EFFECT OF THE DIETARY N-3 FATTY ACIDS SOURCES ON BREAST MEAT QUALITY IN THE HEN

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Background

Highly unsaturated fatty acids (HUFA) of the n-3 series, namely EPA (20:5 n-3) and DHA (22:6 n-3) have been shown to have positive effects on human health. These findings have led to the suggestion that it may be desirable to increase the dietary n-3/n-6 fatty acid ratio (Lands, 1989). Consequently, EPA or DHA or their precursor, the 18:3 n-3, are being introduced in animal feeding of monogastric animals, poultry included, because of lipids are adsorbed and could be deposited in the meat and in the egg in the form in which they are consumed. For the laying hens feeding, among the raw materials rich in n-3 FA, vegetable sources are moderately rich in n-3 HUFA but, some of them contain high levels of their precursor, the C18:3 n-3. Linseeds are rich in C18:3 n-3 which can be partially converted in EPA and DHA and deposited in the egg and in the hen tissues. It was demonstrated that diets supplemented with polyunsaturated fatty acids (PUFA) decreases the MUFA and increases the PUFA levels in the meat, particularly that of the n-3 series. As expected, TBARS index increases as PUFA increases (Dalle Zotte *et al.*, 2001). By this way, the meat of laying hens could increase its nutritional properties and to be more adequate for human consumption.

Objectives

The objective of the present study was to compare the effect of the use of 4 diets differing in the n-3 fatty acids source on the overall breast meat quality measured 24 hours *post mortem* and 7 days *post mortem* in the laying hen.

Methods

Four iso-caloric diets containing different levels of PUFA n-3 were tested (table 1). The control diet was a commercial diet (C) meanwhile the other 3 experimental diets were prepared adding to the C diet the following PUFA supplements: extruded linseed (EL), grounded linseed (LS) and a product rich in n-3 HUFA of marine origin (NF) at 10.0, 21.4 and 3.4% of the control diet. Seventy two laying hens of 20 wk of age were housed two by two in cages within a room with environmental control and fed *ad libitum* for 8 weeks the 4 diets, enriched also with 300 mg α-tocopherol acetate/kg. Diets were analysed for chemical composition and for FA profile, by GC prior to Folch extraction, according to A.O.A.C. methods (1984). At slaughter, the m. *Pectoralis superficialis* was removed from each animal and weighted. Part of it was frozen until chemical analyses; moisture, ether extract and ash were determined meanwhile protein content was calculated by difference (A.O.A.C., 1984). The cholesterol content was also determined (Casiraghi *et al.*, 1994). The remaining part of m. *Pectoralis superficialis* was over-wrapped in oxygen permeable PVC film and stored at 5°C under 1000 Lux illumination for up to 7 days. Twenty-four hours *post mortem* the muscle was submitted to pH and $L^*a^*b^*$ colour (CIE, 1976) measurements. At the end of the storage period, on the same muscle the following measurements were done: pH, $L^*a^*b^*$ colour, drip losses, calculated as the percentage reduction in weight relative to the initial weight, and cooking losses. The cooked samples were used for triplicate Warner-Bratzler shear force measurements on cores (diameter 1.25 cm) obtained by cutting the meat along the muscle fibres. Analysis of variance (Harvey, 1987) tested the diet effect.

