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EFFECT OF THE INCLUSION TIME OF EXTRUDED LINSEED SUPPPLEMENTATION BEFORE SLAUGHTER ON n-3 FATTY ACIDS ENRICHMENT OF CHICKEN MEAT

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Abstract

An experiment was conducted on nine hundred chicken of a label strain to study the effect of the inclusion time of extruded linseed on fatty acids (FA) composition and quality parameters of meat. The results showed that n-3 fatty acids content of thigh muscle increased with linseed supplementation and was related to the inclusion time of this supplement (27 *vs* 14 d before slaughter). This higher content of n-3 fatty acids resulted in a decreased n-6/n-3 ratio, which was beneficial for the consumers health. The treatments showed no effect on feed conversion and daily weight gain or carcass yield. No significant difference between meat quality parameters of the breast samples were detected, except for dry matter.

Résumé

Une expérience a été réalisée sur 900 poulets de souche à croissance lente pour étudier l'influence de la durée d'incorporation de graines de lin extrudées avant abattage sur la composition de la graisse intramusculaire et sur la qualité de la viande. Une augmentation significative de la proportion en acides gras n-3 est observée avec la complémentation en lin, la hausse la plus forte étant obtenue avec la durée d'incorporation la plus longue (27 j *vs* 14 j avant abattage). Le gain moyen quotidien, l'indice de consommation et le rendement carcasse sont similaires entre les différents régimes. De même, aucunedifférence significative de la qualité de la viande sur la base des paramètres étudiés n'a été observée, à l'exception de la matière sèche.

Introduction

In Western societies an unbalanced dietary consumption is observed, in particular an excess of saturated fatty acids is consumed and a too high n-6/n-3 polyunsaturated fatty acids ratio is noticed. Numerous research activities have been devoted to increasing the levels of n-3 polyunsaturated fatty acids, having beneficial effects on human health, in widely consumed products of animal origin whose lipid composition is easily modified. The use of linseed is a natural way that could reach this objective. The purpose of this experiment was to study the effect of the inclusion time of extruded linseed on the fatty acids pattern and quality of broiler meat.

Material and Methods

Animals and diets

Nine hundred males, 2-d-old chicks of a "label" strain were randomly arranged in 6 pens (150 animals per pen) and three dietary treatments (2 replicates per treatment). Feed and water were provided ad libitum. During the experimental period, between 46 and 73 d of age, three treatment groups were established according to the feeding program : control diet throughout the feeding period (R0) ; control diet from 46 to 59 d of age and linseed diet from 59 to 73 d of age (R14) ; linseed diet throughout all period (R27). Experimental diets, composed of wheat, maize and soybean meal, were formulated to beisoenergetic and isonitrogenous (Table 1). Part of wheat and soybean meal of control diet was replaced by extruded linseed (3.25 % of the diet) in the linseed diet. Feed conversion ratio and weight gain during the experimental period were recorded . At 73 d of age five animals of each pen were taken for further analyses (ten birds per treatment).

Laboratory analyses

Samples of each diet were analysed for nitrogen content, crude protein, dry matter, and lipid content. The fatty acids pattern of meat, performed on the broiler thigh muscle, was determined by difference using theFolch extraction method. Extracted lipids were saponified with KOH before to be methylated with 3% methanolic HCl to obtain fatty acid methyl esters (FAMEs). FAMEs were analysed for fatty acids pattern by using gas chromatography and internal standards. Parameters of meat quality were determined in each left breast of ten individuals per treatment (five per pen). Cooking losses were determined by difference of weight of all the left breast muscle , before and after cooking, wrapped in vacuum bags, in aBain-marie at 75°c for 1 hour. Tenderness was calculated on cooked samples of breast (cubic portion of 1 cm in side, prepared in accordance with Touraille, 1981).

The texture of samples was determined by measuring the maximum shear force (N) with the Warner-Brazler shear tool adapted to a SMS-TAXT-2 Texture Analyser. The corresponding area (N*s) represented the hardness of meat.

