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The effect of enriching diets containing rape seed oil or soyabean oil with fish oil (LYSI) on the profile of fatty acids in breast and leg muscles of broiler chicken

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ABSTRACT

One hundred and twenty-eight broiler chickens divided into four experimental groups were fed diets containing soyabean or rape seed oil alone or mixed with fish oil at a ratio of 95 : 5. In diets and the breast and leg muscle the fatty acids (FA) profile was determined. FA profile depended mainly on the type of added vegetable oil. The PUFA/MUFA ratio in feeds, modified by the addition of fish oil, affected mainly the ratio of poly- to monounsaturated FA in the breast muscle, whereas the UFA/SFA ratio had a greater effect on the leg muscles. This confirms the varied sensitivity of muscles differing in lipid content to dietary fat quality. In the muscles of chickens given fish oil, a small amount of docosahexaenoic acid was found. However, the amount of the supplement used (0.1-0.2% fish oil) seemed insufficient to alter the FA profile in broiler muscle to an extent desired from the dietetic standpoint.

KEY WORDS: fatty acids, fats, fish oil, chickens, breast and leg muscle

INTRODUCTION

Considering dietary fat exclusively as a energy source belongs to the past. Recognition of the relation between the quality of dietary fat and carcass lipids, and their impact on human health has resulted in intensified efforts towards increasing PUFA n-3 content in broiler meat. However, attempts focused on enriching meat

in important FAs started earlier (Miller and Robish, 1969). Enrichment of meat can be achieved by feeding vegetable oils, especially rape seed oil, because of its desirable proportion of C18:3 and C18:2 acids.

Vegetable oils are capable of changing the intramuscular lipid composition in the desired direction, however, they cannot ensure a satisfactory level of EPA and DHA (eicosapentaenoic and docosahexaenoic acid). The desired concentration of long-chain PUFA in the carcass results from feeding broilers with substantial amounts of fish oil and/or meal, however, this can be accompanied by an unpleasant odour and taste of the meat.

The aim of the presented study was to search for a beneficial effect of a limited dose of fish oil combined with vegetable oils on the FA profile in chicken breast and leg muscle.

MATERIAL AND METHODS

The experiment was carried out on 128 one-day-old Starbro broilers kept in cages, divided at random into 4 groups (4 replicates per group). Chickens were given: starter, days 1-14; grower, days 15-35; and finisher, days 36-42. The main ingredients of diets were: ground maize and wheat, solvent soyabean meal and meat-and-bone meal. The broiler starter diet was supplemented with 2% dietary fat, grower and finisher diets, with 4%. All of the diets were isoprotein (22.1% starter and 20.5% grower/finisher) and isocaloric (13.2 and 13.5 MJ ME, respectively). The only experimental variable was kind of dietary fat. Diets for groups 1 and 2 were supplemented with plant oils only: rape seed (RO) and soyabean (SO). In groups 3 (RO+FO) and 4 (SO+FO) plant oils were combined with fish oil (LYSI) in a proportion of 95:5. The concentration of FA in diets and oils is given in Table 1.

On the last day of the experiment, 8 cockerels from every group, of average body weight for the group (2938, 2917, 2919 and 2930 g, respectively), were selected, slaughtered after 8 h fasting, and dissected. In lipids extracted from homogenized breast and leg muscles (thigh and second thigh together) without skin, the FA profile was determined using an INCO 505 M gas chromatograph (2 m long column packed 10% LAC-3R-728 +1% H_3PO_4. The data was subjected to one-way analysis of variance.

RESULTS

The concentration of FA in diets depended mainly on plant oil. The PUFA/MUFA proportion was substantially higher in the diets containing SO, whereas the UFA/SFA proportion in the diets supplemented with RO. Fish oil slightly im-

