

# The effect of flaxseed on the fatty acid profile of the quail meat

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Abbreviated title: Flaxseed and quail meat fatty acids profile

## Summary

An experiment was carried out to study the effect of flaxseed on fatty acid profile of quail meat. Therefore, 340 female and 60 male quail breeders (*Coturnix coturnix japonica*) were randomly divided into two groups (Omega- O and Control-C). Group O was fed with a ration consisting of 10% flaxseed while group C was fed a ration without flaxseed. Eggs from both groups were incubated separately. Chicks of both O and C egg groups were divided in four different groups OO and OC, and CO and CC, respectively. Chicks in groups OO and CO were fed with a growing/fattening ration consisting of 10% flaxseed, whereas chicks in OC and CC groups were fed with a ration without flaxseed. Meat samples were obtained from the breast and the legs, separately. The fatty acid profile was determined with Gas Chromatography. The  $\alpha$ -linolenic acid mean percentage ( $\pm$ SD) for the groups OO, OC, CO, CC was 12,73% $\pm$ 1,36, 2,48% $\pm$ 0,71, 12,39% $\pm$ 1,85, 3,66% $\pm$ 1,05 respectively, linoleic acid mean percentage ( $\pm$ SD) was 26,88% $\pm$ 1,81, 30,58% $\pm$ 2,78, 28,13% $\pm$ 1,97, 31,04% $\pm$ 4,19 respectively, and the Omega 6/Omega 3 mean ratio ( $\pm$ SD) was 1,89 $\pm$ 0,15, 7,38 $\pm$ 1,43, 1,99 $\pm$ 0,16, 5,97 $\pm$ 1,36, respectively. In conclusion, the incorporation of flaxseed in quails' rations had a favourable effect on the fatty acid profile of the produced meat.

Keywords: Omega-3, omega-6 fatty acids; flaxseed; quail meat

## Introduction

The beneficial effects of the omega-3 fatty acids to the overall human health are well established (Simopoulos, 2000, 2002, 2004 & 2008). The incorporation of omega-3 fatty acids into egg yolk using fish oils and flaxseed is one of the strategies for the production of qualitative poultry products (Cherian et al., 1996; Yannakopoulos et al., 1999). Flaxseed is considered as a good source for the enrichment of poultry meat with omega-3 fatty acids and specifically in a-linolenic acid (Kratzer et al., 1996; Tserveni-Goussi *et al.*, 1999). A large number of 'designer types' of hen eggs and poultry meat are available in the market for some years. With regard to the Greek market, products based on the use of flaxseed in poultry diets, like omega-3 hen eggs, omega-3 eggs with herbs and omega-3 broiler meat with herbs, have been available for approximately a decade (Yannakopoulos, 2008; Yannakopoulos and Tserveni-Goussi, 2008).

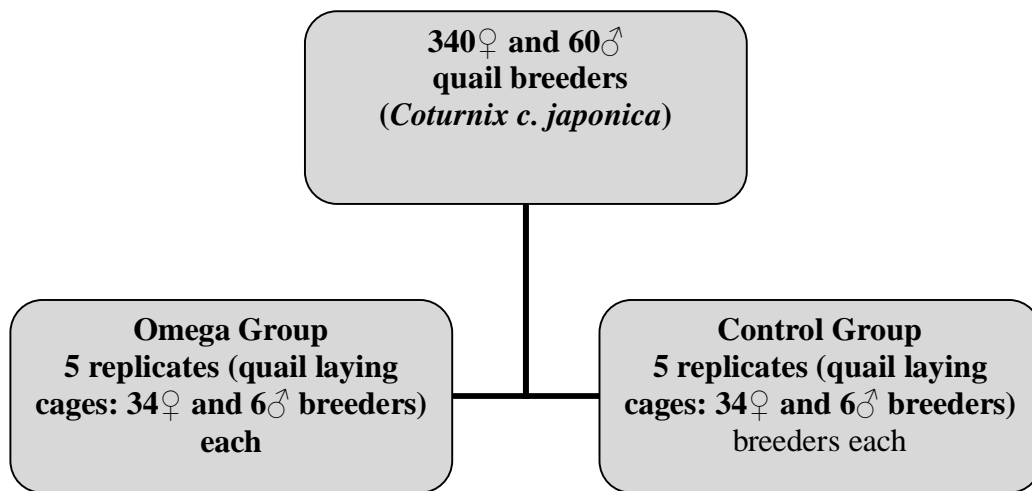
Quail meat production varies around the world with the main producing countries being in Europe and America (Minvielle, 2004). Quail meat is considered as a delicate type of meat and is characterized by low levels of fat and cholesterol.

