b}
Palmatic/C16:0	38.47±0.30^{c}	35.32±0.44^{b}	36.56±0.81^{ab}	36.57±1.70^{a}
Palmitolic/C16:7	9.01±0.28^{a}	11.70±0.10^{b}	9.12±0.67^{a}	9.87±0.51^{a}
Stearic/C18:9	35.15±5.36	34.97±4.98	35.08±5.20	35.02±5.09
Oleic/C18:9	42.35±0.17^{a}	45.00±0.94^{b}	43.13±0.29^{a}	42.80±0.69^{a}
Linoleic/C18:6	17.47±2.01	14.76±0.12	16.87±1.72	17.61±0.46
Linolenic/ C18:6,9	0.03±0.004^{a}	0.11±0.01^{a}	0.76±0.08^{b}	0.80±0.04^{b}
Arachidic/C20:0	0.52±0.03	0.56±0.005	0.52±0.03	0.57±0.005
Arachidonic/C20:5,8,11,14	0.10±0.005^{b}	0.09±0.005^{b}	0.06±0.02^{b}	0.01±0.04^{a}
Behenic/C22:0	0.33±0.005^{b}	0.38±0.04^{b}	0.26±0.03^{a}	0.22±0.02^{a}

Table 5 Calculation of different profiles of the fatty acids in experimental groups of grower diet period

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	85.49	30.16	0.35	30.02	0.14	0.005	0.351
T1	81.382	34.38	0.42	34.16	0.22	0.006	0.420
T2	83.68	32.93	0.12	32.09	0.84	0.026	0.383
T3	77.25	33.81	0.44	32.98	0.83	0.025	0.427

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

Table 6. Calculation of different profiles of the fatty acids in experimental groups of finisher diet period

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	75.386	68.966	0.91	68.828	0.139	0.002	0.913
T1	71.844	71.653	1.00	71.45	0.203	0.003	0.995
T2	73.261	70.206	0.96	69.385	0.821	0.012	0.947
T3	67.215	71.092	1.06	70.278	0.814	0.012	1.046

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

Statistical analysis

Data were subjected to ANOVA procedures and the significance of differences among the means estimated using Duncan test (Duncan's new multiple range test). Probability level of $P<0.01$ was considered for significance in all comparisons. Values in percentage were subjected to transformation of Arc sin v100. All statistical analyses were performed using the software SPSS 17.5 for Windows® (SPSS Inc., Chicago, IL).

RESULTS AND DISCUSSION

It is widely accepted that dietary manipulation, especially dietary lipid modifications, can alter lipid composition of different tissues of animals (Mourot and Hermier, 2001).

Effect of diets on the fatty acid profile of breast muscle

Fatty acids have three major physiological roles; first, they are building blocks of phospholipids and glycolipids. These amphipathic molecules are important components of biological membrane. Second, fatty acid derivatives serve as hormones, and intracellular messengers. Third, fatty acids are fuel molecules. They are stored as triacylglycerols, which are uncharged esters of glycerol (Stryer, 1988). Animals are unable to convert fatty acids into glucose. Specially, acetyl CoA cannot be converted into pyruvate or oxaloacetate

In monogastric animals the fatty acid composition of the tissues will reflect that of the diet (Lands et al., 1990). The effect of treatments on fatty acid profile in breast meat showed in table 7.

Table 7. The effects of diets on fatty acid compositions of breasts muscle in experimental for both sexes' broilers