Table 1: Calculated nutrient content, chemical analyses and major fatty acids composition of control and experimental diets enriched with extruded linseed

	Control diet	**Linseed diet**
Calculated nutrient content		
ME, Kcal/kg	2800	2800
Calcium, g/kg	9.50	8.88
Available P, g/kg	4.10	3.83
Methionine + Cysteine, g/kg	8.07	7.60
Lysine, g/kg	11.08	10.37
Chemical analyses	%	%
Dry matter	89.78	88.02
Crude protein	20.37	20.24
Ether extract	6.02	6.80
Crude fiber	2.49	2.83
Fatty acids pattern (g/100g fatty acids)		
C16:0	13.02	11.22
C18:0	2.80	2.80
C18:1	22.90	21.60
C18:2	55.83	47.68
C18:3	4.72	15.90
Σ SFA	16.46	14.74
Σ MUFA	22.99	21.68
Σ PUFA	60.55	63.58
n-6/n-3	11.84	3.00

SFA = saturated fatty acids ; MUFA = monounsaturated FA ;
PUFA = polyunsaturated FA

Statistical analysis

Analysis of variance (ANOVA) was used to compare the three treatments. Thehomoscedasticity and normality hypotheses were respectively checked with Bartletts's test and with Ryan and Joiner's test. Some parameters that did not respect one or both applications conditions were submitted to logarithmic transformation beforeretesting the two hypotheses and performing one-way ANOVA. When ANOVA pointed out some significant differences between the three treatments, the mean observed in the three groups were compared with Tukey's pairwise comparison test (family error rate = 0,05).

Results and discussion

As expected, only the different n-3 fatty acids content of the dietary fat gave rise to a typical difference in the pattern of the thigh fat of birds receiving control or experimental treatments (Table 2). There were no significant difference in the total saturated, monounsaturated and polyunsaturated fatty acids contents between treatments because of similar proportion of these FA classes in the two diets (Table 1). According to Lopez-Ferrer et al. (2001), the higher content of n-3 fatty acids with experimental diet resulted in a decreased n-6/n-3 ratio, which tried to achieve human health recommendations.

Table 2 : Fatty acids composition of thigh samples of chickens assigned to three different feeding programs

Fatty acid (g/100g FA)	R0	R14	R27	P
C16:0	22.38 [1.54]	22.54 [0.97]	21.83 [0.90]	NS
C16:1 n-7	3.62 [0.73]	3.96 [0.99]	3.87 [1.02]	NS
C18:0	9.00 [0.65]	8.43 [0.69]	8.69 [0.77]	NS
C18:1cis n-9	23.98 [2.50]	24.59 [2.25]	25.58 [3.29]	NS
C18:2cis n-6	25.61 [3.43]	24.79 [1.55]	23.89 [2.49]	NS
CLA	0.38 [0.09]	0.35 [0.06]	0.34 [0.10]	NS
C18:3 n-3	1.74 [0.36]	2.93 [0.32]	3.80 [0.51]	***
C20:3 n-9	0.59 [0.09]	0.56 [0.12]	0.55 [0.10]	NS
C20:3 n-6	0.34 [0.06]	0.28 [0.06]	0.38 [0.13]	NS
C20:4 n-6	4.98 [0.75]	4.53 [0.94]	4.32 [0.98]	NS
Σ SFA	34.38 [3.40]	33.97 [1.87]	33.57 [2.17]	NS
Σ MUFA	31.74 [2.75]	32.36 [2.42]	32.97 [3.69]	NS
Σ PUFA	33.88 [3.77]	33.66 [2.15]	33.48 [3.66]	NS
n-6/n-3	18.54[a] [3.43]	10.28[b] [1.20]	7.63[c] [064]	***

[a,b,c]*Values in the same row with no common superscript are significantly different*
SFA = saturated fatty acids ; MUFA = monounsaturated FA ; PUFA = polyunsaturated FA
[ ] = standard deviation
***P< 0.001

Figure 1 showed a positive effect of linseed including time on C18:3 n-3 content of thigh fat. The linear response observed seemed to indicate a constant pattern of change in C18:3 n-3 accumulation throughout the experimental period.

