

THE EFFECT OF DIETARY *CAMELINA SATIVA* OIL ON QUALITY OF BROILER CHICKEN MEAT*

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Abstract

An experiment was conducted on 600 broiler chickens to determine the effect of using *Camelina sativa* oil as a dietary component on meat quality indicators. Broiler chickens were raised on litter under standard conditions of feeding and maintenance. In the second period of rearing, the control group (I) received a diet containing 6% rapeseed oil. Experimental groups were fed on a diet containing 3% rapeseed oil and 3% *Camelina sativa* oil (group II) and 6% camelina oil (group III). At the end of rearing 8 chickens from each group were slaughtered. A simplified analysis of the carcasses was conducted. Blood samples were taken to determine the content of total fat, triglycerides, total cholesterol and its fractions. Muscle samples were analysed for the content of dry matter, total protein and crude fat, fatty acid composition and malonic aldehyde (TBA). The meat was subjected to sensory evaluation. It was found that the introduction of *Camelina sativa* oil to the grower diet for broiler chickens does not have a negative effect on rearing parameters and carcass quality. What was observed was a tendency to reduce the proportion of abdominal fat in the carcass with increasing level of oil used in compound feed and increases in the total protein content of breast meat in group II receiving 3% of camelina oil. The addition of 6% of *Camelina sativa* oil to compound feed significantly decreased the content of total cholesterol and its fractions in the blood plasma of chickens in comparison to the other groups. The introduction of 3% and 6% of *Camelina sativa* oil to chicken diets enriched the breast meat in *n*-3 PUFA, mainly α -linolenic acid (ALA) and did not impair the flavour qualities of the cooked meat. The meat from chickens fed on a diet containing 6% of camelina oil was characterized by a greater increase of ALA.

Key words: broiler chickens, *Camelina sativa* oil, meat lipids, polyunsaturated fatty acids, cholesterol

Fatty components of compound feeds used in animal nutrition are the main component of dietary energy and a source of polyunsaturated fatty acids, necessary for the proper functioning of the organism. A deficiency of these acids inhibits the

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growth and proper development of animals and can cause many diseases (Palmquist, 2009). Moreover, the composition of fatty acids in fat reserves, deposited in tissues is not irrelevant from the standpoint of human nutrition. In chickens under normal feeding conditions, fat reserves including intermuscular fat, are composed of mainly saturated fatty acids (C16:0, C18:0) and unsaturated fatty acids with one double bond (C16:1, C18:1).

Chickens do not have the ability to synthesize polyunsaturated fatty acids, hence they must be delivered with food. The results of studies conducted in recent years have shown that the composition of fatty acids contained in the carcasses of chickens can be relatively easily modified by the diet (Aziza et al., 2010 a, b). It was found that polyunsaturated fatty acids α -linolenic (C18:3 *n*-3; ALA) and linoleic (C18:2 *n*-6; LA) contained in the compound feed for monogastric animals, are absorbed and incorporated in unchanged form into tissue lipids which influences the fatty acid composition of the muscle (Flachowsky et al., 1997; Barowicz et al., 2002). Tissue concentrations of these fatty acids correspond closely to their content in feed as opposed to saturated (SFA) and monounsaturated fatty acids (MUFA), which can be synthesized *de novo* (Leeson and Atteh, 1995; Leskanich and Noble, 1997). A rich source of polyunsaturated fatty acids (PUFA) used in animal feeding are oilseeds and oils from oilseeds. Numerous studies have demonstrated the beneficial effect of plant oil supplements on the fatty acid profile of lipids in meat and eggs (López-Ferrer et al., 1999; López-Ferrer et al., 2001).

Currently one oilseed plant that is receiving renewed interest in agriculture and the industry is *Camelina sativa*, the cultivation of which was replaced in the postwar period by flax and canola. The oil content of camelina seed is 500 g/kg (Zubr and Matthauss, 2002). *Camelina sativa* oil has highly specific nutritional properties due to its chemical composition. It contains many desirable dietary components, especially polyunsaturated fatty acids and is one of the richest plant sources of *n*-3 fatty acids (Crowley and Fröhlich, 1998; Hrstar et al., 2011). Furthermore, it has a long shelf life of 6 months because it contains antioxidants from the group of tocopherols (vitamin E, 17–18 mg/kg of oil) (Abramović et al., 2007). It also distinguishes itself from other oils with a specific taste and a pleasant, moderate and clean flavour without admixture of any foreign aroma (Abramović et al., 2007).