Fatty acids	Groups*			
	C	T1	T2	T3
Fatty acid composition (% of total FA) in female				
Lauric / C12: 0	0.09±0.01^{c}	0.06±0.02^{ab}	0.08±0.01^{b}	0.04±0.01^{a}
Myristic/C14:0	0.74±0.05^{c}	0.46±0.06^{a}	0.68±0.13^{b}	0.52±0.11^{ab}
Palmatic/C16:0	33.88±3.65^{b}	30.37±1.23^{ab}	31.13±2.06^{ab}	27.20±2.81^{a}
Palmitolic/C16:7	14.6±0.23^{a}	17.40±1539^{c}	15.50±0.18^{b}	15.52±0.18^{b}
Stearic/C18:9	10.71±0.96	9.96±1.60	10.40±0.78	10.18±0.66
Oleic/C18:9	25.50±0.18^{a}	28.5±0.18^{c}	26.00±0.48^{ab}	26.32±0.28^{b}
Linoleic/C18:6	18.20±0.77^{b}	15.35±0.21^{a}	17.93±1.29^{b}	18.58±0.39^{b}
Linolenic/ C18:6,9	0.05±0.02^{a}	0.12±0.06^{a}	0.78±0.10^{b}	0.80±0.05^{b}
Arachidic/C20:0	0.02±0.01^{a}	0.07±0.02^{b}	0.08±0.01^{b}	0.06±0.01^{b}
Arachidonic/C20:5,8,11,14	0.38±0.07	0.38±0.13	0.34±0.05	0.32±0.07
Behenic/C22:0	0.13±0.03	0.20±0.24	0.07±0.01	0.03±0.01
Fatty acid composition (% of total FA) in males				
Lauric / C12: 0	0.13±0.03	0.16±0.04	0.14±018	0.88±0.1
Myristic/C14:0	0.85±0.05c	0.56±0.07a	0.76±0.05bc	0.62±0.13ab
Palmatic/C16:0	34.50±1.29	33.00±0.82	30.40±4.47	29.35±3.05
Palmitolic/C16:7	17.60±9.08	13.85±2.34	12.03±1.41	10.07±2.66
Stearic/C18:9	16.06±0.04c	16.34±1.06c	14.68±0.17b	12.12±0.12a
Oleic/C18:9	20.35±0.53a	23.04±1.42b	21.89±0.62ab	21.10±0.43 b
Linoleic/C18:6	15.55±0.17c	14.57±0.37b	12.40±0.12b	10.58±0.22a
Linolenic/ C18:6,9	0.18±0.01a	0.18±0.15a	0.57±0.09b	0.64±0.03b
Arachidic/C20:0	0.02±0.02	0.06±0.03	0.06±0.02	0.03±0.03
Arachidonic/C20:5,8,11,14	0.23±0.02	0.22±0.04	0.25±0.04	0.27±0.04
Behenic/C22:0	0.10±0.01ab	0.15±0.02 b	0.10±0.39ab	0.04±0.03 a

a,b means with different superscript within row are significantly different (P< 0.01). *Values are $\bar{x}$ ± Std. Deviation of 50 chickens.* C: 5% Packed fat; T1: 2.5% sunflower oil + 2.5% Packed fat T2: 2.5% rapeseed oil + 2.5% Packed fat; and T3: 2.5% packed fat + 1.25% sunflower oil + 1.25% rapeseed oil

In female broilers there were significant (P<0.01) effects of diets on this parameter in general for chicks, with exception for steric, arachidonic and behenic acids, which showed insignificant (P>0.01) effects. Dietary fatty acids are absorbed by monogastric animals and deposited in their tissues without significant modification. There were, therefore, considerable potential for the manipulation of the fatty acid profiles of poultry tissue by dietary means, thus to increase the supply of n-3 PUFA suitable for human consumption (Coetzee

and Hoffman, 2002). Lauric acid increased with including of SF, but reduced with high level of USF. Myristic acid reduced in all experimental groups compared with group control. This is meaning the non-reduction in saturated fatty acids, which conceder as positive influence on breast meat quality. Palmitic acid tended to significant ($P<0.01$) decrease by mixing with USF and blend of T3 (27.20%), but increased significantly by including SF in the diet. The highest value was in C group (33.88%) for total FA. Palmitoleic acid (omega-7 monounsaturated fatty acid) higher retention in the breast muscle was found in groups T1. Stearic acid (octadecanoic acid; C: 18) reduced dramatically by increasing of USF compared to control, but the difference between C and other treatment was just tendencies ($P<0.05$). This could be due the synergism between SF and USF phytochemicals.

