LIPID STABILITY OF MEAT AND LARD ENRICHED IN OMEGA-3 FATTY ACIDS AND α-TOCOPHEROL

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Background

Due to the positive described effects of the n-3 polyunsaturated fatty acids (PUFA) in humans (1,2) many researches have tried to decrease the ratio PUFA n-6/n-3 in meat and meat products to reach values lower than 4 according with the recommendations of British Nutrition Foundation (3). This modification of the PUFA relationship usually involves an increase of the n-3 fatty acids because of the effect of the intake of diets enriched in linolenic acid. This effect is particularly evident in monogastric animals such as pig (4,5,6,7), poultry (8) and rabbit (9).

Objectives

The objective of this work was the study of the lipid stability of lard and meat enriched in omega-3 fatty acids and vitamin E.

Material and Methods

Experimental design

Fifty Large White x Great York female pigs were randomly distributed and located in individual cages and fed a conventional pig diet until they weighed 48.1±3.55 kg. At this moment five experimental diets were randomly assigned to ten pigs randomly selected. All pigs were fed for *ad libitum* consumption with the appropriate diet. All diets were formulated with the same ingredients except for the fat source (which was incorporated at 30 g kg^{-1} in all cases) and vitamin E. Dietary fat sources were sunflower oil (a fat source rich in C18:2 n - 6) for the control diet (C), linseed oil (L, rich in C18:3, n - 3) and a blend of olive oil (rich in C18:1 n - 9) and linseed oil (1/1, w/w, batch LO). Within each dietary fat treatment containing L, one group (L, LO) was fed a basal level of vitamin E (20 mg α-tocopheryl acetate kg^{-1} diet)(Hoffman La Roche, Switzerland) and the other group (LE, LOE), received a supplemented level (200 mg α-tocopheryl acetate kg^{-1} diet).

Slaughter, sample collection and chemical analysis

Animals were stunned, slaughtered and exanguinated at a local slaughter house at 100.1 ± 7.09 kg live weight. Samples from the meat (*Psoas major*) and lard (backfat) were immediately taken, frozen in liquid nitrogen, vacuum packed in low-oxygen permeable film and kept frozen at -22°C until analysed. Sample analysis (n=10) were carried out in triplicate.

Concentration of α-tocopherol was quantified as described by Rey et al (10). Analysis were carried out by reverse phase HPLC (HP 1050, Hewlett Packard, Waldbronn, Germany). Separation was made on a C18 column (RP-18, Hewlett Packard). The mobile phase was methanol:water (97:3 v/v) at flow rate of 2 ml/min, and the detector was fixed at 292 nm.

Lipids from meat and lard samples were obtained using the method of Bligh and Dyer (11) and methylated in the presence of sodium metal (0.1 N) and sulphuric acid (5% in methanol anhidro) to obtain fatty acid methyl esters which were analysed using a Perkin Elmer 8420 (Beaconsfield, Buckinghamshire, England) gas chromatograph equipped with a flame ionization detector and a capillary column HP-Innowax (30 m x 0.32 mm id and 0.25 mm). The temperature program was as follows: injector and detector temperature 250°C, the initial column temperature was 170°C, which was kept for 2 min., 170°C to 240°C at 3.5°C.min^{-1}, hold for 20 min.

The liability of meat and lard homogenates to iron-ascorbate-induced lipid oxidation was determined by the method of Kornbrust and Mavis (12). TBARS were expressed as nmols malonaldehyde (MDA)/mg protein. Protein was measured by the procedure of Lowry (13).

Statistical analysis

Data were analysed using the General Linear Model of SAS (14). An individual pig was the experimental unit for analysis of all data. The comparative analysis between means were conduced using the Duncan multiple range test. Data were presented as the means of each group and the standard deviation (SD) of the mean.

Result and Discussion

The figure 1 shows the PUFA n-6/n-3 ratio, the α-tocopherol content and the lipid stability of samples from meat (*Psoas major*) and lard from pigs fed on Control and Experimental diets. Meat and lard from animals fed on Control diet had higher ($p<0.05$) PUFA n-6/n-3 ratio than those of Experimental diets enriched in linseed and olive oil (L, LE, LO and LOE). Values ranged from around 10 of samples from animals fed on Control diet to values close to 2 in samples from Experimental diets. In both tissues (meat and lard) is possible to establish a hierarchy for fatty acid n-6/n-3 ratio with Control > LO, LOE > L, LE. The present finding indicates that it is possible to obtain a clear reduction of the PUFA n-6/n-3 ratio reaching lower values according with the recommendations of the British Nutration Foundation (3). This result is in agreement with those previously reported (4,6). Diet LE and LOE incorporated 200 mg of α-tocopheryl acetate.kg^{-1} diet. As a direct consecuence, the α-tocopherol content in meat and lard was significatively ($p<0.05$) increased, twice in lard and 3-4 times in meat. No effect of the α-tocopherol content on the n-6/n-3 ratio was detected.