However, the information of the fatty acid profile of quail meat through nutritional manipulation is limited. Furthermore, the effect of the dietary incorporation of flaxseed in quails' rations has not been studied before. Hence, the objective of the present study was to evaluate the effect of the dietary inclusion of flaxseed in both the parental and growing diets of quails on the fatty acid profile of the produced meat.

## Materials and Methods

Three hundred and forty (340) female and sixty (60) male quail breeders (*Coturnix coturnix japonica*) aged five weeks were divided at random into two groups (Omega and Control) as shown in Figure 1. Each group consisted of five replicates, in Italian style laying quail cages, with thirty four (34) female and six (6) male quail breeders each.

Figure 1 Quail breeders groups used in the study.



The Omega group was fed with a ration for breeders containing 10% flaxseed while the Control group was fed with a respective ration without flaxseed (Table 1). Both rations were isonitrogenous and isocaloric and were fed throughout the study. At the age of ten (10) and sixteen (16) weeks, eggs from both groups were collected and were incubated separately. Following incubation and for each age, hatched chicks derived from the Omega egg group were divided at random in two groups OO and OC, whereas the ones of the Control egg group in CO and CC groups (Figure 2).

Each one of the growing groups consisted of 400 day old chicks at the start of the experiment that were raised in 4m<sup>2</sup> of deep litter floor. For each age, chicks in OO and CO groups were fed with a growing/fattening ration containing 10% flaxseed, whereas chicks in OC and CC groups were fed with a ration without flaxseed. Both rations were also kept isonitrogenous and isocaloric (Table 1). Feed and water were provided for *ab libitum* consumption.

Figure 2 Growing quails' groups for each breeders age used in the study.

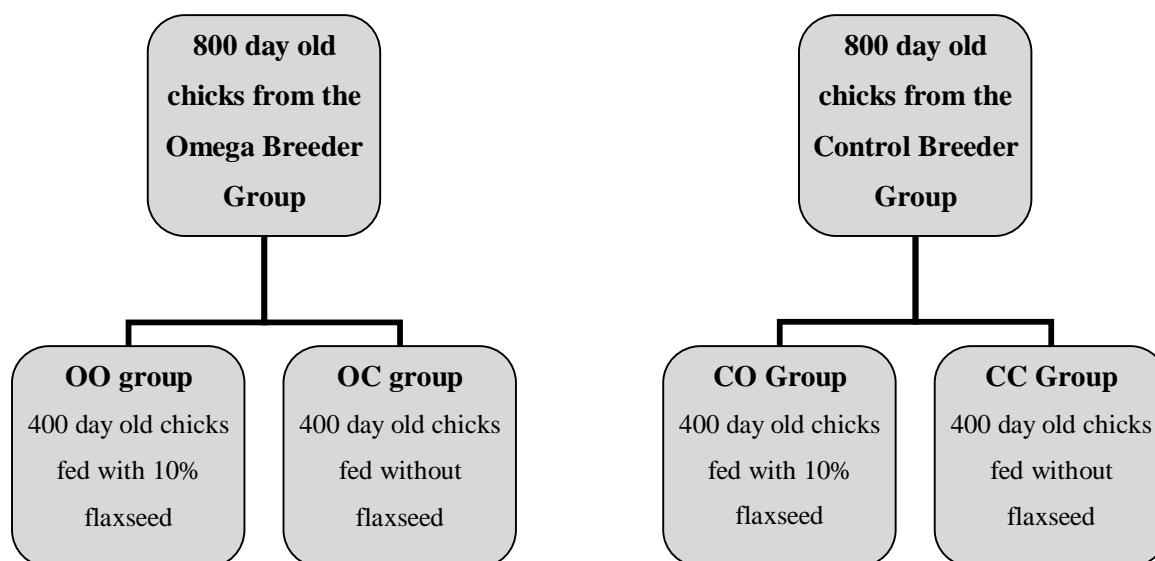


Table 1 Total protein (%), total fat (%), moisture (%), ash (%) and fatty acid composition (%) in breeding and growing/fattening rations.

