Journal of Animal and Feed Sciences, 14, Suppl. 1, 2005, 459–462

Effect of fish oil and vitamin E in the diet on the fatty acid composition of breast meat in broiler chickens

J. Koreleski[1] and S. Świątkiewicz

National Research Institute of Animal Production,
Department of Animal Nutrition and Feed Science
32-083 Balice, Poland

ABSTRACT

The experiment was conducted on 640 Cobb chickens allocated to 16 groups, 5 replications of 4 males and 4 females each. From 22 to 42 days of age the chickens were fed diets containing 50 g of rapeseed oil and 0, 3, 5 and 8 g of fish oil (FO) and were supplemented with 0, 40, 150 and 300 mg · kg^{-1} of α-tocopheryl acetate. At the end of the experiment the chickens were killed and breast meat was analysed for PUFA and α-tocopherol content.

At a dietary level of 5 g·kg^{-1} or more of fish oil, the EPA and DHA content in breast meat lipids increased and the PUFA n-6/n-3 ratio declined. Graded levels of vitamin E added to the diet increased the α-tocopherol content in meat in a dose-dependent manner. An interaction was not found on the effect of vitamin E and FO in the diet and PUFA in meat.

KEY WORDS: fish oil, α-tocopherol, EPA, DHA, breast meat, broiler chickens

INTRODUCTION

Dietary administration of long-chain n-3 polyunsaturated fatty acids (PUFA) may increase their content in the lipid fraction of animal products (Scaife et al., 1994) and could be a positive fatty-acid modulator in human diets (Lewis et al., 2000). The fat from cold marine fish contains high concentrations of docosapentaenoic (DPA) and docosahexaenoic (DHA) acids and can efficiently increase n-3 fatty acid content in poultry diets (Miller and Robisch, 1969). Polyunsaturated fatty acids (PUFA) are sensitive to oxidation and tocopherols help maintain lipid stability of PUFA-enriched meat (Cherian et al., 1996).

This work was conducted to determine the effect of graded levels of fish oil and α-tocopherol incorporated to the diets for the second period of feeding on the

[1] Corresponding author: e-mail: jerzy.koreleski@izoo.krakow.pl

fatty-acid composition of the lipid fraction and on the vitamin E content in breast meat of chickens.

MATERIAL AND METHODS

Standardized fish oil (FO) H465 from Lysi h.f., Reykjavik and DL-α-tocoferyl acetate (Lutavit E 50 from BASF) were used as a source of PUFA and vitamin E in the diet, respectively. The lipid fraction of fish oil contained, %: EPA 7.9, DPA 0.9 and DHA 8. The experiment was performed on 640, 21-day-old sexed Cobb chickens, fed during the first 3 weeks of life with a standard diet. The chickens were weighed and randomly allocated to 16 groups, each with 5 replications of 8 birds (4 males and 4 females) kept in wire cages. The chickens were fed *ad libitum* grower/finisher type diets based on soyabean meal and maize and contained 5% of rapeseed oil. The basal diet with a natural α-tocopherol content of 8.1 $mg \cdot kg^{-1}$ was supplemented with 0, 40, 150 or 300 mg α-tocopheryl acetate and 0, 3, 5 or 8 $g \cdot kg^{-1}$ of fish oil, which replaced rapeseed oil. On day 42 of age, 4 males and 4 females from each group were slaughtered. Breast muscles (left part of the *M. pectoralis maior*) without skin and outer fat were excised and frozen. The fatty-acid composition of breast meat was determined with a GC Varian 3400 gas chromatograph equipped with a CP-Wax 58, 25 m × 0.53 mm, 1.0 μm column and content of α-tocopherol was determined according to Manz and Phillipp (1981). Data were subjected to two-way factorial analysis of variance (Statistica ver. 5.0 PL) and differences were examined by Duncan's multiple range test.

