# EFFECT ON THE QUALITY OF RABBIT AND CHICKEN MEAT OF ADDING N-3 FATTY ACIDS AND PLANT ANTIOXIDANTS TO THE FEED

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**Abstract. The increase of C18:3 n-3 (ALA) deposits in meat is sought after in order to improve the nutritional quality of meat products. The reported studies are an assessment of what has been carried out with the broiler and the rabbit, by adding increasing quantities of ALA to the feed. It is equally important to preserve these fatty acids (FA) from peroxidation. The effectiveness of plant antioxidants (PA) was tested. The chickens received isolipidic diets providing 0.55 g, 0.91 g or 6.05 g of ALA/kg of feed. The ALA deposit in the meat relates to the addition in the diet. The rabbits received a standard diet (5.9 g ALA/ kg) or diets enriched with ALA (9.2 g/kg) and more or less of plant antioxidants (batch T, PA and PA+). The ALA contents are 602, 850 and 868 mg/100g of meat (p<0.001). The malondialdehyde values are 225, 285 and 224 nM (p<0.001). The different meats were subjected to sensorial analysis which did not identify any differences of perception between the feed treatments. These studies therefore show the effectiveness of n-3 fatty acid deposits and the interest of PA in the animal's diet.**

## I. INTRODUCTION

Supplementation of diets with unsaturated fatty acids (FA), in particular those of the n-3 family, improves the nutritional quality of the meat of most animal species (1). These unsaturated FA can have increased risks of peroxidation, which spoils the sensorial qualities of the meat (2). The addition of antioxidants such as vitamin E or polyphenols to the feed reduces the peroxidation of the fatty acids in the meat (3). The aim of this study is i) to assess the variability of n-6 and n-3 fatty acid deposits in the meat according to the value of the C18:2 n-6 (LA) and C18:3 n-3 (ALA) precursor ratio and ii) to determine the impact of adding plant antioxidants (PA) together with an introduction of n-3 fatty acids, on peroxidation of these fatty acids.

The studies are carried out on rabbit and poultry meat which are meats which have a positive image with the consumer because of their good nutritional qualities. A sensorial analysis will complement the nutritional parameters studied.

## II. MATERIALS AND METHODS

### a) *Study of the broiler ("Label" breed)*

Label-Rouge broilers, divided into 3 batches, from 65 to 91 days of age received isolipidic (3.2 %) and isoproteic diets containing fatty acids whose LA/ALA ratio value was 23, 10 and 2 (i.e. diets D23; D10; D2). The range of this ratio from 10 to 13 corresponds to standard feed; the range from 20 to 23 corresponds to an incorporation of maize or sunflower and that of 2 to an incorporation of linseed. All these diets form part of livestock practices. The LA and ALA contents (in g/kg of feed) are respectively 12.6 and 0.55 for D23, 9.4 and 0.91 for D10 and 12.2 and 6.05 for D2. All the diets are supplemented with vitamin E (31 ppm) associated with PA (4 mg/kg of equivalent gallic acid). At slaughter, the breasts and thighs are sampled. The skin of the breast is split open. The samples were vacuum-packed and frozen at -18° in preparation for measurements.

### b) *Study of the rabbit*

42 young Hyplus strain rabbits aged 36 days were divided into 3 batches according to their original litter and weaning weight and raised in individual cages until 73 days of age. The average weight of the rabbits was 1087, 1643 and 2714 g respectively at 36, 50 and 73 days (non-significant diet effect).

The 3 batches received 3 different diets from 50 to 73 days, with the same rationing plan: a standard diet as control (T), and 2 other diets supplemented with an equivalent quantity of C18:3 n-3 (ALA) as extruded linseed (GLE). The PA0 diet contained no added PA whilst batch PA+ contained PA (80 mg/kg of equivalent gallic acid), associated with 50 ppm of vitamin E (vs 15 for the control). The percentage of ALA in the diets was respectively 20.3, 25.1 and 25.3 % and the content in g/kg of feed was 5.99, 9.29, and 9.14.

At slaughter, the carcasses were weighed and split into two parts. On one part, all of the meat was collected and the other half was cut up into legs, shoulders and back. The samples were vacuum-packed and frozen at -18° in preparation for measurements.

*c) Measurements*

The measurements are identical for the meats of the two species. The lipids were extracted from all the samples taken according to the method of (4) Folch *et al.* (1957) using a methanol chloroform mixture. The fatty acid profile of the meat was determined by Gas Phase Chromatography, after saponification and methylation of the total lipids (5).

