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A POSSIBILITY OF INCREASING THE CONTENT OF OMEGA-3 POLYUNSATURATED FATTY ACIDS IN BROILER MEAT

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Abstract: Decreased intake of n3 polyunsaturated fatty acids (PUFA) and loss of balance of n-6/n-3 PUFA in the diet of people in the past 100-150 years may partly explain the occurrence and permanent increase of typical diseases of modern civilization such as cardiovascular, heart disease, allergies and various malignant diseases. The increase input of long chain PUFAn3 in the human diet can be achieved by enriching animal foods (meat, milk and eggs) with long chain PUFAn3 by feeding animals with feed rich in PUFAn3. Therefore the aim of our study was to determine the possibility of increasing the content of PUFAn3 and decreasing the ratio of PUFAn6/PUFAn3 in broiler meat using rapeseed cake in their nutrition. Three hundred sixty male day-old Cobb hybrid chickens were randomly divided into 12 groups of 30 individuals. Control groups of broilers were fed with mixture that did not contain any rapeseed cake (T-0) and experimental groups were fed with mixtures that contained rapeseed cake in the amount of 5 and 10% (T-5 and T-10). Each feeding treatment had four replicates. At the end of the study, 42 days old broilers were weighed and sacrificed immediately thereafter. Samples of breast muscle of 5 animals from each treatment were taken for the purpose of determining the composition of fatty acids. As a result we got that content of PUFAn3 increased significantly in breast muscle of T-10 group (1,62; 1,60; 2,20). In accordance with this, relationship of PUFAn6/PUFAn3 significantly decreased in breast muscle that treatment (20,94; 21,73; 16,15).

Key words: rapeseed cake, broiler, PUFAn3, PUFAn6,

Introduction

As a result of negative health perceptions of animal fats in the public and the rapid development of industrial processing of vegetable oils, during the last fifty years at the global level has resulted in changes in the structure of fats in human nutrition. The use of unsaturated fats from vegetable edible oils has significantly increased while the use of saturated fats of animal origin decreased

(*Higgs, 2002*). Global replacement of saturated animal fats in the diet with unsaturated vegetable oils in the past few decades, took place mainly through the increased intake of linoleic acid (LA) which is in large amounts in sunflower oil, corn, soybeans and other edible oils (*Simopoulos, 1991; Higgs, 2002, Newton 2001*). In addition, modernization and development of agriculture in the last century, and increase productivity of meat production based on intensive fattening with cereals which are also rich source of LA, have led to the production of meat rich in n-6 polyunsaturated fatty acids (PUFAn6), while reducing the content of n-3 polyunsaturated fatty acids (PUFAn3) in meats of fattening animals. Similar changes have occurred in the composition of polyunsaturated fatty acids of table eggs and fish from intensive rearing (*Simopoulos, 1991 and 1999; Van Vilet, 1990; Lacey, 1992*). These changes, in a relatively short period of time led to the conclusion that the intake of n-6 polyunsaturated fatty acids in the diet of the population, especially in developing countries has increased strongly compared to the intake of essential n-3 polyunsaturated fatty acids. The recent medical knowledge shows that developing cardiovascular and other chronic diseases in humans a significant role has relationship of the two groups of polyunsaturated fatty acids: n-6 acids whose main representative is linoleic acid (LA, C18: 2 n-6) and n-3 acids whose main representative is alpha linolenic acid (ALA, C18: 3 n-3). In the body, elongation and desaturation processes from LA formed other long-chain n-6 acids such as arachidonic acid (AA, C20: 4 n-6), while from ALA formed long-chain n-3 fatty acids such as eicosapentaenoic (EPA, C20: 5 n-3) and docosahexaenoic acid (DHA, C22: 6 n-3) (*Karolyi, 2007*). It is estimated that the prehistoric development of the genus Homo and the later development of modern man as a species progressed with a diet that contained equal amounts of essential omega-6 and omega-3 polyunsaturated fatty acids (PUFAn6/PUFAn3 ratio 1-2 : 1) while in the diet of people today, this relationship changed significantly in favour of omega-6 acids and it is 10 to 20 or more : 1 (*Simopoulos, 1991, 1999 and 2002, Newton 2001, Finley and Shahidi, 2001*). Loss of balance of omega-6 and omega-3 polyunsaturated fatty acids in the diet of people in the past 100-150 years may partly explain the occurrence and causes a permanent increase in the typical diseases of modern civilization such as cardiovascular, heart disease, allergies and various malignant diseases (*Newton, 2001*), and represents an entirely new phenomenon in the long human evolution (*Simopoulos, 1991*). The increase input of long chain n-3 polyunsaturated fatty acids in the human diet can be achieved by taking dietary supplements for example in the form of fish oil capsules, through increased consumption of oily sea fish or indirectly by enriching animal foods (meat, milk and eggs) with long chain n-3 PUFA by feeding animals with feed rich in n-3 PUFA (*Raes et al., 2004*).