Oleic acid tended to increase by supplementation of USF in feed broiler diet, a significant difference was observed among C and all treatments. This is could be attributed to the high level of oleic acid in the USF, which means high availability in the diet compared to other groups (tables 8 and 9). Linoleic acid (omega-6 fatty acid) decreased by mixing SF with USF in the diet. In the point of view of the bird's health, decrease in omega 6 fatty acids has been shown to attenuate inflammation due to reduced production of eicosanoids (Kinsella et al., 1990). On the other hand T3 had higher level than C, in the point of view of human nutrition had positive point, as the benefit of unsaturated fatty acids for human health. Including USF and blend of differs level mixing of USF (T3) increased the level of linolenic acid in the breast muscle. Equal levels of SF and USF in the diet tended to reduce the level of linolenic acid in the breast muscle of broiler chicken. Supplemented packed fat lowered arachidic acid level in the breast compared among C group (0.02%) with other treatments. While tended to increase arachidonic acid level. The higher value obtained in C and T1 group (0.38%) compared to other groups. Behenic acid increased in the breast muscle by equal level of packed fat and rapeseed oil. The higher value was in T1 group (0.20%). The total unsaturated fatty acids percentages are higher in experimental groups (table 8).

Table 8. Calculation of different profiles of the fatty acids in experimental groups of female breast's muscle

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	45.55	58.73	1.29	58.3	0.43	0.007	1.28
T1	41.12	61.75	1.50	61.25	0.50	0.008	1.49
T2	42.44	60.55	1.43	59.43	1.12	0.018	1.40
T3	38.03	61.54	1.62	60.42	1.12	0.019	1.59

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

Compared to the C group (58.73%), this is means in the point of view of human health, the better quality of the fat included in the breast meat even the fat content in the breast is higher in groups consumed diets mixing SF with USF. Higher concentrations of polyunsaturated and lower content of monounsaturated fatty acid were found in chickens received T1 and C groups (61.75%, 58.3%) respectively.

From table 9) it appears that the total unsaturated fatty acids percentages are higher in experimental groups compared to the C group, this is means, in the point of view of human health, the better quality of the fat included in the breast meat even the fat content in the breast is higher in groups consumed diets mixing SF with USF. Higher concentrations of polyunsaturated and lower content of monounsaturated fatty acid were found in chickens received T3 (0.91%) and T2 (0.82%) respectively.

In male broilers, Table 7 observed results of analysis fatty acids that Lauric acid increased with including of mixing different type of fat SF and USF as in T3 (0.88%), but reduced with high level of USF as inT2 and T1 (0.14%, 0.16%) respectively and only using SF as in T1 (0.13%) .This can be attributing type of muscle for accumulation this type of fatty acids.

Myristic acid reduced in all experimental groups compared with group control (0.85%). This is meaning the non-reduction in saturated fatty acids, which conceder as positive influence on breast meat quality. Palmitic acid tended to significant ($P<0.01$) decrease by mixing with USF and blend of T3 (29.35%), but increased significantly by including SF in the diet. The highest value was in C group (34.50%) for total FA. Palmitoleic acid (omega-7 monounsaturated fatty acid) higher retention in the breast muscle was found in group C (17.60%) even insignificance ($P>0.01$) just arithmetical differs. Stearic acid (octadecanoic acid; C: 18) reduced dramatically by increasing of USF compared to control, but the difference between C (16.06%) and T1 (16.34%) was just tendencies ($P>0.01$). This could be due the synergism between SF and USF phytochemicals.

Oleic acid tended to increase by supplementation proportion of USF in feed broiler diet, a significant difference was observed among C (20.35%) and all treatments. This is could be attributed to the high level of oleic acid in the USF, which means high availability in the diet compared to other groups (Tables 7 and 9). Linoleic acid (omega-6 fatty acid) increased by mixing SF with USF in the diet which used sunflower oil 2.5% in T2 (0.57%) and in T3 (0.64%). In the point of view of the bird's health, decrease in omega 6 fatty acids has been shown to attenuate inflammation due to reduced production of eicosanoids (Kinsella et al., 1990). On the other hand T3 had higher level than C, in the point of view of human nutrition had positive point, as the benefit of unsaturated fatty acids for human health. Including USF and blend of differs

level mixing of USF (T3) increased the level of linolenic acid in the breast muscle. Equal levels of SF and USF in the diet tended to reduce the level of linolenic acid in the breast muscle of broiler chicken.

