INFLUENCE OF A DIETARY LINSEED OIL AND VITAMIN E SUPPLEMENTATION ON OXIDATIVE PROCESSES OF TURKEY COOKED-HAM HOMOGENATES CURED WITH DIFFERENT LEVELS OF NITRITE

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Background

Several studies have shown that n-3 polyunsaturated fatty acids (PUFA) such as eicosapentanoic acid (EPA, C20:5 n-3) and docosapentanoic (DHA, C22:6 n-3) provide protection against cardiovascular diseases (Mercier et al., in press; Mossab, 2001). Those requirements can be provided by a variety of foods which are naturally rich in C18:3 n-3 such as vegetable oils (soya oil, linseed oil), fishes or with foods which can be enriched with n-3 PUFA such as poultry meat. Increasing the degree of polyunsaturation accelerates oxidative processes in meat such as flavour, colour, and nutritive value. Lipid oxidation is the primary cause of off-flavours and myoglobin oxidation is responsible of discoloration processes with lipid and protein oxidation being interdependent phenomena (Renerre and Labadie, 1993). Moreover, many studies have shown that dietary supplementation of vitamin E is necessary to decrease lipid oxidation in pork as in poultry and to increase colour stability in beef. But the effect of vitamin E on protein oxidation in meat is not documented (Renerre, 1999).

In pork cooked-ham, nitrite is responsible for its reddening effect, development of its well-loved flavor (by its antioxidative properties) and prevention of bacteriologic deterioration as against the growth of *Clostridium Botulinum* (Cassens, 1995). But nitrite can also react with amines and amino acids in meat which produce carcinogenic *N*-nitrosamines (Pegg and Shahidi, 1997). To aid in lowering *N*-nitrosamine formation, a reduction of the level of nitrite in cooked ham is recommended with, in parallel, the use of antioxidants such as lipophilic derivatives of ascorbic acid or α-tocopherol at a level which is not determined. To-day, a few factorial design (Walsh et al., 1998) has allowed the study of the interaction between the effect of dietary α-tocopherol administration and level of added nitrite on oxidative processes in cooked ham. In this aim, two experiments were done : the first was realized on cooked-ham after storage to measure lipid oxidation, colour stability and sensorial analysis (to be published). The second, described in this paper, was done on turkey cooked-ham homogenate after a chemical oxidation.

Objectives

The study was designed to examine the effect of linseed oil and vitamin E dietary supplementation on lipid and protein oxidation of turkey cooked-ham cured with different levels of nitrite.

Methods

One hundred male BUT9 turkeys were obtained from a commercial hatchery one-day after hatching. Turkeys were fed pellet diets containing linseed oil (5% or 10%) and vitamin E (30 ppm or 400 ppm) and animals were slaughtered at 16 weeks (INRA, SRA Nouzilly). For the preparation of the cooked ham done with *pectoralis major* muscle (ADIV , Clermont-Ferrand), three different doses of sodium nitrite were used : 10, 50, and 100 ppm, 100 ppm being recommended. On ham homogenates, the oxidative processes were measured after an oxidation by the system ferric iron / ascorbate (Mercier et al., in press).

Two comparisons were done : firstly the effect of vitamin E level (30/400 ppm), with 10% of linseed oil and 100 ppm of sodium nitrite (samples noted **a** and **e**, Figs 1, 2); secondly, the effect of nitrite level (10/50/100 ppm) with 5% of linseed oil and 400 ppm of vitamin E (samples noted **b**, **c** and **d** ; Figs 1, 2).

Lipid oxidation of turkey cooked ham was measured by the TBARS content (Lynch and Frei, 1993) and the results were expressed as nmol. MDA/ml. For protein oxidation, the amount of carbonyl groups was expressed as nmol. DNPH fixed/mg protein (Oliver et al., 1987). The level of vitamin E in feed as in ham was determined by Roche laboratory (Gatellier et al., in press). Results in TBARS values and carbonyl groups content were treated by analysis of variance (ANOVA) using the SAS (1988) statistical package (results not showed).