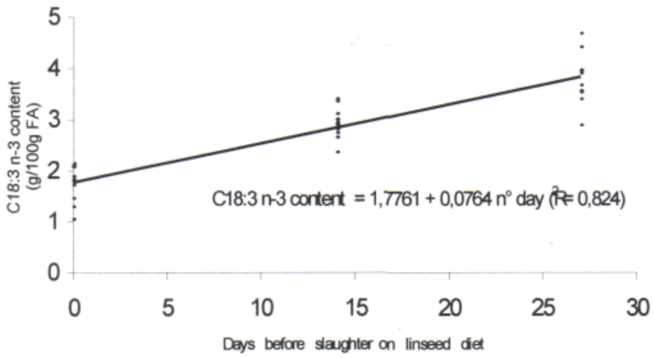

Figure 1 : Influence of the number of days prior to slaughter in which birds received linseed supplement on C18:3 n-3 content of thigh fat

There were no significant difference in performance parameters among treatments excepted for final weight. However, the slightly higher weight of R27 birds couldn't be attributed to the feeding program because this little difference was already observed in the weight of birds at the beginning of the trial period. The linseed supplementation tended to improve feed efficiency, although there was no significant difference.

Table 3 : Performance parameters of chicken

Variable	R0	R14	R27	P
Weight at 2 d (g per bird)	39.58 [1.22]	39.49 [1.30]	39.48 [1.21]	NS
Weight at 46 d (kg per bird)	1,57^{a} [0.20]	1,57^{a} [0.19]	1.61^{b} [0.18]	*
Weight at 73 d (kg per bird)	2.92^{a} [0.30]	2.97^{a} [0.27]	3.05^{b} [0.30]	*
Daily weight gain, g per bird between 46 and 73 d	50.27 [0.14]	51.97 [1.76]	53.4 [0.86]	NS
Feed efficiency between 46 and 73 d	3.15 [0.15]	2.94 [0.11]	2.93 [0.06]	NS
Carcass yield at slaughtering (%)	65.69 [4.22]	64.15 [5.53]	62.66 [4.76]	NS

^{a,b}Values in the same row with no common superscript are significantly different
[ ] = standard deviation
*P< 0.05

No differences of meat quality parameters between treatments were detected, excepted for dry matter (Table 4). We had no explanation for this observed difference.

Although analysis of variance revealed no significant difference, the thigh fat content tended to gradually increase with the linseed including time. This observation had no effect on tenderness and cooking losses parameters.

Table 4 : Quality meat parameters

Variable	R0	R14	R27	P
Dry matter (%)	23.59^{a} [0.42]	24.27^{b} [0.67]	23.77^{ab} [0.57]	*
Fat (% DM)	7.30 [1.19]	7.60 [1.48]	8.18 [1.53]	NS
Tenderness :				
Force (N)	14.54 [2.24]	14.47 [2.72]	14.75 [1.88]	NS
Hardness (N*s)	135.15 [21.10]	133.46 [27.22]	146.76 [22.41]	NS
Cooking losses (%)	16.75 [1.86]	16.43 [2.53]	16.89 [1.79]	NS

^{a,b}Values in the same row with no common superscript are significantly different
[ ] = standard deviation
*P< 0.05

However, the slaughterer, who didn't know the trial protocol, had given his opinion about carcass quality at the slaughtering time. He immediately picked the two pens who had received the linseed supplement during the longer time out in the 6 pens (150 birds per pen). According to him, the birds of these two pens were plucked easier and had a nicer and more homogeneous visual quality carcass that those of the other pens.

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