Table 9: calculation of different profiles of the fatty acids in experimental groups of male breast's muscle

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	50.68	53.91	1.06	53.5	0.41	0.01	1.06
T1	49.55	51.86	1.05	51.46	0.4	0.01	1.04
T2	45.24	47.14	1.04	46.32	0.82	0.02	1.02
T3	41.54	42.66	1.03	41.75	0.91	0.02	1.01

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

Supplemented packed fat lowered arachidic acid level in the breast compared among C group (0.02%) with other treatments. While tended to increase arachidonic acid level. The higher value obtained in T3 (0.27%) and T2 (0.25%) group compared to other groups. Behenic acid increased in the breast muscle by equal level of packed fat and rapeseed oil. The higher value was in T1 group (0.15%). From (Table 9) it appears that the total unsaturated fatty acids percentages are higher in experimental groups compared to the C group, this is means, in the point of view of human health, the better quality of the fat included in the breast meat even the fat content in the breast is higher in groups consumed diets mixing SF with USF. Higher concentrations of polyunsaturated and lower content of monounsaturated fatty acid were found in chickens received T3 (0.91%) and T2 (0.82%) respectively.

Effect of diets on the fatty acids profile of thigh muscle

In the female, the effect of treatment on fatty acids profile on thigh muscle observed in Tables 10 and 11. In general there were significant differences ($P<0.01$) for most of fatty acids, nevertheless there were insignificant differences ($P>0.01$) for lauric, palmitoleic and arachidonic acids. There were tendencies differs among treatments for lauric acid (Table 10).

The higher value was in T2 (0.12 %) followed by C (0.10%), T1 (0.10%) and T3 (0.06%). Myristic acid was high light in group C (0.78 %) higher value than other groups.

Palmitic also higher value was in group C (33.55 %). This is due to type of SF which diet content. Although there were insignificant for palmitoleic but high value was in treatment which content high percentage of USF in T1 (15.65%). Stearic acid was partly equal in group T1 and C groups (15.90%, 15.25%) respectively and higher than other treatments.

Table 10: The effects of diets on fatty acid compositions of thigh's muscle in experimental for both sexes' broilers.

Fatty acids	Groups*			
	C	T1	T2	T3
Fatty acid composition (% of total FA) in female				
Lauric / C12: 0	0.10±0.06	0.10±0.02	0.12±0.01	0.06±0.01
Myristic/C14:0	0.78±0.20c	0.51±0.03a	0.73±0.04bc	0.63±0.12ab
Palmatic/C16:0	33.55±0.47b	31.23±0.80b	32.19±0.19b	27.80±2.45a
Palmitolic/C16:7	15.13±0.36	15.65±2.43	13.30±1.50	11.83±2.49
Stearic/C18:9	15.25±0.13bc	15.90±1.20 c	14.30±0.08 b	11.15±0.21 a
Oleic/C18:9	20.48±1.17a	24.50±2.17b	21.30±0.14a	20.83±0.88a
Linoleic/C18:6	15.23±0.13c	14.22±0.26b	13.30±0.48a	12.73±0.28a
Linolenic/ C18:6,9	0.04±0.01a	0.12±0.22a	0.76±0.01b	0.85±0.12b
Arachidic/C20:0	0.01±0.004a	0.05±0.007ab	0.07±0.02 b	0.04±0.04ab
Arachidonic/C20:5,8,11,14	0.30±0.01	0.26±0.03	0.29±0.01	0.29±0.02
Behenic/C22:0	0.12±0.01bc	0.17±0.02 c	0.08±0.04ab	0.03±0.03 a
Fatty acid composition (% of total FA) in males				
Lauric / C12: 0	0.17±0.03	0.18±0.04	0.16±0.18	0.10±0.01
Myristic/C14:0	0.88±0.05c	0.59±0.07a	0.79±0.04bc	0.64±0.11ab
Palmatic/C16:0	35.50±1.29	34.00±0.82	31.40±4.47	30.10±3.48
Palmitolic/C16:7	10.60±9.08	12.85±2.34	11.03±1.41	9.32±3.48
Stearic/C18:9	16.56±0.04c	16.84±1.06c	15.18±0.17b	12.50±0.33a
Oleic/C18:9	18.35±0.53a	21.04±1.42b	19.89±0.62ab	19.60±1.31ab
Linoleic/C18:6	13.55±0.17c	12.57±0.37c	10.40±0.12b	9.08±0.83a
Linolenic/ C18:6,9	0.01±0.01a	0.17±0.15 a	0.59±0.09 b	0.63±0.03 b
Arachidic/C20:0	0.04±0.01	0.08±0.03	0.78±0.02	0.04±0.02
Arachidonic/C20:5,8,11,14	0.19±0.02	0.18±0.04	0.21±0.04	0.24±0.05
Behenic/C22:0	0.8±0.02b	0.23±0.02b	0.18±0.04b	0.12±0.05a