Because very little information is available in the literature on the usefulness of adding *Camelina sativa* oil as an alternative to rapeseed oil in broiler nutrition, these issues should be more thoroughly investigated. Therefore, the aim of this study was to assess the effectiveness of different dietary levels of *Camelina sativa* oil in broiler chicken diets. It was hypothesized that the dietary addition of this oil may affect the growth, feed conversion, blood lipids, and selected breast meat characteristics.

Material and methods

The study was conducted in duplicate on 600 broiler chickens (line Ross 308) assigned randomly to three groups of 38 birds each, raised on litter and fed *ad libitum* diets with free access to water. In the second period of rearing, the control group (I)

received a grower diet containing 6% rapeseed oil. Experimental groups were fed a diet containing 3% rapeseed oil and 3% *Camelina sativa* oil (group II) and 6% *Camelina sativa* oil (group III). The composition of compound feed is shown in Table 1.

Table 1. The composition and nutritional value of grower diet for broiler chickens

Ingredients	Group		
	I	II	III
Maize	28.00	28.00	28.00
Wheat	30.46	30.46	30.46
Soybean meal (46%)	31.50	31.50	31.50
Rapeseed oil	6.00	3.0	-
Camelina oil	-	3.0	6.0
Limestone	1.15	1.15	1.15
Dicalcium phosphate	1.70	1.70	1.70
NaCl	0.35	0.35	0.35
DL-Methionine	0.21	0.21	0.21
L-Lysine HCL	0.13	0.13	0.13
Vitamin-mineral premix (0.5%)*	0.50	0.50	0.50
The nutrient content			
metabolizable energy (MJ/kg)		13.00	
total protein		20.00	
lysine		1.15	
methionine		0.52	
Ca		0.92	
P		0.40	

*Composition of vitamin-mineral premix provided as follows, per kilogram of premix: vitamins: E – 8000 mg, K₃ – 450 mg, B₁ – 400 mg, B₂ – 1450 mg, B₆ – 850 mg, B₁₂ – 6000 mg, calcium pantothenate – 2400 mg, folic acid – 200 mg, biotin – 20000 mg, choline – 67140 mg; mixture of trace minerals: Co – 80.0 mg, Cu – 3000 mg, Fe – 13000 mg, I – 180.0 mg, Mn – 20000 mg, Zn – 13000 mg, Se – 50 mg.

During the experiment individual body weight of chickens, feed consumption for each group and the number of dead chickens were recorded. At 49 days of age, 8 chickens from each group were slaughtered.

Birds were decapitated, bled for 2 minutes, scalded at 54°C for 120 seconds, mechanically defeathered and manually eviscerated, washed and hung to drip. The organs (heart, liver, gizzard) as well as abdominal fat pad were weighed. The other parts such as breasts and leg muscles, both without skin were separated from carcasses after cooling. Samples of breast muscles were frozen at –20°C until the time of analysis. Carcass yield was determined using live weight and carcass weight, and breast meat yield was determined using carcass and breast weights.

Blood plasma triglyceride content, total cholesterol (TC) and its HDL fraction were determined by enzymatic-colorimetric diagnostic kits manufactured by Pointe Scientific. Higher fatty acids in meat samples were determined by gas chromatog-

raphy in the form of methyl esters. The fat from samples was extracted by using a mixture of chloroform and methanol (2/1) according to the modified method of Folch et al. (1957), after which the extract was evaporated at 65°C by means of liquid nitrogen. The residue was saponified with 0.5 N NaOH in methanol (20 min., 80°C), then esterified with BF₃ in methanol (Morrison and Smith, 1964) for 10 min. at 80°C, and finally hexane was added. After salting out with a saturated NaCl solution, the hexane layer was collected into a chromatography vial and analysed using a Varian 3400 gas chromatograph (CP-Wax-58, 25 m, 0.53 mm, 1 µ, FID, helium, 6 ml/min), a 8200 CX autosampler and Varian Star 4.5 data processing software.

