EFFECTS OF VEGETABLE AND ANIMAL FAT ENRICHMENT IN BROILER FEED ON CONTENT OF FATTY ACIDS IN WHITE AND RED MEAT

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ABSTRACT

In order to gain a more complete insight into the effects of vegetable and animal fat enrichment in broiler feed on content of fatty acids in meat, an experimental research has been conducted on 240 *Cobb 500*female broilers, divided into four separate treatments of 60 broilers each. The experiment was conducted in the period of 42 days. During that period, the first group of broilers was fed with 3% pork fat enriched feed – treatment 1, second group was fed with 3% soy oil enriched feed – treatment 2, third group with 3% bovine tallow – treatment 3, and fourth group with 3% sunflower oil – treatment 4. The content of fatty acids in red and white broiler meat was determined by the gas chromatography method. The content of saturated fatty acids in the red meat was not of statistical significance ($p>0.05$), the content of monounsaturated fatty acids was of statistical significance ($p<0.05$), while the content of polyunsaturated fatty acids in the red broiler meat was of high statistical significance ($p<0.01$) with reference to the applied feeding treatments. The content of saturated fatty acids in the white meat was not of statistical significance ($p>0.05$), while the content of monounsaturated and polyunsaturated fatty acids in white broiler meat was of high statistical significance ($p<0.01$) with reference to the applied feeding treatments. The n-6/n-3 fatty acids ratio in red broiler meat was determined as follows: treatment 1 - 19.3:1; treatment 2 - 16.0:1; treatment 3 - 20.5:1; treatment 4 - 12.9:1. The n-6/n-3 fatty acids ratio in white broiler meat was: treatment 1 - 20.3:1, treatment 2 –16.1:1, treatment 3 –17.6:1 and treatment 4 –12.2:1.

Keywords: broiler meat, sunflower oil, vegetable fat, animal fat, fatty acids content

INTRODUCTION

Birds generally have a high capacity for lipid biosynthesis (Klasing, 1998) including modern broilers or meat of chickens that have a tendency to accumulation of excess fat. This accumulation of body fat in broiler chickens, which is also an important source of fats in the human diet, has a significant impact on human health.

Many studies connected the selection of chickens with the tendency of reduction of accumulation of triacylglycerol as well as the ability to produce changes in the composition in triacylglycerol due to a modification in the dietary intake of lipids (Leskanich & Noble, 1997). The aim of the current studies was to improve the intake of polyunsaturated fatty acids through diet in order to achieve favorable ratio n-6 fatty acids towards n-3 fatty acids.

Nutritional studies on humans have shown that we can manipulate with composition of body fats with changing of intakes of the polyunsaturated fatty acids towards saturated fatty acids in the diet, especially with intakes of long-chain polyunsaturated fatty acids in the diet (Field at al. 1990, Pan at al. 1994, Luo at al. 1996, Couet at al. 1997). The enrichment of chicken meat with the essential linoleic and linolenic acid is possible when as a food additive sunflower oil and soya oil are used instead of lard (Božić, 1997).

Mehmet et al. (2005) analyzed the effects of different sources of fats such as soybean oil, chicken fat, tallow on fatty acid content of abdominal fats and content of fatty acids in white and red meat in broiler chickens. They found low content of total monounsaturated fatty acids in the white meat in broilers that they were feeding with supplemented soybean oil. Linoleic acid C18: 2n-6 was concentrated in the red meat, in the abdominal fat and in the white meat in broilers that they were feeding with supplemented soybean as well as in the red meat in broilers that they were feeding with supplemented chicken fat. Crespo & Esteve-Garcia (2001) used in the nutrition of female broilers addition of beef tallow, olive oil, sunflower oil and flaxseed oil. Broilers, being were fed with diet adding beef tallow, had high values of saturated acids, mainly of myristic, palmitic and stearic acid as compared to broilers were fed with the addition of olive oil, sunflower oil or linseed oil. They found higher levels of arachidonic acid C20: 4n-6 and of the fatty acids of the n-6 series in broilers that were fed with the addition of sunflower oil, except in abdominal fat. A higher level of eicosapentaenoic acid C 20:5 n-3 and docosahexaenoic acid C22: 6 n - 3 were found in the red and white meat of broiler chickens that were fed with an addition of flaxseed oil, whereas in abdominal fat these fatty acids were not measurable.

