EFFECT OF VITAMIN E SUPPLEMENTATION DIETARY ON COLOUR STABILITY AND LIPID OXIDATION IN TURKEY MEAT

Véronique SANTE, M. RENERRE and A. LACOURT .

Station de Recherches sur la Viande I.N.R.A. Theix F-63122 Saint Genès Champanelle

SUMMARY

To reduce discoloration in turkey meat during ageing, dietary supplementation with Vitamin E was tested. It is known that Vitamin E supplementation improves pigment and lipid stability in beef. So, this experiment describes the effect of Vitamin E supplementation in the diet on lipid oxidation and on colour stability.

Vitamin E was added during the last 3 weeks (supplemented animals 250 mg/kg ; controls 40mg/kg). Thirty twelve-week-old turkeys (B.U.T.) were killed and chilled in slaughterhouse conditions. Then, turkey meat was cut and wrapped in oxygen permeable film. Colour coordinates (L* a* b*), pH values and reflectance difference at 630 and 580 nm were determined at different *post mortem* times. TBA (thiobarbituric acid) values and Vitamin E content were quantified just after slaughter and 7 days later.

Vitamin E supplementation resulted in a lower myoglobin oxidation ($p< 0.01$) and higher redness a* until 5 days. Later, no significant difference in metmyoglobin content and redness a* was found. No difference in TBA values and ultimate pH were detected whatever the *post mortem* times. Although it had no effect on lipid oxidation, the Vitamin E supplementation seemed to reduce the rate of discoloration.

INTRODUCTION

Many studies have been conducted to slow down lipid oxidation in meat (FAUSTMAN et al 1991). It was shown that lipid oxidation is catalysed by several metals ions including Fe^{++} which can be haeminic or non haeminic. It was also described that pigment oxidation and lipid oxidation seemed closely related (ANTON et al 1991). Use of biological antioxidants such as α dl tocopherol prevents lipid oxidation. Indeed, it is well established that α dl tocopherol supplementation of poultry diet results in an increase of its concentration in the muscle tissue and in a concomitant increase in the prevention of rancidity of meat (MARUSICH 1975). However, informations are lacking concerning how colour stability of turkey meat could be influenced by dietary α dl tocopherol supplementation.

MATERIAL AND METHODS

Animals

In the last phase of growth, 14 animals from the control group have received 40 ppm of α dl tocopherol (i.e. 17 U.I.) in the diet during 2 weeks. For the experimental group (14 turkeys), the supplementation was 250 ppm of α-dl tocopherol (i.e. 107 U.I.) during the same time. The animals were transported from the experimental farm to the slaughterhouse and then killed and chilled. 24h later, the turkey meat was cut, placed on a fibre board tray and wrapped in oxygen permeable film.

Tissue concentration of α dl tocopherol

A muscle sample was removed just after death and 7 days later. The α dl tocopherol content was quantified in the *Pectoralis superficialis* muscle by HPLC.

pH measurements

pH was determined at 20h and 48h post mortem using a combined glass probe electrode.

Colour measurements

They were performed at 2, 5, 7 and 12 days *post mortem*. Each sample was oxygenated 1 h before the measurement using a Kontr spectrometer. Spectra were obtained between 360 and 760 nm. the results were expressed as lightness (L*), redness (a*) and yellowness (b in the CIELAB (1976) system. The rate of meat discolouration was determined by measuring reflectance differences at 630 and 580 nm Haeminic iron content was quantified according to Hornsey method (1956).

Lipid oxidation

It was determined by thiobarbituric acid (TBA) test. 1g of muscle was precisely weighted and mixed with a polytron in 10ml of KCl 154 mM An aliquot of 0,5ml was taken : for the blank, the non induced and the induced samples. 50µl BHT were added in the non induced and blan samples. The tubes were kept in ice during 30 min. In the induced samples, 20µl of activated mixture ($FeSO_4$ 0,2mM; ascorbic acid 5mM were added and the tubes were incubated at 37°C during 30 min. Then 3ml H_3PO_4, 1ml TBA 30mM were added. Induced and non induced samples were then placed in boiling water during 45 min. After cooling, all the tubes have received 4ml butanol. They were centrifugated at 4000 rpm during 15 min. Optical density was read with a spectrofluorometer with a 532 nm excitation wavelength and a 553 nm emission wavelength. The results are expressed as nmol malonaldehyde (MDA)/ mg protein.

Protein analysis

Protein contents were determined according to Lowry (1951) method with the same mix as used for lipid analysis.

RESULTS AND DISCUSSION

Figure 1 shows tissue concentration of α-dl tocopherol in both groups. The muscles from the supplemented group contains 1.2 times more α-dl tocopherol than the control ones. However, this represents only a small increase with respect to the importance of the supplementation as the experimental to control ratio in diets was 6.3. In other species such as pigs or chicken, a similar amount of α-dl tocopherol supplementation has shown an higher accumulation of α-dl tocopherol in muscle (MONAHAN 1990, MARUSICH 1975). This small increase, in turkey, of α-dl tocopherol muscle tissue concentration can result from its low lipophilic property. Such a result was already observed by MARUSICH (1975) who have reported that the assimilation of Vitamin E by the chicken breast for a same intake is 3 times less in turkey breast. This can also be explained by physiological differences between these two species : indeed, turkey was shown to exhibit important excretion and little reabsorption of Vitamin E by the small intestine (SKLAN 1982). But, one way to increase Vitamin E level in turkey could be a supplementation by higher level of Vitamin E in the diet but this solution has disadvantages from an economical point of view.