In the breast muscle samples, the content of dry matter, total protein and crude fat was measured using standard procedures (AOAC, 1995). Cholesterol was assayed colorimetrically using a colour reaction with a 10% solution of FeCl₃ (in acetic acid) diluted 100-fold with sulfuric acid. Sample preparation involved homogenization of the sample in a mixture of chloroform and methanol (2/1) and evaporation, saponification, extraction with hexane, re-evaporation, and the colorimetric determination at a wavelength of 570 nm.

The TBA was determined after 6 months of storage in a deep freeze. To determine TBA, meat samples were prepared according to a modified version of the method of Salih (1987) as modified by Pikul (1993). TBA values were determined by the colorimetric method in the presence of 2-thiobarbituric acid.

Breast meat samples held for sensory analysis were frozen at -20°C until evaluation. Breast meat was analysed after cooking to determine the sensory impact of the oil used on flavour and aroma quality. The sensory evaluation of meat samples was conducted by six panelists. The day before the analysis, 200 g of each sample was thawed at 4°C, and cooked individually in a covered container in 400 ml of 0.6% saline, until the temperature inside the meat reached 70°C. The temperature was measured using a special thermometer. After cooling the meat samples were evaluated within 10 minutes. The aroma, juiciness, tenderness and flavour of the meat were evaluated based on a five-point scale where 5 meant strong appreciation and 1 an extreme dislike.

The results were subjected to one-way analysis of variance, and the significance of differences was verified by Duncan's multiple range test using the GLM procedure of SAS software v. 9.2.

Results

Comparative analysis of the fatty acid profile of oils in compound feed for broiler chickens showed that camelina oil has a higher content of *n*-3 PUFA, mainly the α -linolenic fatty acid and more favourable *n*-6/*n*-3 PUFA ratio than rapeseed oil (Figure 1). Changes in fatty acid composition of the diet used in the second period of rearing after the introduction of camelina oil are shown in Table 2. Increasing the proportion of that oil caused a decrease in MUFA content and increased the content of *n*-3 PUFA, mainly α -linolenic fatty acid.

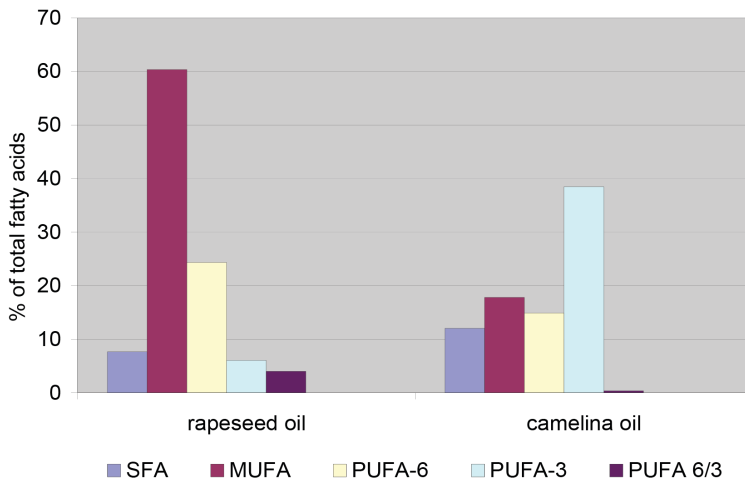


Figure 1. Fatty acid profile of oils used in the diet for chickens

Table 2. Fatty acid profile of the diet (% of total fatty acids)

Item	Group		
	I	II	III
SFA	10.8	11.3	11.4
C16:0	8.071	8.264	8.919
C18:0	1.658	1.743	1.926
MUFA	50.1	40.3	20.1
C16:1	0.162	0.137	0.096
C18:1	49.561	39.016	17.557
PUFA	39.0	48.3	68.5
PUFA <i>n</i> -6	30.1	28.4	29.2
LA (C18:2)	30.195	27.950	27.960
PUFA <i>n</i> -3	7.4	14.8	28.6
ALA (C18:3)	7.425	14.775	28.636
PUFA <i>n</i> -6/ <i>n</i> -3	4.1	1.9	1.0
OFA	9.2	9.6	9.4

Rearing results of broiler chickens are shown in Table 3. There were no significant differences in the body weight of chickens and feed consumption between the groups. In the first three weeks of rearing mortality rate in each group was similar and ranged from 1.08 to 1.28%. In the second period mortality rate in groups I and II was similar. An interesting finding is the absence of mortality in group III after the introduction of 6% *Camelina sativa* oil to the diet. However, this requires confirmation in future studies.