a,b means with different superscript within row are significantly different (P< 0.01). *Values are $\bar{x}$ ± Std. Deviation of 50 chickens.* C: 5%Packed fat; T1: 2.5% sunflower oil + 2.5% Packed fat T2: 2.5% rapeseed oil + 2.5% Packed fat; and T3: 2.5% packed fat + 1.25% sunflower oil + 1.25% rapeseed oil

It was clear that oleic acid was higher in treatment which included high percentage of USF and type rapeseed in group T1 (24.22 %). Linoleic is one type of USFA so was high in diet of group C (17.43%) in pre-starter period, (32.78%) in starter period, (13.10%) in grower period and (17.47%) in finisher period which uses just SF in diet feeding. Opposite observed for linolenic in group C was lowest value (0.02%, 0.52%, 0.20% and 0.30) for all periods' consecution (tables 2 and 5). High values with treatment included high percentage of sunflower oil. Even little value for arachidic but increase with mixing of SF with USF by equal proportion as in T1 and T2 (0.07%, 0.08%) respectively.

Nevertheless insignificant for arachidonic acid, but high value was tendencies in groups C and T1 same value (0.38%). Behenic was higher value than in the breast. The high value was in group T1 followed by group C and decrease in mixing more of USF as in group T3. These results agree somewhat with results of Kinsella et al. (1990).

In general total SFA in group C is higher value (48.93%) than other group, while total of USFA in group T1 was higher value (54.68%). This can be attributing to type of fat including in diets of these treatments (Table 11).

Table 11: calculation of different profiles of the fatty acids in experimental groups of female thigh's muscle

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	48.93	51.18	1.05	50.84	0.34	0.007	1.039
T1	47.35	54.68	1.15	54.37	0.31	0.006	1.148
T2	46.64	48.26	1.03	47.9	0.36	0.008	1.027
T3	39.02	45.04	1.15	44.71	0.33	0.007	1.146

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

In the male: the effect of treatment on fatty acids profile on thigh muscle observed in tables (10 and 12). In general there were significant differences ($P<0.01$) for most of fatty acids, nevertheless there were insignificant differences ($P>0.01$) for lauric, palmitic, palmitoleic, arachidic and arachidonic acids. There were tendencies differs among treatments for lauric acid. The higher value was in T1 (0.18%) followed by C (0.17%), T2 (0.16%) and T3 (0.10%). Myristic acid was high light in group C (0.88) higher value than other groups. Palmitic also higher value was in group C (35.50). This is due to type of SF which diet content, [note table 1 in pre-starter (38.03%) and starter (29.45%) periods of diet]. Although there were insignificant for palmitoleic but high value was in treatment which content high percentage of USF in T1 (12.85%). Stearic acid was partly equal in group T1 (16.84%) and C (16.56%) group and higher than other treatments. This is due to content in the diet of pre-starter and starter periods (Table 1) and grower with finisher periods of the diet (Table 4).

Table 12: Calculation of different profiles of the fatty acids in experimental groups of male thigh's muscle

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	52.9	48.7	0.92	48.5	0.2	0.004	0.92
T1	51.15	46.81	0.92	46.46	0.35	0.01	0.91
T2	47.54	42.12	0.89	41.32	0.8	0.02	0.87
T3	42.76	38.87	0.91	38.00	0.87	0.023	0.89

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

It was clear that oleic acid was higher in treatment which included high percentage of USF and type rapeseed in group T1 (24.22), also due to content in all diets periods (Tables 1 and 4).

Linoleic is one type of USFA which include one double bond with a long serious so was higher in diet of group C (13.55%) which similar uses just SF in diet feeding.

