Effect of type of basal fat on meat composition and n-3 fatty acids deposition efficiency in turkeys

E. Delezie*, J.M. Aerts, M. Aluwé, G. Huyghebaert & D. De Brabander
Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences, Scheldeweg 68, B-9090 Melle, Belgium.
*E-mail: Evelyne.delezie@ilvo.vlaanderen.be.

Abstract

It is known that the consumption of long-chain n-3 polyunsaturated fatty acids (LC n-3 PUFA) reduce the risk of heart, vascular and other modern diseases. As the consumption of n-3 PUFA in most western populations is sub-optimal, the enrichment of poultry products with LC n-3 PUFA can increase their intake. The objective of this study was to investigate the effects of diet composition on turkey performance and meat fatty acid concentrations. A 12- week growth trial was set up with three experimental diets, only differing in supplemental fat to obtain a high variable fatty acid profile. Performance parameters did not differ among the groups. The PUFA profile in tissues changed due to the different diets: tissue n-3 PUFA were positively related to dietary n-3 PUFA, consequently a better n-6/n-3 FA ratio was achieved if linseed or fish oil were added to the diet. As linseed oil was not very efficient as LC n-3 PUFA precursor, highest levels of LC n-3 PUFA were obtained if fish oil was supplemented to the diet.

Introduction

The impact of LC n-3 PUFA on human health is well established. In recent years there has been much interest in the beneficial effects of the LC n-3 PUFA and the ratio between the ω-6 and ω-3 PUFA due to their presumed healthy effects for humans. Some of these effects have been well documented and have a clear effect on some "western society" chronic diseases (Racine and Deckelbaum, 2007). Nutritional enhancements as the enrichment of animal products with LCn-3 fatty acids can significantly contribute to the nutritional requirements of the consumers without any change in the consumer's eating behaviour.

A lower n-6/n-3 FA ratio induces a more appropriate balance of both their respective LC PUFA (arachidonic acid: (AA) versus eicospentaenoic acid (EPA) and docosahexaenoic acid (DHA)) and eicosanoids with specific and opposite metabolic properties (Simopoulos, 2000). The need for increasing linolenic acid (LNA) and decreasing linoleic acid (LA) and the role of direct supply of LC n-3 PUFA through the diet in view of restoring the optimal physiological n-6/n-3 balance for the prevention of chronic diseases on population level, is currently the subject of scientific debate.

The objective of the present study was to investigate the effect of type of fat supplement on meat composition and n-3 fatty acids deposition efficiency in turkeys. The study focused on the enhancement of n-3 fatty acid content of meat by replacing a n-6 rich oil (soybean) with n-3 rich oils (linseed and fish oil) in the animal's diet.

Material and methods

A growth trial was set up with 540 male turkey poults. The turkeys were housed in an environmentally regulated stable and distributed among 9 pens. The turkey poults were randomly assigned to 3 treatments each with 3 replicates. This experiment was designed as factorial arrangement of treatments, with diet and age as factors. Each pen was considered as an experimental unit.

Each diet consisted of a standard 4-phase feeding including a starter, grower I, grower II and finisher diet. The three kinds of isoenergetic and isonitrogenous maize soybean meal based diets each comprised a 97 % constant basal component and a varying 3% oil fraction. The three oil supplements were soy-oil (SO) (diet I), linseed (LO) (diet II) and fish oil (FO) (diet III) (30g/kg). The turkey poults consumed the diets and water *ad libitum* for 12 weeks. The fatty acid profiles of these oils and feeds were analysed by gas chromatography.

Every 4 weeks over the 12 week test period, birds from each pen were group weighed, their feed intake was determined and feed efficiency and mortality were calculated. At week 4, 8 and 12, tissue samples of breast and thigh were collected from 2 birds of each pen with a body weight close to the average pen weight. After a chloroform/methanol (2:1 (v/v)) extraction and subsequent methylation of the FA according to Sukhija and Palmquist (1988), FA composition of the breast and thigh samples were analyzed by GC- flame ionisation detection.

Comparison of the performance among dietary treatment groups were performed by one-way analysis of variance (ANOVA) using STATISTICA. The fatty acids concentrations were analysed using a 2-factorial analysis to investigate the effect of oil source and age of the turkeys on n-3 fatty acid levels. Significant differences between treatments were tested with LSD test. Differences due to treatments or age were considered significant if the P-value was < 0.05.

Results and discussion

Supplementation of 30g/kg linseed oil or fish oil to the diet of turkeys did not cause significant changes ($P > 0.05$) in body weight, feed intake, daily weight gain and feed conversion (feed intake/weight gain) compared with the soy-oil fed control group (Table 1).

Table 1. Performance of the turkeys (week 1 – week 12)

Diet	D1 (SO)	D2 (LO)	D3 (FO)	P-value
Daily feed intake (g)	263.5	262.3	269.5	0.83
Daily weight gain (g)	127.7	128.2	126.8	0.96
Feed conversion	2.1	2.1	2.1	0.67
Final body weight (g)	14367	14429	14270	0.96

These data suggest in accordance with the results found by Lopez-Ferrer et al. (2001), that performance of broilers is not effected by source of oil added to the diet which is an important criterion for economically-sustainable animal production systems. However, data regarding the effect of source of oil on performance are inconsistent. Newman et al. (2002) found a higher feed intake and feed conversion ratio by increasing the PUFA levels in diets. In general, the inclusion of higher PUFA levels does not cause adverse effects on performance and mortality as compared to the control fed counterparts. Detrimental effects on these parameters were only observed if the oils were fed at high doses, were overheated or both (Billek, 2000).

There were no significant differences among the treatment groups in levels of saturated, monounsaturated or PUFA. However, the levels of n-3 FA in tissue samples differed between diets. Table 2 presents the fatty acid composition of breast (Table 2a) and thigh (Table 2b) samples at increasing age of the turkeys.