	<i>Control laying diet</i>	<i>Omega laying diet</i>	<i>Control growing diet (OC, CC groups)</i>	<i>Omega growing diet (OO, CO groups)</i>
Total Protein	22.0	21.9	24.7	25.0
Total lipids	6.0	6.6	6.0	6.9
Moisture	9.7	9.1	10.9	10.4
Ash	10.4	10.3	6.6	6.2
Linoleic acid <sup>1</sup>	38.44	39.41	38.71	31.14
a-linolenic acid <sup>1</sup>	3.14	15.76	2.95	27.20
EPA1	0.35	0.15	0.34	0.37
DHA <sup>1</sup>	0.50	0.28	0.50	0.47
SFA <sup>1</sup>	22.42	15.68	22.04	13.38
MUFA <sup>1</sup>	34.89	28.67	35.13	27.29
PUFA <sup>1</sup>	42.63	55.59	42.77	59.29
Total ω-6	38.65	39.41	38.98	31.22
Total ω-3	3.98	16.18	3.79	28.08
Ω-6/Ω-3	9.70	2.43	10.28	1.11

<sup>1</sup> Linoleic acid: 18:2 n-6; a-linolenic acid: 18:3 n-3; EPA: 20:5 n-3; DHA: 22:6 n-3; SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids.

The experimental growing period lasted for five weeks. At the end of this period all chicks were slaughtered. A sample of fifteen (15) breasts and fifteen (15) legs from each group were collected for each breeding period, wrapped in plastic bags and stored at  $-30^{\circ}\text{C}$  for further fatty acid analysis. The total fat was extracted with a method similar to that described by Yannakopoulos *et al.* (2009). In each sample 3g of frozen quail meat (breasts and thighs were analyzed separately) were weighed in a volumetric cylinder containing 10ml of methanolic solution of BHT (0.15%, w/v) and 50ml of a diethyl ether–petroleum ether mixture (1:1). Sample was homogenised using an Ultra-Turrax® homogenizer by the addition 6ml of a water solution of NaCl (0.98%, w/v). The mixture was centrifuged, the fat-extraction solvents were transferred to a 250ml flask and evaporated in vacuum. The mixture was re-dissolved in n-hexane and derivatization to FAMES was carried out with methanolic solution of KOH 2M, according to ISO 5509:2000 standards. Measurements of FAMES were made by the use of a Varian CP-3800 gas chromatographer with a Varian CP-8400 auto-sampler and an FID detector. The composition of the quail breast and leg meat (% of the total fat) in linoleic acid (LA: 18:2n-6),  $\alpha$ -linolenic acid (ALA: 18:3n-3), eicosapentaenoic acid (EPA: 20:5n-3), docosahexaenoic acid (DHA: 22:6n-3), total Omega-6 fatty acids, total Omega-3 fatty acids and total Omega-6/Omega-3 ratio were calculated.

All data collected were statistically analyzed using Statistix 9.0 software. An ANOVA model was used and means were compared for significant differences ( $P < 0.05$ ) using the Tukey's HSD All-pairwise Comparisons Test.

## Results and discussion

Results showed that between the two ages (10 and 16 weeks), there was not any statistically significant difference for the measured parameters and, therefore, it is not discussed any further. The fatty acids composition of the quail breast and leg meat is given in Table 2. As can be seen from the results, the paternal diet did not affect the fatty acid profile of the produced meat. LA content in the quail meat was significantly ( $P < 0.05$ ) lower in groups where chicks were consuming diets with flaxseed (groups OO and CO), while, between different carcass parts (breast and leg meat) there was not any significant difference. ALA percentage was significantly ( $P < 0.05$ ) higher in groups where chicks were consuming diets with flaxseed (groups OO and CO) while differences in distribution between thighs and breasts were not statistically significant. The incorporation of flaxseed in quails diets had a significant ( $P < 0.05$ ) effect on the EPA content with groups OO and CO having the highest values compared to OC and CC groups in both breast and leg meat.

Significant differences were also recorded between breast and leg meat within the same group, as EPA values were lower in the leg meat. Interestingly, DHA content was not affected by the flaxseed incorporation in quails' diets with the highest ratios ( $P<0.05$ ) to be observed for the breast meat.

Table 2 Mean ( $\pm$ SD) fatty acid composition (%) in breast and leg meat of Japanese quail.