Opposite observed for linolenic in group C was lowest value (0.01%) and high value with treatment included high proportion of mixing USFA in T3 (0.63%).

Even little value for arachidic but increase with mixing of SF with USF type sunflower oil in T2(0.78%). Nevertheless insignificant (P>0.01) for arachidonic acid, but high value was tendencies in group T3 (0.24).

Benhenic was higher value than in the breast. The high value was in group T1 (0.23%) followed by group T2 (0.18%) and decrease in mixing more of USF as in group T3 and in C group.

In general total SFA and USF in group C is higher value (52.9%, 48.7%) respectively than other group. This is can be attributed of ability thigh muscle to precipitate of total fat between the tissues muscles.

Effect of diets on the fatty acids profile of liver

An increased production of cholesterol and other repair factors in the liver increases the levels of these molecules in the bloodstream and, over time, renders them risk factors for cardiovascular disease. Thus, the primary measure for lowering cholesterol and other secondary risk factors in the bloodstream is to stabilize the artery walls and, thereby, decrease the metabolic demand for increased production of these risk factors in the liver (Rath, 1993). In females, Tables (13 and 14), there were observed insignificant differences (P>0.01) for lauric, myristic palmitic,oleic, aracidic, arachidonic and behenic acids. On the other hand there were significant differences (P<0.01) for palmitoleic, steric, linoleic and linolinleic acids. Lauric acid have higher value in group T1 (0.13%) followed by group C (0.09%). Myristic in group T3 was higher value (0.61%) followed by group control (0.51). This is may be

attributing for process of liver to convert to cholesterol. Palmitic nevertheless insignificant but tendencies have high value in group C (13.33%) because of SF utilization in this diet of group. Stearic was high light significant in group C (14.44%) which used packed fat ,on the other hand for oleic acid was higher value in group T3 (19.50%) due to mixing differs type and level of USF . Linoleic acid have role for combination of LDL in the liver, high level was in group C (15.23%).

Table 13. The effects of diets on fatty acid compositions of liver in experimental for both sexes' broilers

Fatty acids	Groups*			
	C	T1	T2	T3
Fatty acid composition (% of total FA) in female				
Lauric / C12: 0	0.09±0.04	0.13±0.13	0.04±0.03	0.06±0.05
Myristic/C14:0	0.51±0.12	0.45±0.16	0.43±0.12	0.61±0.16
Palmitic/C16:0	30.25±1.26	30.03±0.68	26.85±4.31	26.00±3.08
Palmitoleic/C16:7	13.33±1.42^{b}	10.98±1.28^{b}	10.18±2.07^{a}	7.69±0.58^{a}
Stearic/C18:9	14.44±0.92^{b}	13.17±0.53^{ab}	11.29±1.37^{a}	11.14±1.36^{a}
Oleic/C18:9	19.27±2.28	19.39±0.84	18.31±0.53	19.50±1.38
Linoleic/C18:6	13.55±0.37^{c}	11.75±1.11^{bc}	9.93±1.02^{ab}	9.20±0.76^{a}
Linolenic/ C18:6,9	0.06±0.06^{a}	0.43±0.25^{b}	0.56±0.08^{b}	0.65±0.02^{b}
Arachidic/C20:0	0.06±0.04	0.08±0.01	0.056±0.03	0.06±0.03
Arachidonic/C20:5,8,11,14	0.20±0.02	0.17±0.03	0.23±0.04	0.24±0.04
Behenic/C22:0	0.07±0.01	0.12±0.02	0.07±0.03	0.06±0.04
Fatty acid composition (% of total FA) in males				
Lauric / C12: 0	0.03±0.04a	0.07±0.01ab	0.10±0.02 b	0.05±0.01ab
Myristic/C14:0	0.77±0.02c	0.52±0.12a	0.67±0.21b	0.52±0.22a
Palmitic/C16:0	34.20±0.82d	30.20±0.14b	32.10±0.64c	26.43±1.04a
Palmitoleic/C16:7	13.98±16.18	16.18±0.22	14.50±1.66	26.43±1.04
Stearic/C18:9	16.43±0.58c	16.18±0.16c	11.20±0.78b	9.07±0.51 a
Oleic/C18:9	26.30±0.14d	22.20±0.18c	19.53±0.26b	20.07±0.03a
Linoleic/C18:6	14.61±1.79	13.06±0.02	14.30±0.95	12.68±0.22
Linolenic/ C18:6,9	0.05±0.01a	0.10±0.01 a	0.80±0.10 b	0.73±0.07 b
Arachidic/C20:0	0.09±0.01b	0.05±0.01a	0.04±0.008a	0.05±0.02 a
Arachidonic/C20:5,8,11,14	0.20±0.01a	0.20±0.01ab	0.27±0.06 bc	0.28±0.01 c
Behenic/C22:0	0.09±0.01	0.11±0.03	0.06±0.09	0.02±0.01