Veladžić et al. (2010) determined a statistically significant difference ($p < 0.01$) for the cholesterol content in blood plasma between the observed treatments, therewith the higher cholesterol content was determined for the treatments in which were added animal fats in relation to treatments in which were added vegetable fats.

Kirshgessner at al. (1993) have found the enhancement contents of crude fat in the white meat of broilers which received in their nutrition higher percent of linoleic acid. Chickens fed with low-protein food (18% crude protein) supplemented with the oil enriched with 2% or 4% conjugated linoleic acid had low triglycerides of liver, a relatively high concentration of saturated fatty acids and relatively low concentration of monounsaturated fatty acids in lipids of liver and adipose tissue than chickens fed without the addition of conjugated linoleic acid. Chickens fed with low-protein food without the addition of conjugated linoleic acid had higher concentrations of triglycerides in the liver than chickens fed with high-protein food (23% crude protein) without the addition of conjugated linoleic acid (Aletor et al. 2003).

MATERIAL AND METHODS

The experiment was set up and implemented in the facilities for the production of chicken meat "Koka – Sana" from Sanski Most. Laboratory samples of chicken meat were performed at the Biotechnical Faculty, University of Bihać.
Day-old Cobb 500 broiler hybrid was placed in four separate boxes (treatments), and there were 60 broilers in each of them. All chickens were held on the floor in facilities fitted for broiler breeding. During the experiment, which lasted for 42 days, temperature, humidity and lighting were regularly controlled. Chicken breeding was split in two periods. From day one to day 15, chickens were bred with the initial mixture containing approximately 23% of proteins. From day sixteen to 42, they were bred with the final mixture containing approximately 20% of proteins, so the final mixtures were isoproteinic and isoenergetic. In chickens' nutrition, there was increased content of fats by 3% (treatment I – lard, treatment II – soybean oil, treatment III – tallow, and treatment IV – sunflower oil). The chickens consumed food and water *ad libitum*. Having turned 42 days of life, chickens were marked with rings, for each treatment separately, and after 12 hours of fasting were killed at slaughterhouse facilities.

After slaughter and meat packing processing of chicken carcasses, the carcasses are chilled to a temperature of 0-4 ° C and then frozen at -18 °C until the moment of analysis, and on the day of analysis thawed to room temperature.
We used six broilers per each treatment for the determination of fatty acids in the red and white meat. Meat samples were analyzed in the laboratory BiotechLab, Sremska Kamenica, Serbia. Preparation of fatty acid methyl esters was performedby the method EN ISO550:2007, and determination of fatty acid methyl esters was performed by gas chromatography method: JUSISO5508:2002.
The results obtained in the experiment were analyzed by ANOVA test and found differences were analyzed using Tukey's test.

Table 1. shows the contents of nutrients in the broilers' feeding.

Table 1. Contents of the mixtures used for feeding broilers
from 0. to 15.days of their lives and from 16. to 42.days of their lives

Nutrients %	Experimental group							
	I/lard		II/soybean oil		III/tallow		IV/sunflower oil	
	0-15	15-16	0-15	15-16	0-15	15-16	0-15	15-16
Corn	53.5	58.5	53.5	58.5	53.5	58.5	53.5	58.5
Soybean shot	38.0	33.0	38.0	33.0	38.0	33.0	38.0	33.0
Sunflower shot	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lard	3.0	3.0	-	-	-	-	-	-
Soybean oil	-	-	3.0	3.0	-	-	-	-
Tallow	-	-	-		3.0	3.0	-	-
Sunflower oil	-	-	-	-	-	-	3.0	3.0
Premix/s-starter, f- finisher	4.0s	4.0f	4.0s	4.0f	4.0s	4.0f	4.0s	4.0f

Premix of starter: lysine 2.34 %; methionine 4.17%; methionine + cystine 4.17%; robenidine 825 mg/kg, vitamin A 275000.00 IU/kg; vitamin D3 125000.00 IU /kg; Vitamin E 1250.00 IU/kg; Premix of finisher: methionine 3.36%; methionine + cystine 3.36%; Vitamin A 314600.00 IU/kg; vitamin D3 114400.00 IU /kg; Vitamin E 1430.00 IU/kg

RESULTS AND DISCUSSION

In the Tables 2. and 3. are shown the contents of fatty acids in the red and in the white meat.