Fatty acids <sup>1</sup>	Groups							
	OO		OC		CO		CC	
	Breast	Leg	Breast	Leg	Breast	Leg	Breast	Leg
LA	26.86 $\pm$ 1.60 a	26.90 $\pm$ 2.03 a	30.66 $\pm$ 2.64 b	30.50 $\pm$ 2.95 b	27.74 $\pm$ 1.72 a	28.50 $\pm$ 2.04 a	30.35 $\pm$ 5.38 b	31.77 $\pm$ 2.27 b
ALA	12.33 $\pm$ 1.30 a	13.14 $\pm$ 1.31 a	2.46 $\pm$ 0.73 <sup>b</sup>	2.49 $\pm$ 0.71 <sup>b</sup>	11.68 $\pm$ 1.98 a	13.06 $\pm$ 1.29 a	3.44 $\pm$ 1.09 <sup>b</sup>	3.87 $\pm$ 0.95 <sup>b</sup>
EPA	0.98 $\pm$ 0.48 <sup>a</sup>	0.48 $\pm$ 0.28 <sup>b</sup>	0.45 $\pm$ 0.20 <sup>b</sup>	0.26 $\pm$ 0.15 <sup>c</sup>	1.21 $\pm$ 0.60 <sup>a</sup>	0.40 $\pm$ 0.10 <sup>b</sup>	0.57 $\pm$ 0.30 <sup>b</sup>	0.29 $\pm$ 0.08 <sup>c</sup>
DHA	1.73 $\pm$ 0.82 <sup>a</sup>	1.27 $\pm$ 1.02 <sup>b</sup>	1.99 $\pm$ 1.36 <sup>a</sup>	1.88 $\pm$ 2.00 <sup>a</sup>	2.51 $\pm$ 1.58 <sup>a</sup>	1.15 $\pm$ 0.61 <sup>b</sup>	2.09 $\pm$ 1.19 <sup>a</sup>	1.37 $\pm$ 0.58 <sup>b</sup>
Omega 6	28.61 $\pm$ 1.58 a	28.10 $\pm$ 2.05 a	33.56 $\pm$ 3.11 b	32.83 $\pm$ 3.03 b	30.14 $\pm$ 1.71 a	29.68 $\pm$ 2.16 a	34.16 $\pm$ 2.36 b	33.48 $\pm$ 2.61 b
Omega 3	15.14 $\pm$ 0.89 a	14.96 $\pm$ 0.91 a	4.74 $\pm$ 0.97 <sup>b</sup>	4.43 $\pm$ 1.14 <sup>b</sup>	15.51 $\pm$ 0.90 a	14.68 $\pm$ 0.96 a	6.26 $\pm$ 1.35 <sup>b</sup>	5.54 $\pm$ 1.03 <sup>b</sup>
$\Omega 6/\Omega 3$	1.90 $\pm$ 0.15 <sup>a</sup>	1.88 $\pm$ 0.14 <sup>a</sup>	7.28 $\pm$ 1.22 <sup>b</sup>	7.69 $\pm$ 1.25 <sup>b</sup>	1.95 $\pm$ 0.12 <sup>a</sup>	2.03 $\pm$ 0.17 <sup>a</sup>	5.72 $\pm$ 1.39 <sup>b</sup>	6.25 $\pm$ 1.29 <sup>b</sup>

<sup>1</sup>Fatty acids LA: 18:2 n-6; ALA: 18:3 n-3; EPA: 20:5 n-3; DHA: 22:6 n-3; Omega 6: Total Omega-6 fatty acids; Omega 3: Total Omega-3 fatty acids;  $\Omega 6/\Omega 3$ : Total Omega-6/Omega-3 ratio.

a, b, c Means in rows not sharing a letter differ significantly ( $P<0.05$ ).

Total omega-6 fatty acids content in the quail meat was significant ( $P<0.05$ ) affected by the diet, with the highest values to be observed in OC and CC groups. Within group, differences between carcass parts were not observed. Omega-3 fatty acids content in groups OO and CO were significantly ( $P<0.05$ ) higher compared to groups OC and CC, while differences between breast and leg meat were not significant. Omega-6/ omega-3 fatty acids ratio was also affected significantly ( $P<0.05$ ) by the incorporation of flaxseed in quails' diets and the lowest values were recorded in groups OO and CO.

The results of this study showed that the incorporation of flaxseed in growing quails' rations increased the total omega-3 fatty acids content while decreased the total omega-6 fatty acids in the produced meat, improving thus its quality. Furthermore, it has been shown that DHA content in quail meat was not affected by the dietary inclusion of flaxseed which can be attributed to the lower conversion ratio of ALA to DHA compared to the conversion of ALA to EPA. These findings come in agreement with the conclusions of Tserveni-Goussi *et al.* (1999) and Yannakopoulos *et al.* (2008) who studied the effect of the dietary incorporation of flaxseed in broilers rations. According to their findings, ALA and EPA were higher in the produced meat from broilers fed with 10% flaxseed, while DHA content was not affected.

In conclusion, the dietary incorporation of flaxseed in growing quails rations had a beneficial effect on the fatty acid profile of the produced meat.

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