TABLE I

Content of fatty acids in the diet and dietary oil, % of FA sum

Fatty acids	S1 RO	S2 SO	S3 RO+FO	S4 SO+FO	G/F1 RO	G/F2 SO	G/F3 RO+FO	G/F4 SO+FO	Rape seed oil	Soyabean oil	Fish oil
C14:0	0.42	0.50	0.50	0.53	0.42	0.48	0.53	0.58		0.12	4.77
C15:0											0.76
C16:0	12.83	16.63	13.89	18.90	13.37	19.31	14.18	20.12	3.75	10.43	14.44
C16:1	0.83	0.90	0.81	1.07	1.01	1.01	1.04	1.11	0.27	0.12	10.01
C18:0	5.16	7.56	5.79	7.92	5.16	9.47	5.87	10.21	1.08	4.10	2.92
C18:1	44.82	35.05	43.11	34.46	52.38	40.68	51.09	39.13	60.88	21.68	28.21
C18:2	30.32	35.00	30.50	32.99	22.11	23.85	21.85	23.15	19.93	53.35	5.72
C18:3	4.65	3.79	4.37	3.45	3.72	2.25	3.46	2.17	9.64	7.04	4.53
C20:0	0.96	0.47	1.03	0.68	0.71	0.52	0.67	0.54			0.17
C20:1									1.75	0.28	1.04
C20:5											14.94
C22:6											9.60
SFA	19.37	25.16	21.21	28.03	19.66	29.87	21.25	31.45	4.83	14.65	23.06
MUFA	45.65	35.95	43.92	35.53	53.39	41.69	52.13	40.24	62.90	22.08	39.26
PUFA	34.97	38.79	34.87	36.44	25.83	26.10	25.35	25.32	29.57	60.39	34.79
PUFA/MUFA	0.77	1.08	0.79	1.03	0.48	0.63	0.49	0.63	0.47	2.73	0.89
UFA/SFA	4.16	2.97	3.71	2.57	4.03	2.28	3.65	2.08	19.14	5.63	3.21

S – Starter, G – Grower, F – Finisher diet

added fats: RO – rape seed oil, SO – soyabean oil, FO – fish oil

proved the PUFA/MUFA ratio (with the only exception for broiler starter containing soyabean oil) but lowered the UFA/SFA ratio.

Feeding diets containing fish oil to broilers resulted in increased concentration of myristic and stearic acids in the breast muscle but did not alter significantly the content of C16:0. In contrast, there was no remarkable effect of fish oil on saturated FA in leg muscle (Table 2.).

TABLE 2

Content of FA in muscle lipids, % of FA sum

Fatty acids	RO	SO	RO+ FO	SO+ FO	SEM	RO	SO	RO+ FO	SO+ FO	SEM
	Breast muscle					Leg muscle				
C14:0	0.68^{a}	0.65^{a}	0.82^{b}	0.77^{b}	0.021	0.68	0.68	0.73	0.71	0.018
C16:0	21.05	23.67	20.69	20.73	0.513	19.89	22.01	19.82	22.90	0.295
C16:1	5.67^{a}	4.92^{b}	5.21	5.12	0.152	6.21^{A}	4.87^{B}	5.45	5.92	0.126
C18:0	6.10^{A}	7.32^{Bb}	7.39^{Bc}	8.07^{Bc}	0.133	5.49^{A}	6.63^{B}	5.76^{A}	6.39^{B}	0.113
C18:1	48.42^{A}	42.31^{B}	46.48^{A}	39.84^{B}	0.201	46.65^{A}	41.14^{B}	47.27^{A}	41.67^{B}	0.204
C18:2	13.90^{A}	16.97^{B}	14.93^{A}	20.72^{C}	0.091	16.38^{A}	21.01^{B}	16.19^{A}	18.03^{C}	0.065
C18:3	1.98^{a}	2.43^{Bb}	1.78^{ac}	1.69^{Cc}	0.053	2.38^{Aa}	2.24^{Aa}	1.97^{b}	1.55^{B}	0.070
C20:1	0.66^{a}	0.66^{a}	0.77^{b}	0.76^{b}	0.052	0.65^{ac}	0.56^{a}	0.77^{b}	0.73^{bc}	0.047
C20:4	0.51^{a}	0.47^{a}	0.48^{a}	0.29^{b}	0.018	0.47^{a}	0.57^{a}	0.59^{a}	0.24^{b}	0.015
C22:1	1.00		1.34		0.004	1.03		1.41		0.005
C22:6			0.10	0.09	0.002			0.04	0.09	0.004
SFA	27.83	31.64	28.90	29.57		26.06	29.32	26.31	30.00	
MUFA	55.75	47.89	53.80	45.72		54.54	46.57	54.90	48.32	
PUFA	16.39	19.87	17.29	22.79		19.23	23.82	18.79	19.91	
PUFA/MUA	0.29	0.41	0.32	0.50		0.35	0.51	0.34	0.41	
UFA/SFA	2.59	2.14	2.46	2.31		2.83	2.40	2.80	2.27	

values followed by different letters differ significantly: capitals at $P<0.01$; small letters $P<0.05$
RO, SO, FO – as in Table 1