Table 2. Contents of fatty acids in the red meat of broilers

Contents of fatty acids (%)					F value
C 14:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	17.000**
$\overline{X}$	0.75^{B}	0.60^{D}	0.77^{A}	0.67^{AC}	
SD	0.05	0.08	0.02	0.08	
CV	0.07	0.14	0.03	0.12	
C 16:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	2.680 NS
$\overline{X}$	24.83	23.78	25.92	24.91	
SD	0.56	8.94	1.17	0.36	
CV	0.02	0.38	0.05	0.01	
C 16:1	Treatment 1	Treatment 2	Treatment 3	Treatment 4	2.306 NS
$\overline{X}$	6.15	4.23	5.67	4.84	
SD	1.73	0.86	0.18	0.35	
CV	0.28	0.20	0.03	0.07	
C 18:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	0.971 NS
$\overline{X}$	6.42	7.16	6.81	6.78	
SD	0.74	0.73	0.02	0.29	
CV	0.12	0.10	0.003	0.04	
C:18n9c	Treatment 1	Treatment 2	Treatment 3	Treatment 4	2.640 NS
$\overline{X}$	37.98	34.26	38.47	34.82	
SD	0.73	0.73	2.81	0.72	
CV	0.02	0.02	0.07	0.02	
C18:2 n6c	Treatment 1	Treatment 2	Treatment 3	Treatment 4	11.442**
$\overline{X}$	22.55^{AB}	28.07^{D}	23.21^{AC}	25.82^{A}	
SD	1.36	1.70	1.13	0.99	
CV	0.06	0.06	0.05	0.04	
C18:3n3	Treatment 1	Treatment 2	Treatment 3	Treatment 4	30.750**
$\overline{X}$	1.17^{DA}	1.75^{BC}	1.21^{CA}	1.99^{ABD}	
SD	0.07	0.15	0.11	0.19	
CV	0.06	0.08	0.09	0.10	
C20:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	28.571**
$\overline{X}$	0.23^{ADC}	0.15^{DB}	0.20^{B}	0.16^{C}	
SD	0.02	0.02	0.05	0.04	
CV	0.11	0.13	0.23	0.25	

Treatment 1-addition of 3% lard; Treatment 2-addition of 3% soybean oil; Treatment 3-addition of 3% tallow; Treatment 4-addition of 3% sunflower oil

F – values of Fisher test, $\overline{X}$ - mean value, SD – standard deviation, CV – coefficient of variation, NS – Inside examined treatments did not establish significant difference ($p>0.05$)
** Highly significant difference ($p<0.01$) between treatments, *significant difference ($p<0, 05$) between treatments

Table 3. Contents of fatty acids in the white meat of broilers

Contents of fatty acids (%)					F value
C 14:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	19.661**
$\overline{X}$	1.04^{ADC}	0.63^{DB}	0.93^{B}	0.69^{C}	
SD	0.10	0.04	0.14	0.05	
CV	0.10	0.07	0.15	0.07	
C 16:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	5.366*
$\overline{X}$	26.19^{b}	25.34^{c}	28.28^{ad}	24.18^{d}	
SD	1.62	1.30	0.83	1.33	
CV	0.06	0.05	0.03	0.06	
C 16:1	Treatment 1	Treatment 2	Treatment 3	Treatment 4	18.280**
$\overline{X}$	5.71^{BA}	5.10^{CA}	7.74^{AD}	4.92^{D}	
SD	0.72	0.44	0.31	0.49	
CV	0.13	0.09	0.04	0.10	
C 18:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	3.756 NS
$\overline{X}$	6.80	6.83	5.87	6.92	
SD	0.81	0.18	0.27	0.20	
CV	0.12	0.03	0.05	0.03	
C:18n9c	Treatment 1	Treatment 2	Treatment 3	Treatment 4	7.482*
$\overline{X}$	36.53^{ad}	34.36^{db}	36.11^{b}	35.44^{c}	
SD	0.16	0.51	0.47	1.03	
CV	0.004	0.01	0.01	0.03	
C18:2 n6c	Treatment 1	Treatment 2	Treatment 3	Treatment 4	21.894**
$\overline{X}$	20.52^{C}	25.98^{AD}	17.13^{DB}	25.58^{B}	
SD	2.36	0.38	0.63	1.83	
CV	0.11	0.01	0.04	0.07	
C18:3n3	Treatment 1	Treatment 2	Treatment 3	Treatment 4	99.651**
$\overline{X}$	1.01^{CBA}	1.61^{BDA}	0.97^{DA}	2.09^{A}	
SD	0.06	0.09	0.07	0.15	
CV	0.06	0.06	0.07	0.07	
C20:0	Treatment 1	Treatment 2	Treatment 3	Treatment 4	96.145**
$\overline{X}$	2.53^{BDC}	0.16^{DA}	2.96^{AC}	0.17^{C}	
SD	0.52	0.01	0.19	0.04	
CV	0.21	0.06	0.06	0.25	