Table 3. Performance of chickens from 1 to 49 days of age

Group	Body weight (g)			Feed consumption (kg/kg)			Mortality (%)		
	day 1	day 21	day 49	1–21 days	22–49 days	1–49 days	1–21 days	22–49 days	1–49 days
I	39.6	683	2618	1.48	1.79	1.71	1.08	2.62	3.68
II	41.3	717	2679	1.32	1.76	1.64	1.23	2.53	3.70
III	40.6	702	2694	1.46	1.75	1.67	1.28	0.0	1.28
SEM	0.12	4.06	12.21	0.10	0.90	0.80	-	-	-

The introduction of 3% or 6% camelina oil to the diet in groups II and III had no significant effect on the quality of carcasses. Observations showed a tendency ($P<0.099$) towards a decrease in the proportion of abdominal fat in carcasses with increasing proportions of camelina oil in the diet (Table 4).

Table 4. The results of simplified carcass analysis

Parameter	Group			SEM
	I	II	III	
Body weight (g)	2659	2713	2679	43.14
Fresh carcass weight (g)	1971	2003	1969	31.66
Carcass weight after cooling (g)	1909	1933	1908	30.47
Carcass yield (%)	74.2	73.8	73.4	0.41
Proportion (%) to carcass weight				
breast muscles	20.0	19.7	19.6	0.28
leg muscles	15.6	15.5	15.4	0.13
liver	1.98	1.87	1.88	0.04
abdominal fat	1.04	1.02	0.94	0.05
skin with subcutaneous fat	3.77	3.89	3.59	0.10

Analysis of blood plasma parameters showed a tendency ($P<0.099$) towards increased triglyceride content and significantly decreased total cholesterol and its fractions in the groups receiving camelina oil in the diet. It is worth noting a downward trend ($P<0.099$) in the LDL/HDL ratio in the experimental groups (Table 5).

Table 5. The results of blood plasma analysis in broiler chickens

Item	Group			SEM
	I	II	III	
Triglycerides (mg/dl)	40.6	46.4	49.1	3.29
Total cholesterol (mg/dl)	118.1 a	115.1 a	96.4 b	3.25
HDL (mg/dl)	85.0 a	83.7 ab	69.6 b	2.75
LDL (mg/dl)	24.9 a	22.1 ab	16.9 b	1.92
LDL/HDL	0.29	0.26	0.24	0.06

a, b – values in rows with different letters differ significantly at $P<0.05$.

Chemical analysis of the chicken breast meat showed an increase in total protein content in birds fed camelina oil in the second period of rearing. Significant differences compared to the control group were found in group II. The dry matter and crude fat content was at a similar level (Table 6).

Table 6. The results of chemical analysis of breast meat (%)

Nutrients	Group			SEM
	I	II	III	
Dry matter	24.73	25.19	25.05	0.094
Total protein	23.33 a	23.80 b	23.74 ab	0.081
Crude fat	0.77	0.81	0.81	0.027

a, b – values in rows with different letters differ significantly at $P < 0.05$.

The cholesterol content in breast meat from the control group was 69.77 (mg/100 g of meat) while in experimental groups a tendency ($P < 0.099$) towards decreased cholesterol content was observed (Figure 2).