The peroxidation potential was measured according to the TBARS method (2-thiobarbituric acid-reactive substances) by the spectrophotometric method after forced oxidation, described by Oriani *et al.* (6).

The results were subjected to a statistical treatment of global variance analysis (GLM procedure with SAS software). The means per batch were then compared 2 by 2 according to the Bonferroni test. The significance threshold was fixed at 5%.

*d) Sensorial analysis*

The cooking was adapted to the nature of the pieces either in the oven in a moist heat at 100°C, in an individual vacuum sachet during 30 minutes, or in a dry heat at 250°C, then in a moist heat at 100°C. The end-of-cooking temperatures were 80°C.

For each type of cut a sensory profile was carried out by a trained panel of 12 people, who had had a training session beforehand. The samples were presented in a monadic procedure (one by one), in only one sitting. Each taster assessed the criteria previously defined on a limited continuous scale going from 0 (nil intensity of the descriptor) to 10 (maximum intensity).

A variance analysis, followed by a Tukey test (at the 5% threshold) of comparison of means was carried out on the individual data, as well as a Friedman rank test.

## III. RESULTS AND DISCUSSION

*a) Study of the broiler meat*

The lipid contents in the breast meat (1.30 to 1.45 %) and in the thigh (9.3 to 10.5 %) are not affected by the diets. The percentages of LA in chicken breasts D2, D10, D23 are 17.9 %; 19.5 and 18.5 ($p<0.03$) and in the thigh 18.9; 19.1; 19.8 ($p<0.08$). For ALA the values are 4.1; 0.95; 0.69 in the breast (p<0,001) and 5.8; 1.3 and 0.9 in the thigh (p<0,001). The LA/ALA ratios are 4.4; 20.7 and 27.4 in the breast meat and 3.2; 15.0 and 22.1 in the thigh. The relationship between ingested fatty acids and deposited fatty acids is found. This is expressed in terms of ALA content in the thigh by values between 70 mg to 475 mg /100g of meat depending on diet composition (fig 1). So the variation is very great in the consumer's plate. The long chain fatty acid contents, such as C22:6 n-3 (DHA), increase with the diet providing the most ALA (0.19 % vs 0.07 % for the other 2 diets $p<0.001$) but the synthesis is still low.

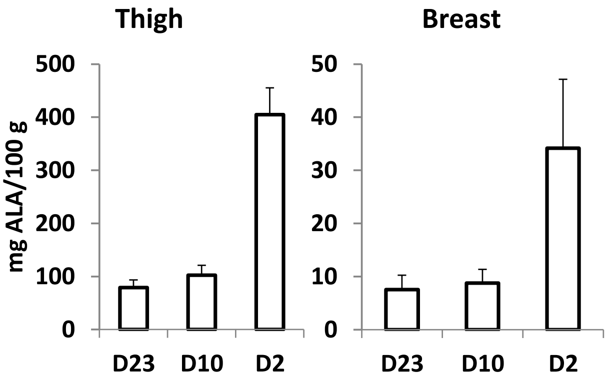


Fig. 1. ALA contents in the breast meat and the thigh according to diets (in ALA mg /100 g of meat)

The sensorial analysis did not reveal any significant differences between the meats of the different animals. So the highest n-3 fatty acid content does not change the overall flavour of the meat in the context of the formulation with antioxidant in all the diets.

*b) Study of the rabbit meat*

The percentage of n-3 FA and in particular of the ALA precursor is significantly higher ($p<0.001$) in the carcass (table 1) or cuts of meat from rabbits receiving a diet enriched with extruded linseed. This confirms the relation between the animal's feed and the nutritional quality of its meat, as well as the positive effect of the n-3 FA in the feed (7). On the other hand, among the n-3 derivatives no effect is noted for the DHA percentage. For the EPA, an increase is noted for the whole carcass and for the shoulder in relation to the quantity of ALA ingested. This confirms the low capacity for desaturation and elongation of the n-3 FA in the rabbit (8).