Treatment 1-addition of 3% lard; Treatment 2-addition of 3% soybean oil; Treatment 3-addition of 3% tallow; Treatment 4-addition of 3% sunflower oil

F – values of Fisher test, $\overline{X}$ - mean value, SD – standard deviation, CV – coefficient of variation, NS – Inside examined treatments did not establish significant difference ($p>0.05$)

** Highly significant difference ($p<0.01$) between treatments, *significant difference ($p<0, 05$) between treatments

The content of saturated fatty acids in the red meat was not of statistical significance ($p>0.05$), the content of monounsaturated fatty acids was of statistical significance ($p<0.05$), while the content of polyunsaturated fatty acids in the red broiler meat was of high statistical significance ($p<0.01$) with reference to the applied feeding treatments. The content of saturated fatty acids in the white meat was not of statistical significance ($p>0.05$), while the content of monounsaturated and polyunsaturated fatty acids in white broiler meat was of high statistical significance ($p<0.01$) with reference to the applied feeding treatments. The n-6/n-3 fatty acids ratio in red broiler meat was determined as follows: treatment 1 - 19.3:1; treatment 2 - 16.0:1; treatment 3 - 20.5:1; treatment 4 - 12.9:1. The n-6/n-3 fatty acids ratio in white broiler meat was: treatment 1 - 20.3:1, treatment 2 –16.1:1, treatment 3 –17.6:1 and treatment

4 –12.2:1. Mehmet et al. (2005) added to broilers feeding 6% fats in the period from 21.to 41.days of their lives. They found the levels of 42.14%, 29.66%, 24.15%, saturated, monounsaturated and polyunsaturated fatty acids respectively in the red meat of chickens feeding with addition of soybean oil and the levels of 48.02%, 24.61%, 22.11% saturated, monounsaturated and polyunsaturated fatty acids respectively in the red meat chickens feeding with the addition of beef tallow. In the white meat of broilers feeding with addition of soybean oil, they found 43.58%, 20.03%, 30.58%, saturated, monounsaturated and polyunsaturated fatty acids respectively and in the white meat of chickens feeding with addition of beef tallow 48.02%, 24.61%, 30.58% saturated, monounsaturated and polyunsaturated fatty acids respectively. Popescu and Criste (2003) used addition of soybean oil in broiler's feeding and found the content of fatty acids in the red meat of broiler's at the end of the fattening period: 26.29% saturated fatty acids, 73.41% monounsaturated and polyunsaturated fatty acids.

CONCLUSION

The dietary treatments used in feeding broilers can significantly affect the amount of fatty acids in the red and white meat of broilers. The highest contents of polyunsaturated fatty acids in the red broiler meat were achieved with the addition of soybean oil in the mixture of food. The highest contents of polyunsaturated fatty acids in the white broiler meat was achieved with the addition of sunflower oil in the mixture of food and it was shown that the addition of soybean oil and sunflower oil affects the increasing of polyunsaturated fatty acids in the meat of broilers.Therefore the recommendation would be that in the nutrition of broilers vegetable supplements should be used, especially sunflower oil, because it considerable reduces the ratio n-6 fatty acids towards n-3 fatty acids in the meat and thus it has more favorable effect on the human body.

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