When the fat polyunsaturation was increased, a higher lipid oxidation could be expected. For this reason the α–tocopherol was introduced in the diet, as a way to increase the tocopherol content in the tissues. To study the lipid peroxidation susceptibility it was calculated the Peroxidation Rate Curve Slope (PRCS, nmol malonaldehyde.mg $protein^{-1}.min^{-1}$), which indicates the lipid peroxidation rate. Samples (meat and lard) from animals fed on diets LE and LOE showed a inhibited lipid peroxidation when compared with those of L and LO samples. The lipid peroxidation rate (PRCS of L *vs* PRCS of LE and PRCS of LO *vs* PRCS of LOE) could be reduced in lard (about 8 times) and in muscle (about 2.5 times). Although the increase of the lipid unsaturation (L or LO *vs* C) enhanced significatively the lipid peroxidation, the phenomenon can be controlled including a high α-tocopherol content in the diet, which, in turn, is accumulated in meat and lard tissues (L and LO *vs* LE and LOE).

Conclusion

It has been obtained a healthier pork meat and lard (PUFA n6/n3 ratio <4) by feeding animals with a diet enriched in lineseed (a rich source of C C18:3, n – 3). The increased lipid oxidation of those tissues due to the enrichement in C18:3, n – 3 was controlled by the diet enrichement with α-tocopherol.

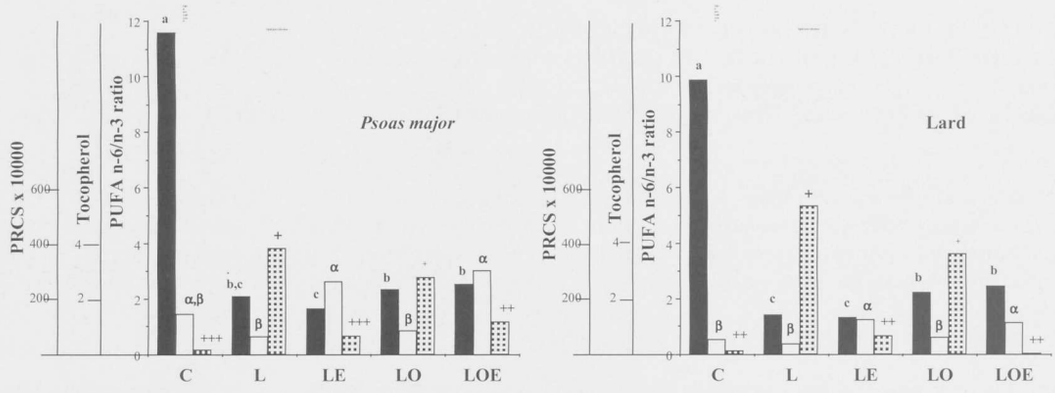

Figure 1. Polyunsaturated fatty acid n-6/n-3 ratio (■), α–tocopherol content (mg Kg^{-1} wet matter,) and Peroxidation Rate Curve Slope (PRCS, Maximum oxidation rate: nmol malonaldehyde.mg $protein^{-1}.min^{-1}$, ▒) of *Psoas major* muscle and lard from pigs fed on diets: C= control (30 g kg^{-1} sunflower oil), L = 30 g kg^{-1} linseed oil, LE = 30 g kg^{-1} linseed oil + 200 mg kg^{-1} α-tocopheryl acetate, LO = 15 g kg^{-1} linseed oil + 15 g kg^{-1} olive oil, LOE = 15 g kg^{-1} linseed oil + 15 g kg^{-1} olive oil + 200 mg kg^{-1} α–tocopheryl acetate. Data with different letters or symbols are significantly different ($p<0.05$).

Acknowledgments

This research was funded by the Comisión Interministerial de Ciencia y Tecnología (CICYT) with the project ALI 98-0705. M. D'Arrigo was awarded a predoctoral scholarship of Agencia Española de Cooperación Internacional (MUTIS programme)

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