a,b means with different superscript within row are significantly different (P< 0.01). *Values are $\bar{x}$ ± Std. Deviation of 50 chickens.* C: 5% Packed fat; T1: 2.5% sunflower oil + 2.5% Packed fat T2: 2.5% rapeseed oil + 2.5% Packed fat; and T3: 2.5% packed fat + 1.25% sunflower oil + 1.25% rapeseed oil

On the other hand for linolenic which have role for combination of HDL was high value in group T3 (0.85%) which mixing proportions more of USF (Simopoulos, 1989; 1991) This is also due to include diet of the high proportion

of linoleic and low proportion of linolenic acid (tables 2 and 5) Arachidic acid insignificant where there high value in T2 (0.08%). On the other side, arachidonic and behenic was in significant but high value was in group T3 and T2 (0.24%, 0.12%) respectively. These results agree with data obtain by Hulan (1983).

Table 14: Calculation of different profiles of the fatty acids in experimental groups of liver's female

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	44.82	46.41	1.04	46.15	0.26	0.006	1.030
T1	43.4	42.72	0.98	42.12	0.6	0.014	0.971
T2	38.266	39.21	1.02	38.42	0.79	0.021	1.004
T3	37.26	37.28	1.00	36.39	0.89	0.024	0.977

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

In males, Tables 13 and 15, there were insignificant differences (P>0.01) for palmitolic, linoleic, arachidic and behenic acids. On the other hand there were significant differences (P<0.01) for other fatty acids. Lauric acid have higher value in group T2 (0.10%) followed by group T1 (0.07%). This is due to include of diet with high proportion in these groups at all periods (Table 1 and 4). Myristic in group C was higher value (0.77%) followed by group T2 (0.67%). This is may be attributed for process of liver to convert to cholesterol. Palmitolic nevertheless insignificant but mathematical have high value in group C because of SF utilization in this diet of group. Stearic was high light significant in group T3. On the other hand for oleic acid was higher value in group C due to liver function. Linoleic acid have role for combination of LDL in the liver, high level was in group C (14.61%).On the other hand for linolenic which have role for combination of HDL was high value in group T2 (0.80%) which mixing proportion more of USF. Arachidic acid where there high value in C (0.09%).

Table 15: Calculation of different profiles of the fatty acids in experimental groups of liver's male

Groups	Total SFA[1], %	Total UFA[2], %	UFA/SFA	Total MUFA[3], %	Total PUFA[4], %	PUFA/ MUFA	MUFA/ SFA
C	50.81	55.14	1.09	54.89	0.25	0.01	1.08
T1	46.54	51.74	1.11	51.44	0.3	0.01	1.11
T2	43.4	49.4	1.14	48.33	1.07	0.02	1.11
T3	35.57	60.19	1.69	59.18	1.01	0.017	1.66

[1] SFA – saturated fatty acids; [2] MUFA – monounsaturated fatty acids; [3] PUFA – polyunsaturated fatty acids.

CONCLUSIONS

Fatty acid content of the breast meat improved quantitatively and qualitatively by mixing SF with USF in broilers diet. It can be obtained improving value by the mixing equal proportion rapeseed with packed fat. The combination of both alternatives in the diet could be of great interest in future studies. A combination of these mixing different types with different level had a greater effect than when they were used individually. We conclude that there is a possible synergistic effect between SF and USF as a phytochemicals by covering the location of chain carbon from cis to trans also from *Alpha* to *Beta* local these covering lead to more benefit from type of fat to delay in digestive system and that's mean more emulation and increasing of absorption of fatty acids lead to more metabolism of fat.