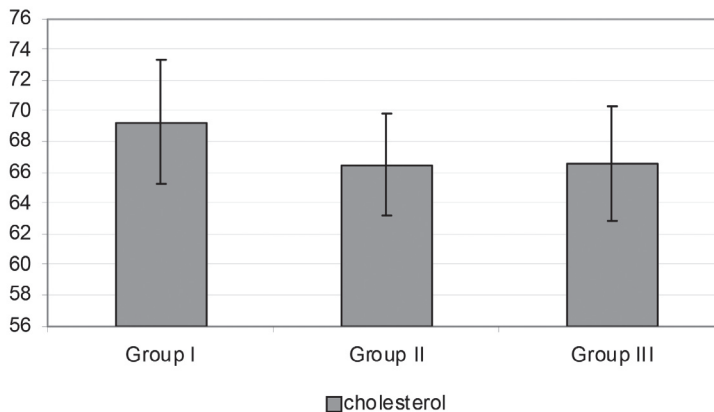


Figure 2. Cholesterol content in breast meat of broiler chicken (mg/100 g of meat)

The analysis of higher fatty acids in breast meat lipids (Table 7) demonstrated that dietary camelina oil significantly reduces the proportion of MUFA and increases the proportion of PUFA, mainly *n*-3 PUFA in chicken meat (Table 7). The most important α -linolenic fatty acid from the *n*-3 group increased significantly. The *n*-6/*n*-3 PUFA ratio was reduced significantly ($P < 0.01$) in experimental groups.

The introduction of camelina oil to the diet in quantities of 3 and 6% had no influence on organoleptic traits of the cooked meat (Table 8).

Table 7. Fatty acid profile of breast meat (% of total fatty acids)

Item	Group			SEM
	I	II	III	
C16:0	19.15	20.04	20.64	2.031
C16:1	0.97	1.19	0.98	0.096
C18:0	8.66 b	9.20 ab	9.77 a	0.569
C18:1	36.03 Aa	30.65 Bb	22.91 Cc	3.307
C18:2 LA	21.1	20.43	21.14	0.522
C18:3 ALA	2.94 C	6.35 B	10.11 A	0.625
C20:4 AA	6.36	5.63	5.48	1.275
EPA C20:5	0.51 C	1.33 B	1.90 A	0.049
DHA C22:6	2.24 b	2.23 b	3.09 a	0.582
SFA	28.71 b	30.04 ab	30.73 a	2.336
UFA	71.29 a	69.96 ab	69.27 b	2.336
MUFA	37.12 A	31.99 B	24.11 C	3.889
PUFA	34.17 C	37.96 B	45.16 A	3.557
PUFA <i>n</i> -6	27.56 a	26.12 b	26.66 ab	1.271
PUFA <i>n</i> -3	5.62 C	9.91 B	15.10 A	0.849
DFA	79.94	79.16	79.03	2.404
OFA	20.06	20.84	20.97	2.403
UFA/SFA	2.49 a	2.33 ab	2.26 b	0.029
DFA/OFA	4.02	3.81	3.80	0.129
MUFA/SFA	1.30 A	1.07 B	0.79 C	0.012
PUFA/SFA	1.19 B	1.27 B	1.48 A	0.011
PUFA <i>n</i> -6/ <i>n</i> -3	4.96 A	2.64 B	1.78 C	0.111

a, b, c – values in rows with different letters differ significantly at $P < 0.05$.

A, B, C – values in rows with different letters differ significantly at $P < 0.01$.

Table 8. Sensory evaluation of cooked breast meat after 7 days of storage

Trait	Group			SEM
	I	II	III	
Odour	4.67	4.62	4.65	0.61
Juiciness	4.49	4.50	4.52	0.94
Tenderness	4.52	4.58	4.61	0.87
Flavour	4.69	4.72	4.68	0.73

Scoring: 5 – highly aromatic odour, juicy meat, crisp, without foreign tastes, 1 – strong foreign smell, dry meat, tough, decidedly unpleasant aftertaste.

The concentration of malonic aldehyde (TBA) in the chicken breast meat measured after 6 months of deep-freeze storage was 0.421 mg/kg in the control group but tended to decrease in the experimental groups (0.399 and 0.397 mg/kg, respectively).

Discussion

To date, nutritional strategies that have been developed for broiler chickens and designed to enrich the meat with the *n*-3 PUFA group are mainly based on using flaxseed oil and marine oils. However, use of these oils results in deterioration of the sensory quality of meat due to the presence of foreign smells and requires addition of antioxidants in order to reduce the lipid oxidation process and thus maintain the quality and shelf life of meat (Aziza et al., 2010 b).