Table 1 FA composition of the whole carcass (in % of identified FA)

| | T | PA0 | PA+ | Rsd | Effect |
|---|---|---|---|---|---|
| Lip % | 8,12 | 8,64 | 8,62 | 1,17 | NS |
| SFA | 30,47a | 28,62b | 28,28b | 0,72 | P<0,004 |
| MUFA | 34,93a | 33,80b | 33,58b | 1,56 | P<0,001 |
| PUFA | 34,59a | 37,57b | 38,14b | 1,05 | P<0,001 |
| LA | 23,29 | 23,41 | 23,55 | 0,02 | NS |
| ALA | 9,41a | 12,31b | 12,69b | 0,58 | P<0,001 |
| EPA | 0,05 | 0,07 | 0,08 | 0,03 | P<0,07 |
| DPA | 0,23 | 0,28 | 0,30 | 0,07 | P<0,07 |
| DHA | 0,02 | 0,01 | 0,01 | 0,02 | NS |
| LA/ALA | 2,48a | 1,91b | 1,86b | 0,07 | P<0,001 |

LA: C18:2 n-6 ; ALA: C18:3 n-3 ; EPA: C20:5 n-3 ; DPA: C22:5 n-3 ; DHA: C22:6 n-3.

On the other hand, ALA's content is significantly higher ($p<0.001$) in all the animals receiving diets supplemented with linseed. What is more, this content is in relation with the lipid content of the cut of meat and the higher it is, the greater the n-3 deposit will be. The thigh which has low lipid content will therefore have the lowest quantity of ALA, even in animals receiving linseed supplementation.

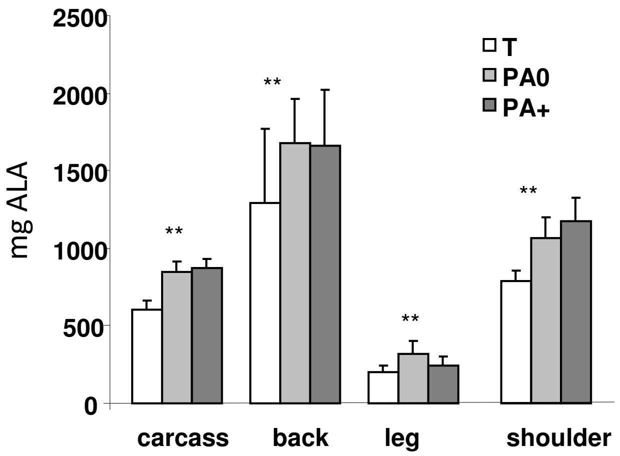


Fig. 2. Comparison of ALA contents (mg/100 g of meat) according to diets

The peroxidation was measured for all the cuts. It will only be recorded for the carcass, as all the results go in the same direction. The FA peroxidation is higher in rabbits receiving linseed, but the PA input in the diet makes it possible to reduce the appearance of MDA, a marker of fatty acid oxidation (fig 3). The differences are significant between the batches for each time studied.

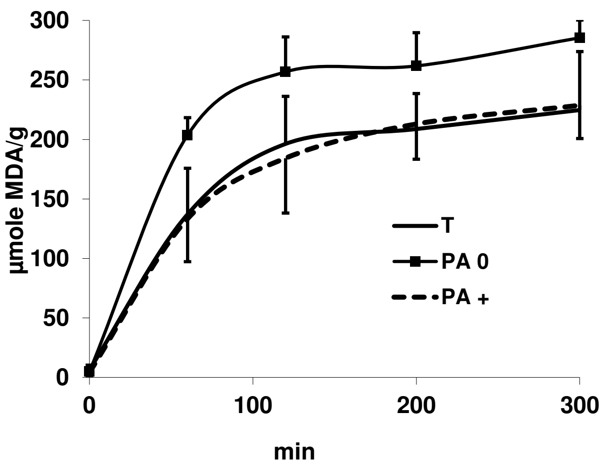


Fig. 3. Comparison of the FA peroxidation (µM MDA/100 g of meat) in the carcass

The sensorial analysis did not show any significant difference between the pieces of meat tasted. The overall flavour of the meat was not changed with the addition of linseed to the feed. This certainly comes from the fact that the quantities of linseed in the feed are not high. However this addition makes it possible to increase the ALA content by more than 30 % and the presence of the PA reduces the peroxidation to a level comparable to the control meat.

This study therefore confirms the interest of n-3 fatty acids in feed to improve the nutritional quality of the meat and the importance of PA to reduce FA peroxidation in the meat.

## IV. CONCLUSION

The addition of n-3 fatty acids to rabbit or broiler feed increases in particular the deposit of these fatty acids in the meat, which will have positive effects for human health. The nutritional quality is improved and at the same time the sensorial quality is not modified whatever the cut of meat. The production of MDA, a fatty acid peroxidation marker, is reduced with the presence of PA. This study therefore confirmed the interest of adding plant antioxidants in the diet of these animals.
All that remains now is to find a balance between the economic aspect of this production and the image of enhanced value that it may have with consumers and the medical profession.

## ACKNOWLEDGEMENTS

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