ACKNOWLEDGEMENTS

This work was financially supported under care of Slovakia Agriculture Ministry and animal nutrition department (Project n. 1/0662/11). Many thanks to the teams of our analysis departments for their accurate and helpful assistance.

REFERENCES

Abbey M, Belling Gb, Noakes M, Hirata F And Nestel PJ. 1993: Am J Clin Nutr 57:391-398.

Ajuyah, A.O- Lee, K.H- Hardin, R.T. - Sim, J.S., 1991. Changes in yield and in the fatty acid composition of whole carcass and selected meat portions of broiler chickens fed full-fat oil seeds. In Journal of Poultry Science. 1991,vol. 70.P. 2304-2314.

Banni S - Martin JC (1998) Conjugated linoleic acid and metabolites. In Trans fatty acids in human nutrition. P. 261- 302 [W Sebedio and W Christie, editors]. Dundee: The Oily Press.

Barlow Sm- Young Fvk - Duthie If (1990) Nutritional recommendations for n-3 polyunsaturated fatty acids and the challenge to the food industry. Proceedings of the Nutrition Society.1990, vol. 49.P. 13-21.

Coetzee, G.J.M. - L.C. Hoffman. 2002: Effects of various dietary n-3/n-6 fatty acid ratios on the performance and body composition of broilers. In: South African Journal of Animal Science, vol. 32, 2002, n. 3, p. 175-184.

Hulan, H.- Wproudfoot, F. G- Nash, D.M. 1983. The effects of different fat sources on general performances and carcass fatty acid composition of broiler chickens. In journal of Poultry Science.1983, vol. 63.P.324–332.

Kinsella, J. E. - B. Lokesh, - R. A. Stone. 1990: Dietary n-3 polyunsaturated fatty acids and amelioration of cardiovascular disease: possible mechanisms. In: American Journal of Clinical Nutrition, vol. 52, 1990, p. 1-28.

Lands, W.E.B. - Morris, A. - Libelt, B. 1990. Quantitative effects of dietary polyunsaturated fats on the composition of fatty acids in rat tissues. In: Lipids, vol. 25, 1990, p. 505-516.

Mahmoud, R. Sadwoon., 1988.Improve and breeding poultry. E1 High Ministry education printer, Baghdad, Iraq.

Mourot J., Hermier D., 2001. Lipids in monogastric animal meat. Reprod Nutr Develop 41, 109-118.

Rath D. (1993): High Cholesterol Levels and Other Secondary Risk Factors for cardiovascular Disease, article Karl Folkers, MD, of the University of Texas at Austin, rang the alarm bells in the Proceedings of the National Academy of Sciences. Stryer, L. 1988. Biosynthesis of Amino Acids and Heme. In "Biochemistry", 3rd ed, W.H. Freeman and Company, New York, p. 575-626.

Simopoulos, A. P. 1989. The future direction of nutrition research: A nutrition and food sciences agency is the key to progress. In Journal of American Institute of Nutrition vol. 119.1989.p.137–139.

Simopoulos, A. P. 1991. Omega-3 fatty acids in health and disease and in growth and development. In Journal of American Clinical. Nutrition, vol.54.1991.p.438–463.

Spss Inc. Armonk, NY - 02 Oct 2009: IBM (NYSE: IBM) announced it has completed its acquisition of SPSS Inc. (Nasdaq: SPSS), a publicly-held company headquartered. In Chicago. IBM announced a definitive agreement to acquire SPSS on July 28, 2009.

Stryer, L. 1988. Biosynthesis of Amino Acids and Heme. In "Biochemistry", 3rd ed, W.H. Freeman and Company, New York, p. 575-626.

Wiseman, J., (1984).Assessment of the digestible and metabolisable energy of fats for nonruminants. In: J. Wiseman (Editor): Fats in animal Nutrition. Butterworths, London, pp. 277-297.

Wiseman, M.J., 1997. Fat and fatty acids in relation to cardiovascular disease: an overview, in British Journal of Nutrition.1997, vol. 78 (Suppl. 1), S3-S4.