Recently a few studies have indicated the possibility of introducing camelina oil as a source of PUFA (mainly *n*-3) and natural antioxidants from the group of tocopherols, without compromising the sensory quality of poultry products (Rokka et al., 2002; Jaśkiewicz and Matyka, 2003).

The present study investigated different levels of *Camelina sativa* oil (3% or 6%) in broiler chicken diets and their effect on fatty acid composition of meat lipids, weight gain, feed intake and performance of birds. It was reported that experimental factors had no significant effect on rearing results. There was no negative influence of experimental factors on carcass quality. However, it was observed that with the increased amount of camelina oil in the diet, the abdominal fat in carcasses had a downward tendency. These findings are similar to the results obtained by Crespo and Esteve-Garcia (2002) and Sanz et al. (2000 b), who found that PUFA reduce abdominal fat deposition to a greater extent than SFA and MUFA. The source of dietary fat had no effect on the crude fat content of chicken breasts. This is consistent with reports of other authors (Ajuyah et al., 1991; Crespo and Esteve-Garcia, 2002). The mechanism by which dietary PUFA modifies body fat deposition is not completely understood. Some studies suggested that the lower fat deposition in broiler chickens fed on a diet containing oils rich in PUFA compared to those fed on a diet poor in PUFA but with a higher level of SFA and MUFA was, in part, explained by a greater rate of lipid oxidation and by a decline in fatty acid synthesis (Sanz et al., 2000 b). Furthermore, PUFA are involved in the induction of uncoupling proteins in the mitochondria. This uncoupling protein-3 is limited in rat skeletal muscle but it was noticed that uncoupling protein-3 had increased twice in rats receiving fish oil in the diet (Baillie et al., 1999). It is supposed that these mechanisms could diminish the dietary energy in animals fed on a diet rich in *n*-3 PUFA in comparison to those fed on a diet rich in SFA. It is suggested that this energy could be dissipated or could be used to enhance protein deposition (Sanz et al., 2000 a). The second pathway could explain why a greater content of total protein in breast muscle from the experimental group receiving 3% of camelina oil was noticed in the present experiment. In our research the higher level of camelina oil (6%) did not increase the protein content of breast meat. A possible explanation is that protein deposition in breast muscle is limited and the higher level of *n*-3 PUFA did not affect the protein content.

The introduction of 6% camelina oil into the diet resulted in a tendency for increased triglyceride content, and significantly diminished the total cholesterol and its fractions in the blood plasma of chickens in comparison to groups I and II. With the addition of 6% of camelina oil a tendency to reduced LDL/HDL ratio in blood was noticed. Similar results were reported by Karvonen et al. (2002) for patients

with high cholesterol levels who received 30 g of camelina oil, olive oil or canola oil daily. After 6 weeks of treatment, LDL levels were reduced by 12.2%, 7.7% and 5.4%, respectively. A decrease in cholesterol content in the meat of chickens from experimental groups receiving dietary camelina oil was also observed in this study (by 4.0% and 3.9%, respectively). Several studies indicate that unsaturated fatty acids in the diet may lower total cholesterol and LDL levels in the blood of humans and animals. In a study with rats, Chichłowska et al. (1997) found cholesterol to decrease significantly in muscle tissue after 30-day supplementation of flax seed in the diet. Also Barowicz et al. (1997) showed that 4 and 8% of flax seed as a source of unsaturated fatty acids in the diet for pigs caused a dose-dependent decrease in serum cholesterol levels. Similarly, a study with broiler chickens showed that feeding a mixture containing 6 or 9% of linseed oil significantly lowers total cholesterol and LDL levels (Pietras, 2001). The content of cholesterol in animal tissues can be affected not only by the mere presence of unsaturated fatty acids in the diet but also by the *n-6/n-3* PUFA ratio.