Therefore, the aim of our study was to determine the possibility of increasing the content of omega-3 polyunsaturated fatty acids and decreasing the ratio of n-6/n-3 polyunsaturated fatty acids in broiler meat by using rapeseed cakes in their nutrition.

Materials and methods

Three hundred sixty male day-old Cobb hybrid chickens were randomly divided into 12 groups of 30 individuals. Each group was placed in a cage with a floor grazing throughout the test duration of 42 days. The trial facility is a few days before the date of receipt of chicken thoroughly cleaned, disinfected and day before entering chicken heated to a temperature of 27 °C (in the occupied zone 32 °C) (according to *Uremović et al., 2002*). Control groups of broilers were fed with mixture that did not contain any rapeseed cake (T-0) and experimental groups were fed with mixtures that contained rapeseed cake in the proportion of 5 and 10% (T-5 and T-10). Each feeding treatment had four replicates. Broilers were fed with starter feed mixture (S) during the first twenty days and then to the end of the study with grower feed mixture (G). The chemical composition of rapeseed cake and feed mixtures are shown in Table 1.

Table 1. Chemical composition of rapeseed cake and feed mixtures

Chemical composition, g/kg	rapeseed cake	T-0 S	T-5 S	T-10 S	T-0 G	T-5 G	T-10 G
Moisture	93.46	107.30	101.76	97.91	113.19	110.88	113.68
Ash	64.36	59.39	63.69	61.39	55.41	59.32	58.00
Crude protein	304.32	223.38	228.36	222.85	200.17	204.49	205.45
Crude fat	94.29	47.66	53.68	57.82	48.87	50.51	59.88
Crude fiber	106.24	29.84	36.30	34.24	27.09	28.35	30.83
Ca	11.97	9.00	10.98	10.16	10.88	10.77	10.98
P	10.57	6.14	6.55	6.64	6.12	6.43	6.51
Starch	4.58	332.19	316.01	322.15	379.15	366.01	341.03

At the end of the study, 42 days old broilers were weighed and sacrificed immediately thereafter. Samples of breast muscle of 5 animals from each treatment were taken for the purpose of determining the composition of fatty acids. The dried lipid extract was methylated (according to *Hartman and Lago*, 1973). Fatty acid methyl esters were separated on a gas chromatograph (Philips, PU 4550) equipped with a split injector (100:1), fused silica capillary column (50m x 0.25 mm i.d., 0.20 μm film thickness of polyethylene glycol (CP-SIL 88, Crompak, Netherlands), flame ionisation detector, and work station (Borwin, France). The fatty acids were identified by comparison of the retention times of the sample with those of the standards, and by co-chromatography. To verify the differences between the content of fatty acids in breast muscle of broilers of different treatment, the results were submitted to the analysis of variance (ANOVA) at the 5% level of confidence (SAS, 2007).

On the basis of body weight gain and amount of feed consumed, conversion of feed mixtures were calculated. Mortality of broilers was observed on a daily basis during the visiting of chickens and it has been written on cards that were hung at the entrance of each cage.

Results and discussions

Production results of broilers are given in Table 2.

Table 2. Production results of broiler

	T-0	T-5	T-10
final body weight, g	2716,42 ± 297,26	2654,62 ± 227,63	2657,46 ± 254,31
feed conversion, kg/kg	1,71	1,70	1,71
mortality, %	0,82	1,65	0,82

As is evident from Table 2 the final body weight and total feed conversion were not significantly different between treatments so that we can say that the use of rapeseed cake did not lead to any negative effect on the final production results of broilers. This is supported with amount of mortality that is within a tolerant for broiler production.

These results are in accordance with most literature data, even though there are references where the rapeseed meal showed better production performance of chicks than soybean meal *(Milošević et al., 2011)*.

Morkunas et al., 1998, stated that partial replacement of soybean oil-meal with 5, 7.5 and 10% of rapeseed cake had no negative effect on the growth of broilers.

Banaszkiewicz et al., 2009, stated that rapeseed cake introduced to diets instead of part of soybean meal had profitable effect on final body weight of chickens, improved slaughter yield, increased content of total and breast muscles in carcass and decreased skin with subcutaneous fat.

Fatty acid profile

Compared with other meats, poultry is relatively rich in polyunsaturated fatty acids, including omega-3 class, because the feed used for the rapid development of the offspring contains these fatty acids (*Barroeta, 2007*). Thus, fatty acid composition of feed is reflected in the fatty acid composition of meat. Fatty acid composition of broiler meat of our investigation is presented in Table 3.