Results and discussion

The proportion of the m. *Pectoralis superficialis* (% of slaughter weight) was significantly higher in hens fed the EL diet ($P<0.01$), supplemented with 10% of extruded linseed, if compared with the groups of birds fed with the other 3 experimental diets (table 2). This result is in part related to the live performance of hens during the experimental period. In particular, in hens belonging to the EL feeding treatment the weight gain was higher than that observed in LS and NF groups; this performance explains the difference in muscle proportion, but the same trend was not observed with the C group, in which the weight gain was the highest ($P<0.05$) and the egg production the lowest ($P<0.05$; data not published). It can be suggested that extrusion treatment could have improved the protein digestibility increasing the muscle mass, as demonstrated by the significantly higher level of protein content in muscle of EL group ($P<0.01$; table 3). Considering the physico-chemical characteristics of breast meat, the data reported in table 2 show that pHu and $L^*a^*b^*$ colour were similar among treatments 24 hours *post mortem*, while after 7 days of refrigerated storage the same traits were partly modified. In particular, the hens fed with the NF diet showed a significantly higher pH value in their m. *Pectoralis superficialis* (5.70 *vs* 5.66, 5.64, 5.65, for the diets C, EL and LS, respectively; $P<0.05$). The high pH observed in breast meat of hens belonging to NF group is the main responsible of its water holding capacity improvement during storage (table 2). Breast cooking losses were significantly lower with the NF diet (22.3% *vs* 24.0%, 24.0%, 24.9%, for the diets C, EL and LS, respectively; $P<0.05$). The Warner-Bratzler shear force measurement indicate a tendency ($P>0.10$) forward a more tender meat by using the supplemented diets, in particular with the LS diet, which was also found to have higher breast water content if compared with that of the C dietary group (72.8 *vs* 71.9%, $P<0.01$), or with the EL group (72.8 *vs* 72.2%, $P<0.05$).
Results from this trial indicate that the use of n-3 FA sources can affect meat quality of hens. As reported elsewhere (Dalle Zotte *et al.*, 2001), the supplemented diets improved the dietetic properties of the breast meat by increasing the PUFA level and the n-6 to n-3 ratio, but its susceptibility to oxidation also increased ($P<0.01$). Here, it has been also demonstrated that a supplementation with commercial products rich in n-3 HUFA of marine origin (NF diet) is able to limit in a appreciable way the meat water losses during medium term refrigerated storage and also after cooking. The use of linseed is also suitable to improve the nutritional properties of the meat: the extruded form (EL) gave best results than the grounded form (LS).

Pertinent literature

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Table 1. Chemical composition and PUFA content of experimental diets

		Control (C)	Extruded Linseed (EL)	Linseed (LS)	n-3 HUFA of marine origin (NF)
Inclusion level	%	-	10.0	21.4	3.4
Moisture	"	9.0	8.6	8.8	8.7
Crude Protein	"	17.5	17.6	17.8	17.8
Ether Extract	"	5.6	6.6	5.9	6.0
Ash	"	12.8	12.0	10.1	13.9
Crude Fibre	"	2.9	3.9	4.2	4.7
Total PUFA	% total FA	32.2	58.4	62.9	39.9
PUFA n-3:					
- C18:3 n-3	"	1.87	31.41	30.40	5.64
- C20:5 n-3	"	0.00	0.00	0.00	1.86
- C22:6 n-3	"	0.00	0.00	0.00	2.24

Table 2. Physicochemical characteristics of m. *Pectoralis superficialis*

		Experimental Diets				
		C	EL	LS	NF	RSD
Animals	No.	18	18	18	18	
M. *Pectoralis superficialis*	% slaughter weight	6.51^{A}	7.16^{Bb}	6.74^{A}	6.75^{Aa}	0.46
Traits measured 24h *post mortem*:						
- pHu		5.64	5.66	5.66	5.68	0.05
- L*		59.2	60.0	60.5	59.4	1.8
- a*		1.61	1.11	1.21	1.30	0.81
- b*		7.01	6.96	6.18	6.54	1.28
Traits measured after 7days at +5°C:						
- Drip losses	%	6.88	6.14	5.78	5.54	1.89
- Cooking losses	„	24.0^{b}	24.0^{b}	24.9^{b}	22.3^{a}	2.4
- Total losses	„	30.9^{b}	30.2^{b}	30.7^{b}	27.8^{a}	3.1
- pH		5.66^{ab}	5.64^{a}	5.65^{a}	5.70^{b}	0.06
- L*		58.9	59.1	60.7	59.6	2.17
- a*		-0.39	-0.21	-0.26	-0.04	0.64
- b*		8.51	7.86	7.64	7.91	1.81
- Warner-Bratzler shear force	Kg/cm^2	2.60	2.50	2.29	2.49	0.75

** or A, B: P<0.01; * or a, b: P<0.05

Table 3. Chemical composition and cholesterol content of m. *Pectoralis superficialis*

		Experimental Diets				
		C	EL	LS	NF	RSD
Animals	No.	18	18	18	18	
Chemical composition (wet basis):						
- Water	%	71.9^{A}	72.2^{Aa}	72.8^{Bb}	72.6^{B}	0.7
- Protein	"	$24.8A^{Bb}$	25.0^{B}	24.5^{ABab}	24.4^{Aa}	0.6
- Fat	"	1.5	1.4	1.4	1.3	0.2
- Ash	"	1.8	1.5	1.3	1.7	0.7
Cholesterol	mg/100g	62.5	61.3	62.8	59.3	5.7

**or a, b: P<0.01