In the present experiment analysis of the profile of higher fatty acids in the lipids of breast meat showed that camelina oil significantly increased the proportion of *n-3* PUFA, mainly α -linolenic (C18:3) and dramatically reduced MUFA content. Furthermore, the content of LA was not significantly affected by the use of camelina oil. These contradict the results of other studies in this field. Huang et al. (2008) and Kouba and Mourot (2011) reported that the use of plant oils as a rich source of ALA in animal feed, significantly modifies both the fatty acid composition of stored fat and the intermuscular fat, increasing the content of linoleic (C18:2) and α -linolenic (C18:3) fatty acids and decreasing MUFA content in both types of fat. In the studies mentioned above, the amounts of palmitic acid (C16:0) and stearic acid (C18:0) were decreased. Ayerza et al. (2002) stated that introduction of 10 or 20% of chia seed as a source of ALA to broiler chicken feeds resulted in an increase of LA and ALA in breast muscle while reducing the content of MUFA and SFA. With the increasing content of chia seed in the diet, the proportion of palmitic fatty acid was decreasing while the declining proportion of stearic fatty acid was recorded only in the group which received the lowest proportion of chia seed (10%).

Azcona et al. (2008) reports that the introduction of 15% of chia seed into the diet of chickens resulted in a decreased proportion of palmitic (C16:0) and stearic fatty acids (C18:0) as well as MUFA. In the same experiment an increase in ALA and a decrease in LA were found in the breast muscles of broiler chickens fed the diet containing 15% flaxseed, compared to the control group. A lower content of palmitic fatty acid was observed but the proportion of stearic fatty acids was not influenced.

However, in our experiment, an increase in the proportion of saturated fatty acids, mainly stearic acid (C18:0) was noticed. Also Bečková and Vaclavkova (2010) observed an increasing tendency in the content of stearic fatty acid in the muscle of animals fed on a diet containing 13.4% linseed. In the same experiment the content of MUFA decreased. It is supposed that the significant reduction of MUFA and the significant increase in stearic fatty acid in the meat lipids of chickens from the experimental groups are due to the fact that *n-3* PUFA effectively inhibit the activity of Δ -9 desaturase, an enzyme which is necessary in the formation of MUFA from

their precursors. The Δ -9 desaturase is the key enzyme needed to convert palmitic to palmitoleic acid and stearic to oleic fatty acid (Palmquist, 2009). Furthermore, based on the results of other authors presented above, it can be concluded that changes in the proportion of SFA, mainly in palmitic and stearic fatty acids between groups II and III may also arise from the different profiles of saturated and unsaturated fatty acids contained in oils and oilseeds used in bird diets.

The *n*-6/*n*-3 PUFA ratio in breast muscle was reduced significantly in a way that is highly desirable from the standpoint of human nutrition in the group receiving 3% and 6% of camelina oil. The same effects were achieved by Schneiderová et al. (2007), who introduced linseed oil as a source of ALA fatty acids to broiler compound feed.

In our experiment, it was noticed that docosahexaenoic fatty acid (DHA, C22:6 *n*-3) and eicosapentaenoic fatty acid (EPA, C20:5 *n*-3) had increased in the breast muscle with increasing levels of oil used in the bird diet. Long-chain PUFA are mainly formed in the liver from LA and ALA by the action of desaturases and elongases (Wood et al., 2008). These fatty acids compete in the metabolism of the same enzymes, therefore higher dietary intake of ALA resulted in the increase of those fatty acids in muscle tissue as well as an increase in its derivatives DHA and EPA. Also Azacona et al. (2008) found that different plant oils used in broiler chicken diets as a source of ALA resulted in the increased level of DHA and EPA in breast muscle. Similar results were obtained by Zuidhof et al. (2009). This has positive implications for a consumer's health, because humans have a low ability to convert ALA to DHA and EPA (Burdge, 2006).

