Protein and lipid oxidation in turkey Sartorius muscle during frozen storage as influenced by dietary fat sources and vitamin E supplementation

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Background

Throughout the European Union countries, the production of turkey meat and products has rapidly increased during the last decade. In poultry rearing, diets are widely supplemented with oil to meet high energy demands of fast growing breeds. While the dietary fat can cause oxidative problems in meat, it was shown that the dietary fat sources were related to the triglyceride unsaturation, and to a lesser extent, phospholipid unsaturation (Genot *et al.* 1997). Furthermore in meat, lipid oxidation and shelf life have been well documented including interactions between dietary fat and vitamin E supplementation in pigs (Monahan *et al.*, 1992), poultry (Lin *et al.*, 1989) and turkey (Mercier *et. al.*, 1998)

New processes, such as mechanical to deboning, used in the meat industry have increased the free radicals and may increase protein oxidation. Moreover it has been shown that protein oxidation can lower the functional properties such as gelling of myofibrillar proteins (Decker *et al.*, 1993). The beneficial effect of vitamin E on the lipid oxidation in meat has been well established but very little is known of the effect on protein oxidation.

Objectives

To establish the effects of dietary fat unsaturation and vitamin E supplementation on lipid and protein oxidation and the relationship between the two phenomenon after six months frozen storage, in turkey *Sartorius* muscle.

Methods

Animals diets and freezing : 36 male turkeys of BUT strain were divided in 3 groups which received a basal diet enriched with 6% of one of the following fat sources : rapeseed or soya oil or tallow fat. Each group was divided into 2 subgroups which received 30 (control) or 200 (vitamin E) ppm of tocopheryl acetate (Hoffman-Laroche, France). Animals were slaughtered at 16 weeks of age, the *Sartorius* muscle removed, put in a plastic bag, stored on ice and, after 6 hours, frozen at -80°C overnight. After 12 hours at -80°C muscles were kept at -20°C until analysis. All the " 0 month " analyses were performed in following week.

The vitamin E content in *Sartorius* muscles at 0 and six months frozen storage was determined according to the method of Buttris and Diplock (1984).

Lipid oxidation measurements were determined at 0 and six months by the TBA-RS according to the method of Lynch & Frei (1993).

Protein oxidation measurements were determined at 0 and six months by the carbonyl content according to the method of Oliver *et al.* (1987). Data are expressed as mean ± S.D. and student t-test was used to determine the significant differences.

RESULTS AND DISCUSSION

Vitamin E supplementation (200 ppm) increased significantly ($p<0.001$) muscle vitamin E content (Table 1). Supplemented animals showed average values about 5-fold higher than in control. Table 1 showed that after six months frozen storage, the vitamin E content in control and supplemented animals decreased from 20 to 40 %. Furthermore the vitamin E content and the decrease during storage were dependent on the fat source and vitamin E supplementation, more important decrease was obtained in control animals fed soya oil .

	Rapeseed oil		Tallow fat		soya oil	
	control	vita.E	control	vita. E	control	vita. E
0 month	2.0 ± 0.4	6.9 ± 0.8	1.1 ± 0.1	7.8 ± 1	0.9 ± 0.2	5.2 ± 0.5
6 months	1.5 ± 0.3 *	5.5 ± 0.9 *	0.7 ± 0.3 *	6.0 ± 1.3 *	0.4 ± 0.2 **	3.9 ± 0.6 **

Table 1 : Vitamin E content at 0 and 6 months frozen storage in *Sartorius* muscle from control and supplemented animals fed different fat sources.
Values are means ± S.D. * $p<0.05$; ** $p<0.01$; *** $p<0.001$