Results and discussion

Residual nitrite in cooked ham was not analyzed but for Dineen et al. (2000), the nitrite losses some days after initial injection was already about 25%; for Cassens et al (1995), the loss will be very higher with only 10-20% of the original nitrite which would be analytically detectable. Mean α-tocopherol concentrations were respectively 1.3 ± 0.1 ppm for non-supplemented samples (30 ppm) and 7.7 + 0.3 ppm for supplemented hams (400 ppm). Vitamin E content of supplemented ham was correct because it was almost 6 times greater than in the controls. These results were similar to those noted previously on turkey meat (Mercier et al., 1998). In cooked ham, with a 500 ppm vitamin E supplementation, Walsh et al. (1998) found a 4.5 fold increase in α-tocopherol over controls fed the basal diet (10 ppm). For Dineen et al. (2000), the rate of α-tocopherol in meat is less important than in our experiment even if the supplementation in vitamin E was higher.

TBARS values of cooked ham from supplemented muscles (400 ppm) were lower than control (30 ppm) (Fig.1) but the differences were not significant because of an important variability. Moreover, with the use of dietary linseed oil (10%), rich in PUFA such as C18:3 n-3, a 400 ppm vitamin E supplementation is perhaps unsufficient to lower TBARS significantly. TBARS values increased significantly with time but the maximum was approached after a 5 h oxidation. By analysis of variance, no significant difference was noted (results not showed). Dineen et al (2000) and Walsh et al. (1998), with cooked ham slices stored in a display cabinet for 10 days, showed higher and significant differences in TBARS between control and supplemented samples (not supplemented in linseed oil) from pigs.

By comparing the nitrite level, hams from supplemented muscles cured with 10 mg nitrite / kg meat had higher TBARS values than hams from supplemented muscles cured with 50 or 100 mg nitrite / kg meat (Fig. 1) particularly after 1 h. When curing was done with 50 or 100 ppm nitrite, the TBARS values were not different. This indicate that hams manufactured from muscles treated with high levels of vitamin E (400 ppm) can be cured with only 50 ppm of nitrite, even with animals fed 5% linseed oil. This result is according to those of Dineen et al. (2000) and suggest that vitamin E is a partial substitute for nitrite in terms of oxidative stability. For Igene et al. (1985), nitrite prevents release of Fe^{2+} from heme pigments, chelates liberated Fe^{2+} and stabilizes the unsaturated lipids within membranes.

By comparing the results from the protein oxidation (Fig.2), it was also shown that carbonyl group content was higher in control ham than in supplemented ham with significant differences obtained by ANOVA ($P< 0.05$). These results are according to those of Gatellier et al (1996) obtained on turkey meat homogenates oxidized by the same ferric iron / ascorbate system. Reactive oxygen species (ROS) can lead to oxidation of amino-acid residues side chains, but also formation of protein-protein cross linkages and result in protein fragmentation.

When curing was done at different levels of nitrite on supplemented muscles, it was shown that carbonyl content was higher with 10 ppm nitrite compared to 50 and 100 ppm nitrite; a supplementation of 50 and 100 ppm giving identical results (Fig. 2). Even with dietary oil rich in PUFA, such as linseed oil (5%), with a high level of dietary vitamin E, it is possible to cure the meat with only 50 ppm nitrite.These results indicate that in turkey cooked ham, protein oxidation (contributing factor to the basic meaty flavor of muscle foods) is also linked to lipid oxidation as in fresh meat from different species (Renerre & Labadie, 1993). For Berthelsen et al. (2000), the mechanism how vitamin E interacts with the curing substance is not well described.

Pegg and Shahidi (1999) reported that a stable uniform cured-meat colour could be achieved with as little as 50 mg/ kg sodium nitrite. For these authors, α-tocopherol-coated salts were very effective blocking-agents of *N*-Nitrosamines formation in dry- and brine-cured bacon products. However for Cassens (1995), the nitrite level must be sufficient to ensure safety of the meat in terms of microbiological based food-borne illnesses. This author thinks that if it is allowed to add nitrite at a maximum of 156 ppm, in practice lower amounts are used probably 120 ppm or less.

To be sure of the beneficial use of nitrite, in presence of vitamin E, in the quality of turkey cooked-ham, it will be useful to examine the influence of dietary linsed oil on sensorial analysis (to be published). For Matthews et al.(1999), the use of 10% of linseed oil in the diet of finishing pigs has no adverse effect on the meat quality. To be sure to have no *N*-nitrosamine problem, the solution is always to find effectively suitable alternatives for nitrite (Pegg and Shahidi, 1997).

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