Meat containing an increased amount of polyunsaturated fatty acids is more susceptible to oxidation which has a negative impact on the organoleptic characteristics of meat (Wood et al., 2008). Previous studies have shown that the use of 6% of linseed oil with similar fatty acid composition to *Camelina sativa* oil in broiler chicken diet, adversely affects the palatability and aroma of meat (Pietras, 2001). In order to improve the oxidative stability of meat lipids, and thus prolong the shelf life of meat, antioxidants had been successfully added to animal feeds (Morrissey et al., 1997; Grau et al., 2001). Natural vitamin E is more effective in inhibiting the lipid oxidation development in chicken meat than some current synthetic antioxidants used in compound feed for animals. The results of numerous studies indicate that the introduction of α -tocopherol to the diet of chickens increases its content in the tissues (Morrissey et al., 1997) and diminishes the oxidation rate of fatty acids of meat lipids (Grau et al., 2001; Aziza et al., 2010 b). This case can be explained by the fact that tissues better absorb the biological form of d- α -tocopherol from compound feed (Gray et al., 1996). Also due to consumer concern about the safety and toxicity of synthetic antioxidants, natural vitamin E sources are preferred (Aziza et al., 2010 b).

In the current experiment, the introduction of 3% or 6% of camelina oil to the diet did not reduce the sensory parameters of cooked meat. Furthermore, the high content of natural antioxidants in camelina oil has slowed down the oxidative processes of meat lipids. This is also reflected in data on the content of malonic aldehyde. After 6 months of deep-frozen storage of meat the concentration of malonic aldehyde in

the breast meat of chickens from experimental groups was lower by 5.3% and 5.7% compared to the control group.

Based on the results obtained it can be concluded that the use 3% or 6% of camelina oil in the compound feed for broiler chickens can be an effective way to modify the fatty acid profile of meat lipids in a way that is desired from the standpoint of human nutrition as well as enriching this meat in natural antioxidants (vitamin E), which can maintain high values for the flavour and aroma of the meat.

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Wpływ udziału oleju z lnianki siewnej (*Camelina sativa*) w dawkach dla kurcząt rzeźnych na jakość mięsa

STRESZCZENIE

W doświadczeniu przeprowadzonym na 600 kurczętach rzeźnych określono wpływ zastosowania oleju lnianki siewnej jako komponentu mieszanki paszowej na wskaźniki jakości mięsa. Kurczęta rzeźne odchowywano na ściółce w standardowych warunkach żywienia i utrzymania. W drugim okresie odchowu grupa kontrolna (I) otrzymywała mieszankę typu grower, zawierającą w swoim składzie 6% oleju rzepakowego. Grupy doświadczalne żywiono mieszankami zawierającymi odpowiednio 3% oleju rzepakowego i 3% oleju lnianki (grupa II) oraz 6% oleju lnianki siewnej (grupa III). Po zakończeniu odchowu ubito po 8 szt. kurcząt z każdej grupy. Wykonano uproszczoną analizę rzeźną tuszek. W pobranych próbkach krwi określono zawartość tłuszczu całkowitego, triacylgliceroli, cholesterolu całkowitego i jego frakcji. W próbkach mięśni piersiowych oznaczono zawartość suchej masy, białka całkowitego i tłuszczu surowego, skład kwasów tłuszczowych oraz TBA. Mięso poddano ocenie organoleptycznej. Stwierdzono, że wprowadzenie oleju lnianki siewnej do mieszanek paszowych typu grower dla kurcząt rzeźnych nie wywiera negatywnego wpływu na parametry odchowu i jakość tuszek z tendencją do zmniejszania udziału tłuszczu sadelkowego w tuszce. Zastosowanie 6%-dodatku oleju z lnianki zwiększa zawartość białka ogólnego w mięsie piersi. Profil kwasów tłuszczowych lipidów mięsa piersi pochodzących od kurcząt otrzymujących w diecie 3% oraz 6%-dodatek oleju z lnianki charakteryzował się wyższym udziałem kwasów wielonienasyconych z grupy $n-3$, a szczególnie kwasu α -linolenowego, co ma istotne znaczenie z punktu widzenia dietytyki człowieka. Najwyższy poziom kwasu α -linolenowego znajdował się w mięsie kurcząt żywionych paszą z 6%-dodatkiem wymienionego oleju. Udział 6% oleju w mieszance istotnie obniża zawartość cholesterolu całkowitego i HDL w osoczu krwi kurcząt. Olej lnianki w ilości 3%, jak również 6% nie pogarszał walorów smakowo-zapachowych mięsa gotowanego.