RESULTS

Increasing α-tocopheryl acetate supplementation to the diet increased the vitamin E concentration of breast meat to 12.61 $mcg \cdot g^{-1}$ (Table 1) as compared with 2.28 mcg in chickens fed the unsupplemented diet. FO at 5 $g \cdot kg^{-1}$ diet raised the vitamin E level in meat ($P<0.05$), FO at 5 and 8 $g \cdot kg^{-1}$ diet increased the EPA and DHA contribution in total fatty acids ($P<0.001$). FO also lowered the PUFA n-6/n-3 ratio in meat, but the ratio of unsaturated fatty acids (UFA) to saturated fatty acids (SFA) was not changed.

DISCUSSION

The effect of including FO into the diet on increasing the EPA and DHA contribution to the lipid fraction of breast meat is in agreement with the reports of Pinchasov and Nir (1992) and Gonzales-Esquerra and Leeson (2000). Our results may suggest that the minimal dietary level effective for EPA and DHA content in

meat lipids is 5 g FO/kg. At this level of FO, a positive effect on vitamin E content in breast meat was also observed, but generally no interaction of vitamin E and FO levels was found. Increased dietary levels of FO lowered the PUFA n-6/n-3 ratio in breast meat, which is beneficial in terms of human diets.

The increases in vitamin E content in breast meat from increased amounts of α-tocopherol added to the diet are in agreement with the results of Młodkowski et al. (2003) and Carreras et al. (2004). The vitamin E concentration increased in a dose-dependent manner, but the contribution of EPA and DHA in lipids was not affected.

Table 1. Content of selected fatty acids (% of total FA) and vitamin E (mcg $\cdot g^{-1}$) in the lipid fraction of breast meat

Item	Fish oil g $\cdot$ kg^{-1}	Vitamin E addition, mg $\cdot$kg^{-1} of diet					SEM	Effect of		
		-	40	150	300	mean		fat	vita-min E	inter-action
$C_{22:5\ n-3}$	-	0.417	0.407	0.448	0.365	0.409^{w}	0.023	***	NS	NS
	3	0.418	0.356	0.415	0.370	0.390^{w}				
	5	0.540	0.414	0.607	0.626	0.547^{x}				
	8	0.566	0.699	0.825	0.583	0.668^{y}				
	Mean	0.485	0.469	0.574	0.486					
$C_{22:6\ n-3}$	-	2.12	1.99	1.87	1.86	1.96^{w}	0.095	***	NS	NS
	3	2.46	1.95	2.20	2.46	2.27^{w}				
	5	2.80	3.03	3.68	3.30	2.95^{x}				
	8	3.71	2.86	3.21	3.69	3.37^{y}				
	Mean	2.77	2.46	2.49	2.83					
UFA/SFA Ratio	-	2.51	2.91	2.93	2.73	2.77	0.038	NS	NS	NS
	3	2.77	2.73	2.66	2.65	2.70				
	5	2.62	2.43	2.61	2.51	2.54				
	8	2.43	2.56	2.48	2.63	2.62				
	Mean	2.58	2.66	2.67	2.63					
n-6/n-3 PUFA	-	5.66	6.19	6.21	6.08	6.04^{z}	0.083	***	*	NS
	3	5.37	5.92	5.86	5.53	5.67^{y}				
	5	5.07	5.21	5.30	4.46	5.01^{x}				
	8	4.64	4.88	4.73	4.90	4.68^{w}				
	Mean	5.19^{a}	5.55^{b}	5.53^{b}	5.14^{a}					
Vitamin E	-	2.47	3.14	7.56	12.28	6.36^{w}	0.487	*	***	NS
	3	2.20	3.55	8.64	11.49	6.47^{w}				
	5	2.39	4.49	9.06	14.49	7.63^{x}				
	8	2.08	3.65	7.75	12.21	6.43^{w}				
	Mean	2.28^{a}	3.73^{b}	8.25^{c}	12.61^{d}					