The results of colour measurements are represented in Table 2, 3, 4 and 5. In both group, redness a* decreases between days 5 and 12 storage. This means a loss of the intensity of red colour of the meat. Nevertheless, the redness value a* is more important in the supplemented group and this difference is statistically significant at 2 days p.m. ($P<0.05$). This trend carries on until 5 days ($p>0.09$). Between 5 and 12 days storage, the differences in redness were not significant. The relatively high correlation of redness value between 2 days and 5 or 7 days ($R = 0.7$), indicates that redness value at 2 days could be an useful parameter to predict the evolution of redness in meat. The control group has exhibited higher lightness values L* until 7 days. This is similar to a paler colour of the meat. The two groups differed by their metmyoglobin content. In the control group, myoglobin was more oxidised at 2 days p.m. ($P<0.05$). This trend continued until 5 days and after reversed (Table 5). The correlation matrix showed that redness value and ΔR value were closely related ($R = -0.84$ at 2 days, $R = -0.95$ at 5 days) (Table 6). The supplementation of α-dl tocopherol in the diet seemed to have indirect consequences on the colour of turkey meat by delaying the onset of metmyoglobin formation. These observations are in accord with those of MITSUMOTO (1991).

Table 2 : evolution of redness a* during storage

days	2	5	7	12
control	2.03±0.7	2.38±0.8	2.1±0.8	1.9±0.8
experimental	2.85±0,6	2.9±0.6	2.5±0.5	1.9±0.6
	p<0.05	p<0,09	NS	NS

Table 3 : evolution of yellowness b* during storage

days	2	5	7	12
control	4.4±1	5.3±0.9	5.5±0.8	
experimental	4.4±0.9	5.4±1	5.6±1.1	5.9±0.8
	NS	NS	NS	NS

Table 4 : evolution of lightness L* during storage

days	2	5	7	12
control	48±2	49±2	49±1	44±2
experimental	47±2	47±2	47±1	44±2
	NS	NS	NS	NS

Table 5 : evolution of R630-R580 during storage

days	2	5	7	12
control	5.5±08	5.3±1	4.5±1	2.8±1
experimental	6.3±0.9	5.5±0.8	4.2±0.8	2.5±0.8
	p<0.05	NS	NS	NS

Figure 1 : Vitamin E content in P. superficialis muscle

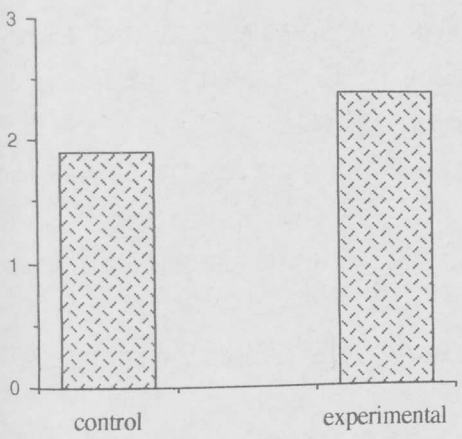

Table 1 : pH values

	20h	48h
Control group	5.93±0.09	5.76±0.08
Supplemented group	5.87±0.06	5.75±0.18

Figure 2 : MDA content /mg protein

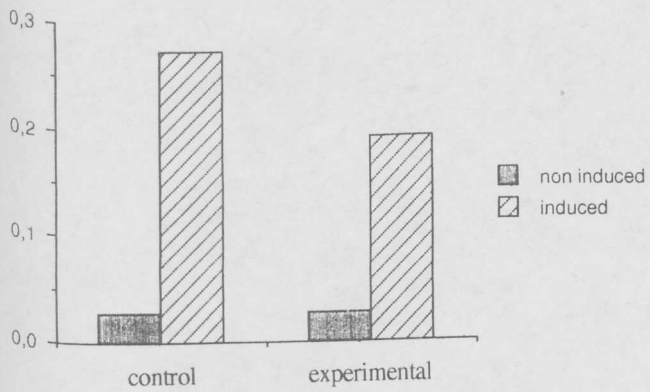

Table 6 : Correlation between redness value and Δ R value

	redness 2 days	redness 5 days
ΔR value 2 days	R = 0.84	ND
ΔR value 5 days	ND	R = 0.95

In non induced condition, the MDA content in breast muscle was in the same order in the two groups although the muscles from the experimental group contained more Vitamin E (Fig. 2). This could be due to the fact that samples were kept at -20°C during almost one month before analysis. At this temperature, lipid oxidation can still occured (WHANG 1987). The correlation between TBA number and colour coordinates were negligible. When peroxidation was induced experimentally, TBA value was shown to decrease in the supplemented group ($p<0.05$) (Fig.2). This can be explained by the fact that cell membranes from experimental group contained more α-dl tocopherol, which in turn protect phospholipids against oxidation by reacting with free radicals.

Table 1 shows the mean pH values for the 2 groups (control and Vitamin E supplemented). Their ultimate pH are in the same order and around 5.75.These pH values are normal ones with respect to those found in PSE ($pH \leq 5.5$) or DFD ($pH \geq 6$) turkey meat. However, we have already shown that pH value is the most important variable in the determinism of meat colour (unpublished results). These discrepancies in our results confirm that more than one factor is contributing in the stability of meat colour. Our results suggest that the oxidation state of the lipids could play an important role in that process as antioxidant activity of Vitamin E induce a better colour stability.

CONCLUSION

The dietary supplementation of Vitamin E (107 U.I.) has an effect on colour stability improvement of turkey meat. This effect is rather limited as no difference was detected after 5 days storage ($p>0.05$). In comparison to other species (pig and chicken), it may be noticed that turkeys show small abilities to stock Vitamin E in the muscle for concentration of α-dl tocopherol in the diet (107 U.I.) used in that study.

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