Table 3. Fatty acid composition

		T-0	T-5	T-10
Linoleic acid	C18:2n6c	26,21 ± 1,83	30,75 ± 2,52	28,12 ± 2,54
γ- linolenic acid	C18:3n6	0,25 ± 0,04	0,27 ± 0,06	0,23 ± 0,06
α- linolenic acid	C18:3n3	0,83 ± 0,10	1,21 ± 0,15	1,11 ± 0,16
Eicosatrienoic acid	C20:3n6	0,76 ± 0,20	0,40 ± 0,03	0,58 ± 0,12
Eicosatrienoic acid	C20:3n3	0,03 ± 0,01	0,01 ± 0,01	0,05 ± 0,01
Arachidonic acid	C20:4n6	4,80 ± 1,02	2,29 ± 0,36	4,78 ± 1,41
Eicosapentaenoic acid	C20:5n3	0,09 ± 0,02	0,04 ± 0,01	0,06 ± 0,02
Docosatetraenoic acid	C22:4n6	1,46 ± 0,31	0,74 ± 0,22	1,38 ± 0,38
Docosapentaenoic acid	C22:5n6	0,52 ± 0,12	0,23 ± 0,04	0,45 ± 0,15
Docosapentaenoic acid	C22:5n3	0,37 ± 0,10	0,20 ± 0,05	0,46 ± 0,14
Docosahexaenoic acid	C22:6n3	0,31 ± 0,11	0,14 ± 0,05	0,51 ± 0,20
ΣPUFAn6		**34,00 ± 0,46**	**34,68 ± 1,91**	**35,54 ± 2,09**
ΣPUFAn3		**$1,62^{b}$ ± 0,15**	**$1,60^{b}$ ± 0,08**	**$2,20^{a}$ ± 0,24**
ΣPUFAn6/ΣPUFAn3		**$20,94^{a}$ ± 1,96**	**$21,73^{a}$ ± 0,67**	**$16,15^{b}$ ± 1,32**

a, b = $p \leq 0,05$

Table 3 shows that concentrations of linoleic acid and total polyunsaturated fatty acids are high in breast muscle of all three different treatments. Content of omega-6 polyunsaturated fatty acids (PUFAn6) in the breast muscle increased when the diet contains rapeseed cake but not significantly. Content of omega-3 polyunsaturated fatty acids (PUFAn3) increased significantly in T-10 group in which broilers were fed with rapeseed cake share of 10%. In accordance with this relationship n6/n3 polyunsaturated fatty acids significantly decreased in breast muscle that treatment. Although there is present a positive decreasing effect of relationship of n6/n3 polyunsaturated fatty acids it is still worse than recommended (4:1) for the comfort and health of people (*Kralik et al., 2002*).

Conclusion

Using of rapeseed cake in broilers fattening with a share of feed mixtures up to 10% did not lead to negative impacts on the final production results of fattening broilers. Our result is showing significant increase of content PUFAn3 in broilers meat and significant decrease of ratio PUFAn6/PUFAn3 in broilers meat. Therefore, we strongly recommended using rapeseed cake in broilers fattening because of its using broilers meat becomes a nutritional foodstuff which has a beneficial effects on human health.

Mogućnost povećanja udela omega-3 polinezasićenih masnih kiselina u mesu brojlera

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Rezime

Smanjen unos n3 polinezasićenih masnih kiselina (PUFAn3) odnosno gubitak ravnoteže n-6/n-3 PUFA u prehrani ljudi u posljednjih 100-150 godina delimično može objasniti pojavu i stalan porast tipičnih bolesti moderne civilizacije kao što su kardiovaskularne bolesti, bolesti srca, alergije i razne maligne bolesti. Povećanje unosa dugolančanih PUFAn3 u ljudsku prehranu može se postići obogaćivanjem namirnica životinjskog porekla (meso, mleko i jaja) dugolančanim PUFAn3 odnosno hranjenjem životinja s hranom koja je bogata PUFAn3. Stoga je cilj našeg istraživanja bio utvrditi mogućnost povećanja sadržaja PUFAn3 i smanjenje odnosa PUFAn6/PUFAn3 u mesu brojlera dodavanjem pogače u njihovu ishranu. Tristašezdeset muških, jednodnevnih pilića hibrida Cobb podeljeni su u 12 grupa od 30 jedinki. Kontrolne grupe pilića hranjene su sa smešom koja nije sadržavala pogaču uljane repice (T-0), a ogledne grupe su hranjene smešama koje su sadržavale pogaču u iznosu od 5 i 10% (T-5 i T-10). Svaki hranidbeni tretman imao je četiri ponavljanja. Na kraju istraživanja odnosno 42. dana istraživanja brojleri su izmereni i žrtvovani odmah nakon toga. Uzorci grudnog mišića od 5 životinja iz svakog tretmana uzeti su u svrhu utvrđivanja sastava masnih kiselina. Kao rezultat, dobili smo da je sadržaj PUFAn3 značajno porastao u grudnom mišiću brojlera iz T-10 skupine (1,62, 1,60, 2,20). U skladu s tim, odnos PUFAn6/PUFAn3 značajno je smanjen u grudnom mišiću istog tretmana (20,94, 21,73, 16,15).

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