Fish oil modified the concentration of some unsaturated FA in broiler muscles. In the breast muscle a significant increase of eicosenoic acid (EPA) was found regardless of the kind of plant oil, whereas an increase in linoleic acid was noted only with respect to SO. In chickens given the SO, a decrease of linolenic and arachidonic acid contents was noted. Supplementation of broiler feed with fish oil also resulted in lowered concentrations of both C18:3 and C20:4 acids in the leg muscle. In muscles derived from broilers fed with RO, the presence of erucic acid was stated. Feeding fish oil resulted in the appearance of DHA, however, in relatively small and varied amounts.

DISCUSSION

The addition of dietary fat to the diet was low, however, it altered the FA profile and the effect of plant oil was dominant. Because of great differences in the concentration of C18:1 and C18:2 FA in the oils, the relation PUFA/MUFA in diets also varied and was higher with respect to SO, whereas the UFA/SFA ratio was lower. Supplementation of diets with fish oil lowered this relation, too.

The differentiated FA profile in muscle, generated by dietary fat, did not directly reflect the change in the FA profile in diets. Furthermore, it seems that the PUFA/MUFA ratio, modified by fish oil supplementation, had a greater impact on the PUFA/MUFA ratio in the breast than in the leg muscle, whereas with respect to UFA/SFA, the tendency was the opposite. Some investigations also confirm the differences in FA deposition between tissues (Hulan et al., 1989; Huang et al.,1990), resulting probably from different contents of tissue lipids and their affinity to dietary FA differing in saturation degree.

Compared with literature reports dealing not only with poultry (Morgan et al., 1992; Leskanich et al., 1994; Sawosz et al., 1999) the influence of fish oil on FA profile in muscle, established in the presented investigations, was not substantial, probably due to insufficient supplementation of broiler diets with fish oil (0.1-0.2%).

CONCLUSIONS

The FA profile in broiler muscle depended mainly on the plant oil added to the diets. Adding soyabean oil increased the PUFA fraction, whereas feeding rape seed oil increased the MUFA content in muscles. Supplementation of plant oils with fish oil (95:5) to a certain extent improved the PUFA/MUFA ratio in the breast muscle and resulted in the appearance of a small amount of DHA in both breast and leg muscles.

The diets supplemented with 0.1-0.2% of fish oil, however, did not significantly change the FA profile in broiler meat in the direction desired from the dietetic standpoint.

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STRESZCZENIE

Wpływ dodatku oleju rybiego (LYSI) do mieszanek z udziałem oleju rzepakowego lub sojowego na zawartość kwasów tłuszczowych w mięśniach piersiowych i nóg brojlerów

Sto dwadzieścia osiem kurcząt podzielonych na cztery grupy doświadczalne żywiono mieszankami natłuszczonymi olejem rzepakowym lub sojowym bez albo z dodatkiem oleju rybiego w proporcji 95:5. W mięśniach piersiowych i nóg kurcząt oznaczono profil kwasów tłuszczowych (KT), który zależał głównie od rodzaju dodanego oleju roślinnego. Zmienione w wyniku wprowadzenia oleju rybiego proporcje PUFA/MUFA w mieszankach w większym stopniu zmieniły proporcje wielo- do jednonienasyconych KT w mięśniu piersiowym, podczas gdy relacje UFA/SFA miały większy wpływ na KT w mięśniach nóg; potwierdza to niejednakową podatność mięśni, o różnej zawartości lipidów, na wpływ jakości tłuszczu paszowego. W mięśniach pochodzących od kurcząt otrzymujących olej rybi stwierdzono niewielką ilość kwasu dokozaheksaenowego.

Zastosowany w badaniach dodatek oleju rybiego w ilości 0,1-0,2% mieszanki okazał się jednak zbyt mały by istotnie zmodyfikować profil kwasów tłuszczowych w kierunku pożądanym z dietetycznego punktu widzenia.