Effects of dietary fat and vitamin E content on lipid and protein oxidation in turkey meat homogenates after a chemical induction

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INTRODUCTION

It is well known, in monogastrics, that feeding with different more or less unsaturated fats affects the composition of triglycerides and, to a lesser extent, of phospholipids. Many studies have shown that fatty acid insaturation degree of the membrane phospholipids determine suceptibility to lipid peroxidation resulting from free radical release in biological membranes. If high dietary vitamin E level has been shown to lower lipid oxidation, on the contrary, a few experiments have been conducted to study, in stored meat, if vitamin E supplementation could, indirectely, lower protein oxidation (Mercier et al., 1998). In beef, in model systems under enzymatic catalysis, it was previously shown that (Anton et al., 1996) lipid and myoglobin oxidation were linked and that addition of different antioxidants could slow down the apparition of radical processes.

The aim of this study (*DIETOX EEC Project*) is to assess, from a turkey meat homogenate, the effect of more or less unsaturated fat source and/ or vitamin E dietary suplementation on lipid and protein oxidation after a chemical induction by the iron / ascorbate system.

MATERIAL AND METHODS

Material

Twenty four turkeys of BUT strain were reared at the Station of Poultry Research (INRA, Nouzilly) and slaughtered at 16 weeks . The animals were fed at libitum and received a common basal diet enriched with 6% of one of the following fat sources: tallow, rapeseed oil or soya oil. For each diet, animals were divided into two groups according to the vitamin E supplemntation: 30 ppm (Control animals: C) and 400 ppm (supplemented animals: S). Pectoralis major and Sartorius muscles were removed about 6h after slaughter and stored at -80°C before use. Five grams of muscle were ground with a Waring-Blendor in 50 ml of a solution containing 100 mM KCl and 50 mM Tris, pH 7.4. After a 3000 g centrifugation, the supernatant is used for measurements. The chemical oxidation is done at 37°C after 0, 3 and 6 hours(Only 6h results will be presented) with the system: 0.1 mM FeCl3 + 0.5 mM sodium ascorbate (Gatellier et al., 1996).

Lipid and protein oxidation

Lipid oxidation was measured by the TBA-RS content according to the method of Lynch & Frei (1993). Results are expressed as nmoles MDA / ml. Protein oxidation was measured by the carbonyl content determination (Oliver et al., 1987). The carbonyl content was expressed as nmoles carbonyls / mg protein.
Data were statistically analysed by analysis of correlation coefficients and by Student t-test analysis.

RESULTS AND DISCUSSION

As shown on figure 1, there was a significant effect of dietary fat source on TBA-RS values ($P < 0.05$) . After a 6 h induction, the highest TBA-RS values, for C as for S animals, were in meat from animals fed soya and rapesed oil compared to animals fed tallow. These results were according to those of Genot et al. (1997) obtained on liposomes prepared from phospholipids of animals fed the same fat source. In meat, after a 9 days storage, the highest TBA-RS values were also found when animals were fed soya oil (Mercier et al., 1998). Moreover, TBA-RS values of muscle extracts from C animals were significantly higher than those of S animals whatever the dietary fat source. In the two muscles, vitamin E content of S animals was always 6 times greater than in C (see Mercier et al., 1998). After a 6 h induction, and particularly when animals were fed rapeseed and soya oil, TBA-RS values of Sartorius muscle (oxidative) were always higher than those of Pectoralis major muscle (glycolytic) even if Sartorius muscle contained about twice as much vitamin E as Pectoralis major muscle whatever the dietary level of vitamin E (results not shown). Sartorius muscle was richer in myoglobin content and in free iron (work in progress) which facilitated lipid oxidation processes.

After a 6 h induction, carbonyl content of muscle extracts from C animals was higher than those from S ones (Figure 1).When animals were fed rapeseed oil, the differences in carbonyl content between C and S samples were highly significant. When animals were fed soya oil or tallow, the differences in carbonyl content between C and S samples were not so marked and were muscle dependant (Figure 1). With the more unsaturated oils (soya and rapeseed oil), the differences in carbonyl content between C and S samples were only significant for Pectoralis major muscle. With Sartorius muscle, more oxidative, the vitamin E supplementation gave positive results for carbonyl content only when animals were fed rapeseed oil or tallow (Figure 1). In turkey meat at day 9 of storage, it was previously observed that vitamin E supplementation induced a slight decrease in carbonyl content for Sartorius muscle. These results were also according to those of Reznick et al. (1992) obtained on vitamin E supplemented rats.

It must be highlighted that, as previously reported on TBA-RS values, carbonyl content of C animals fed rapeseed oil was very near of those fed soya oil, on one hand, and significantly higher than those fed tallow on the other hand (Figure 1). These differences in oxidative status between different fat sources could be directly linked to the higher content of vitamin E in supplemented animals fed tallow and to differences in fatty acid composition of the muscular phospholipids (Genot et al., 1997).