The amount of n-3 FA was significantly increased if LO or FO was added to the diet. Highest values were obtained if turkeys were given the FO supplemented diet. The n-3 content increased mainly in the form of LNA and LC n-3 PUFA if broilers were fed diet II and diet III, respectively. However, LC n-3 PUFA also reached higher values if the precursor LNA was added to the diet. The results indicate that the turkeys are able to convert the precursor of the n-3 family towards its derivates but conversion-efficacy is rather low. The n-6/n-3 ratios obtained in breast and thigh were significantly lower for turkeys fed diet III versus all other groups especially due to a decrease in AA and increase in EPA and DHA.

Table 2. Fatty acid profile of breast (a) and thigh samples (b) (% of total fatty acids)

a) Fatty acid profile of breast samples

	C18:0	C18:1n9	C18:2n6	C18:3n3	C20:4n6	C20:5n3	C22:6n3	n-3	n-6/n-3
Week 4									
Diet I[1]	14.44 [a]	11.77[a]	34.88[a]	2.26 [b]	6.51 [a]	1.01 [c]	1.38[c]	5.27 [c]	9.81 [a]
Diet II[1]	14.01 [a]	11.85[a]	29.83 [b]	5.39 [a]	4.11 [b]	3.08 [b]	4.60 [b]	13.70 [b]	2.79 [b]
Diet III[1]	12.89 [b]	9.62[b]	19.90[c]	0.76 [c]	3.29 [b]	6.18 [a]	14.97 [a]	22.11 [a]	1.10 [c]
Week 8									
Diet I	13.03 [a]	13.33 [a]	32.03 [a]	3.97 [b]	7.0 [a]	1.47 [c]	2.79[c]	8.61 [c]	5.99 [a]
Diet II	12.83 [a]	13.42[a]	29.23[b]	7.50 [a]	4.81 [b]	2.76 [b]	3.78 [b]	14.63 [b]	2.47 [b]
Diet III	11.59[b]	11.58[b]	19.74[c]	1.11 [c]	3.77 [b]	5.50 [a]	15.09 [a]	21.89 [a]	1.13 [c]
Week 12									
Diet I	12.71 [a]	15.26 [a]	29.66 [a]	1.80 [b]	10.61 [a]	0.83 [c]	2.92[c]	5.77 [c]	7.27 [a]
Diet II	12.68 [a]	15.38 [a]	26.14 [b]	8.55 [a]	5.53[b]	2.78 [b]	3.76 [b]	15.66 [b]	2.11 [b]
Diet III	11.64 [b]	13.22[b]	17.51[c]	1.17 [c]	4.03[b]	6.06 [a]	15.87 [a]	23.25 [a]	0.97 [c]
ANOVA									
Diet (D)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Age (A)	0.001	0.031	0.001	0.068	0.001	0.61	0.76	0.22	0.023
D*A	0.97	0.97	0.49	0.087	0.001	0.19	0.58	0.23	0.029

b) Fatty acid profile of thigh samples

	C18:0	C18:1n9	C18:2n6	C18:3n3	C20:4n6	C20:5n3	C22:6n3	n-3	n-6/n-3
Week 4									
Diet I	10.80 [a]	17.03[a]	41.47[a]	3.73 [b]	4.13 [a]	0.37 [c]	0.74[b]	4.94 [b]	9.42[a]
Diet II	9.69[a]	17.06[a]	32.91[b]	16.88 [a]	2.24 [b]	1.10 [b]	1.10 [b]	19.32 [a]	1.86[b]
Diet III	9.29[b]	14.16[b]	27.27[c]	2.92[b]	1.77 [c]	5.53 [a]	7.58 [a]	16.14 [a]	1.84[b]
Week 8									
Diet I	11.68 [a]	14.65 [a]	40.42 [a]	3.71 [b]	6.44[a]	0.49 [c]	1.15[b]	5.49[b]	8.76[a]
Diet II	11.85 [a]	14.48[a]	32.23[b]	14.35[a]	3.56 [b]	1.93 [b]	1.91[b]	18.51[a]	1.99[b]
Diet III	10.58[b]	12.32[b]	26.24[c]	2.35 [b]	2.74 [c]	5.84 [a]	9.49[a]	17.82[a]	1.68[b]
Week 12									
Diet I	13.56 [a]	13.62 [a]	36.08 [a]	3.72 [b]	7.71 [a]	0.73 [c]	1.67[b]	6.26[b]	7.63[a]
Diet II	13.09 [a]	13.89 [a]	30.78 [b]	11.25 [a]	5.53[b]	1.67 [b]	1.86[b]	15.06[a]	3.21[b]
Diet III	12.78 [b]	12.06[b]	24.08[c]	3.22 [b]	3.78[c]	5.27 [a]	9.67[a]	18.30[a]	1.58[c]
ANOVA									
Diet (D)	0.010	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Age (A)	0.001	0.001	0.001	0.020	0.001	0.006	0.001	0.54	0.784
D*A	0.58	0.27	0.11	0.002	0.058	0.014	0.033	0.002	0.024

[1]Diet I: diet supplemented with soy-oil, Diet II: diet supplemented with linseed oil, Diet III: diet supplemented with fish oil.

Conclusions

The present investigation demonstrates the effects of dietary fatty acid profiles on tissue fatty acid composition. Feeding a higher amount of n-3 PUFA (diet II and diet III) resulted in a similar body weight and feed conversion efficiency of turkeys fed the soy-oil based diet. Furthermore, the dietary FA profile was reflected in the animal products, consequently the enrichment of animal products with LC n-3 PUFA can significantly contribute to the nutritional requirements of the consumers.

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