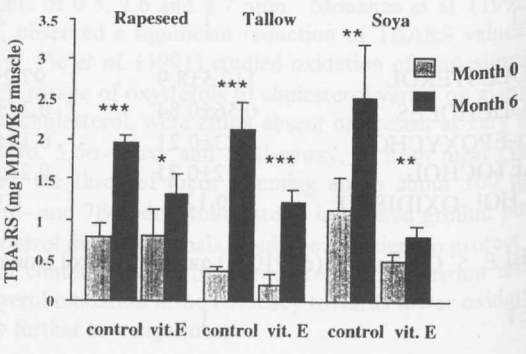

Figure 1 : TBA-RS at 0 and 6 months frozen storage in *Sartorius* muscle from control and supplemented animals fed different fat sources.
Values are means ± S.D. * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Dietary fat source influences the uptake of vitamin E in muscle. The tocopheryl acetate is stable in food but is hydrolysed to α-tocopherol during the absorption. During absorption, the extent of oxidation is proportional to the level of unsaturation in the dietary fat, and more unsaturated oils, such as soya, give lower α-tocopherol levels in muscle. Vitamin E decreases during frozen storage of turkey burgers have been reported (Wen *et al.*, 1996). Figure 1 shows TBA-RS evolution after six months frozen storage. Significant lipid oxidation occurred during storage in control and, to a lesser extent, in supplemented animals. The highest TBA-RS values in control occurred in muscles from soya fed animals which present the highest poly-unsaturated fatty acids content. The influence of dietary fat unsaturation on the turkey muscle fatty acid composition has been previously reported (Genot *et al.*, 1997).

Unsaturated dietary fat also raises TBA-RS during frozen storage (Lin *et al.*, 1989). Moreover, at six months and particularly with soya fed animals, the TBA-RS values in muscles from supplemented animals were significantly lower than in control. The beneficial effect of vitamin E during frozen storage has been also reported (Wen *et al.*, 1996).

Figure 2 shows the carbonyl content evolution during six months frozen storage. During this period, the protein oxidation was very slow and only significant in muscles from animals fed the control diet. A slow protein oxidation in turkey muscles has been reported in turkey muscles during chill storage (Mercier *et al.*,1998). Protein oxidation also occurred in " beef heart surimi "stored at different frozen temperature(Wang *et al.*,1997).

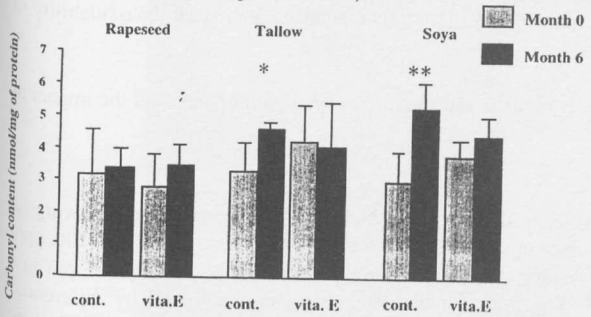

Figure 2 : Carbonyl content in Sartorius muscle from control and supplemented animals fed different fat sources. Values are means ± S D ; * = p<0.05 ; ** = p<0.01.

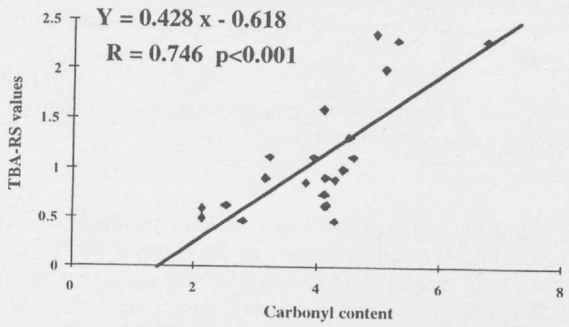

Figure 3 : Correlation between TBA-RS and carbonyl (0 and 6 months) content in Sartorius muscle from control and supplemented animals fed soya oil.

The increase in protein oxidation during the storage was only significant in muscles from control animals. The highest increase in carbonyl content was observed in muscles from soya fed animals. Figure 2 shows that, after six months, vitamin E lowered significantly protein oxidation in supplemented animals compared to the control in soya fed animals. A 10 000 I.U. supplementation showed the same effect on protein oxidation *in vivo*, in resting and exercised rats (Reznick *et al.*, 1992). Considering both 0 and six months frozen storage, Figure 3 shows that protein oxidation was correlated with lipid oxidation. Nevertheless, no significant correlation have been shown with muscles from animals fed the two other fat sources. In beef oxidative muscles, like *Diaphragma* (Mercier et al., 1995), the TBA-RS values were correlated to the carbonyl content formation. This result suggests that a highly unsaturated dietary fat raises lipid oxidation which, when sufficient, can cause protein oxidation from oxidised lipid products.

Conclusions

This work showed the relative impact of dietary fat sources on lipid and protein oxidation in meat during frozen storage. It was also shown a significant correlation ($p<0.01$) between TBA-RS and carbonyl contents when animals were fed soya oil. A 200 ppm vitamin E supplementation lowered protein oxidation appeared in meat from soya fed animals.

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