$^{a, b, c, d}$ - values in the columns with different letters differ significantly (P≤0.05); $^{w, x, y, z}$ - values in the rows with different letters differ significantly (P≤0.05); NS–P>0.05, * - P≤0.05, *** - P≤0.001
UFA - unsaturated fatty acids, SFA – saturated fatty acids, PUFA - polyunsaturated fatty acids

CONCLUSIONS

The supplementation of broiler diets with FO in amounts equal to or more than 5 $g \cdot kg^{-1}$ increases the EPA and DHA contribution in breast muscle lipids and, with vitamin E supplemented in amounts $\geq$ 40 $mg \cdot kg^{-1}$, increase the α-tocopherol content in breast muscles in a dose-dependent manner.

REFERENCES

Carreras I., Guerrero L., Guardia M., Esteve-Garcia E., Gracia Regueiro J., Sarraga C., 2004. Vitamin E levels, tiobarbituric acid test and sensory evaluation of breast muscles from broilers fed α-tocopheryl acetate- and β-carotene- supplemented diets. J. Sci. Food Agr. 84, 313-317

Gonzales-Esquerra R., Leeson S., 2000. Effects of menhaden oil and flaxseed in broilers on sensory quality and lipid composition of poultry meat. Brit. Poultry Sci. 41, 481-488

Lewis N.M., Seburg S., Flanagan N.L., 2000. Enriched eggs as a source of n-3 polyunsaturated fatty acids for humans. Poultry Sci. 79, 971-974

Manz UY., Philipp K., 1981. A method for the routine determination of tocopherols in animal feed and human foodstuff with the aid of high performance liquid chromatography. Int. J. Vit. Nutr. Res. 51, 342-348

Miller D., Robisch P., 1969. Comparative effect of herring, menhaden, an safflower oils on broiler tissues fatty acid composition and flavor. Poultry Sci. 48, 2146-2157

Młodkowski M., Świątkiewicz S., Koreleski J., Kubicz M., 2003. The effect of supplemental vitamin E and dietary rape seed oil level on broiler performance, meat and fat quality. J. Anim. Feed Sci. 12, 121-132

Pinchasov Y., Nir I., 1992. Effect of dietary polyunsaturated fatty acid concentration on performance, fat deposition and carcass fatty acid composition in broiler chickens. Poultry Sci. 71, 1504-1512

Scaife J.R., Moyo J., Galbraith H., Michie W., Campbell V., 1994. Effect of dietary supplemental fats and oils on the tissue fatty acid composition and growth of female broilers. Brit. Poultry Sci. 35, 107-118

STRESZCZENIE

Wpływ tłuszczu rybnego i witaminy E w diecie na skład kwasów tłuszczowych mięśnia piersiowego kurcząt brojlerów

Wykonano doświadczenie na 640 kurczętach brojlerach w wieku od 22 do 42 dni, które żywiono mieszanką paszową natłuszczoną olejem rzepakowym, nie uzupełnioną lub uzupełnioną 3, 5 i 8 $g \cdot kg^{-1}$ tłuszczu rybnego (FO) oraz octanem α-tokoferylu w ilości 40, 150 i 300 $mg \cdot kg^{-1}$. Po zakończeniu doświadczenia kurczęta ubito i w mięśniu piersiowym oznaczono zawartość NNKT oraz α-tokoferolu.

Przy udziale tłuszczu rybnego w diecie równym lub wyższym niż 5 $g \cdot kg^{-1}$ zwiększył się udział EPA i DHA w lipidach mięśnia piersiowego i zawęził się stosunek NNKT n-6/n-3. Wzrastający dodatek witaminy E do paszy zwiększał w mięsie zawartość α-tokoferolu, a wzrost był zależny od dawki witaminy. Nie stwierdzono interakcji wpływu witaminy E i tłuszczu rybnego w paszy i na zwartość NNKT w mięsie.