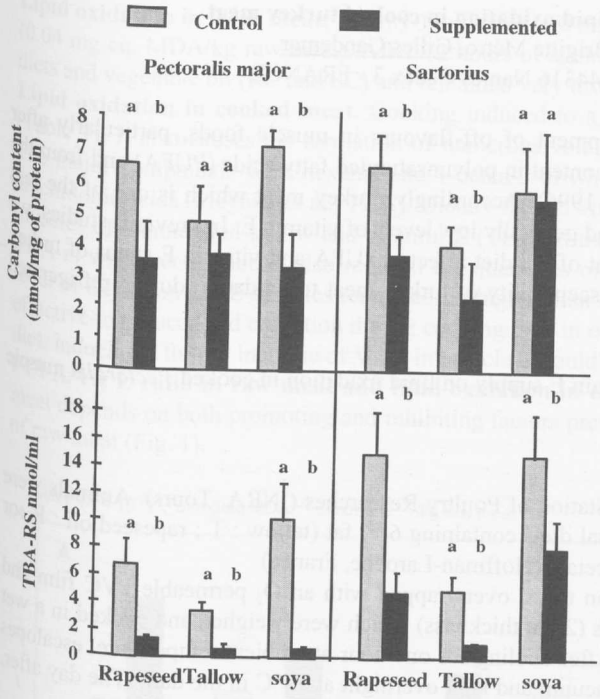

Figure 1 : Protein(carbonyl content) and lipid(TBA-RS) oxidation after a 6 hours chemical induction by a Fe3+/ascorbate system.

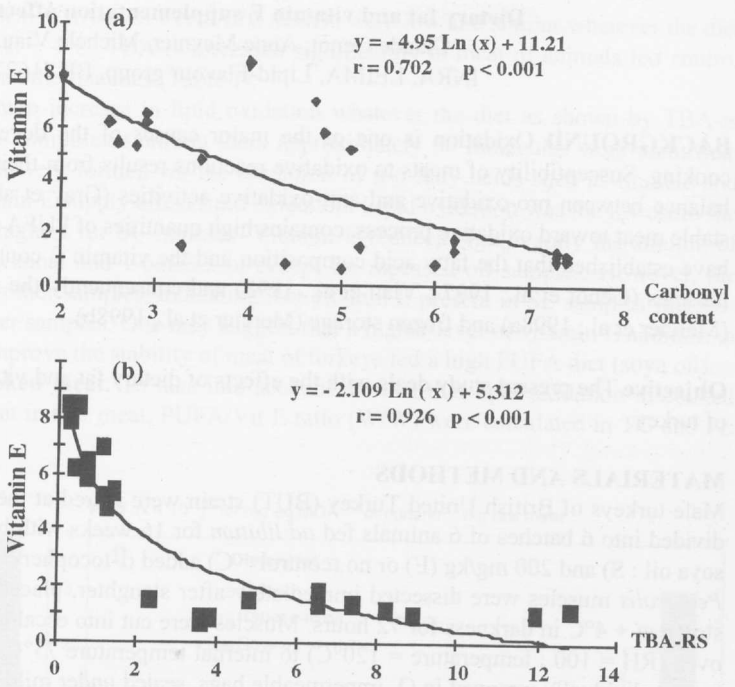

Figure 2 : Correlation between (a) vitamin E and protein oxidation (b) vitamin E and lipid oxidation in a 3000 g homogenate (Pectoralis major) after a 6 hours chemical induction by a Fe3+/ascorbate system. (n=24, total of the 3 oils)

By using an enzymatic induction (ADP+Fe Cl3+NADPH), which activates the microsomal enzymic system, it was observed that (work in progress) when animals were fed soya oil, the TBA-RS values and the carbonyl content were higher than those of animals fed rapeseed oil or tallow.

Moreover, it must be also underlined that TBA-RS values, and carbonyl content to a lesser extent, were significantly and negatively correlated (logarithmic curve, $P < 0.01$)) with the vitamin E content of the muscle (Pectoralis major muscle) with the highest correlation coefficient between vitamin E / TBA-RS compared to vitamin E / carbonyl content (Figure 2). In Sartorius muscle, the correlation coefficients between vitamin E / TBA-RS and vitamin E / carbonyl content were also significant but more low (results not shown). These results suggested that, as previously observed in the literature on muscle (Reznick et al., 1992), or on frozen meat (Mercier et al., this session), lipid oxidation was coupled with protein oxidation. Other results have also shown that in beef-heart surimi (Srinivasan and Xiong, 1996), vitamin E supplementation inhibited protein and lipid oxidation.

Moreover, and consequently, it was observed in this experiment that lipid and protein oxidation (n=24) were significantly and positively correlated (with $P < 0.001$(results not shown).

CONCLUSION

After a chemical induction, muscles of animals fed tallow are less susceptible to lipid and protein oxidation than those fed soya or rapeseed oil. In these oxidative conditions, and after a 400 ppm vitamin E supplementation, TBA-RS values and, to a lesser extent, carbonyl content of S samples are, whatever the dietary fat, lower than those of C ones.

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