Dietary supplementation with vitamin E and retail storage of beef meat

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INTRODUCTION

Consumers relate the bright red colour of meat to freshness and increase in colour stability provides an opportunity to reduce economic los associated with discolored beef (Renerre, 1990). To slow these oxidative processes, many researchers have shown that dieta supplementation in vitamin E could lead to a greater color stability and a lower lipid oxidation (Faustman *et al.*, 1989b). This beneficial effe is depending on many factors such as the vitamin E level, the studied muscle (oxidative / glycolytic) and the retail mode of the meat.
The aim of this work was to evaluate the effect of vitamin E supplementation on colour stability of beef, stored in conditions near of th industrial practises, either in modified atmosphere or in air.

MATERIAL AND METHODS

60 Montbeliard bulls were given *ad libitum* access to diets consisting of maize, completed with corn, minerals and vitamins. In the fir rearing, with 24 animals, 8 animals per treatment were supplemented with vitamin E at a dosage of 125 (C), 1600 for 45 days (S1) and 16 for 125 days (S2) mg / head/ day. All animals were slaughtered at about 380 kg carcass weight. After removing of the carcass, at 24 h *post mortem*, *Longissimus dorsi* muscle was overwrapped in oxygen permeable film for 3 days, cut into slices which were stored after in modifie atmosphere (66% O_2/25% CO_2 / 9% N_2) during a maximum time of 15 days. In the second rearing, with 36 animals, 12 animals per treatme were supplemented with vitamin E such as previously shown (C/S1/S2). After removing from the carcasse, *Longissimus dorsi* muscle was first, stored under vacuum for 6 days at 0-2°C. At this time, the muscle was cut into slices wich were stored on fireboard trays, overwrapp with O^2 permeable PVC film, for a maximum of 11 days. To approach practical conditions for the two experiments, meat was stored at 0/2° in darkness during the night, and at 7/9°C, under constant illumination from cool fluoresent light, during the day.
Controls were done to measure the growth rate, the slaughter yield and the commercial classification. Analysis of tissue samples for α tocopherol were performed by the procedure NF V18-402 in the Hoffman - Laroche laboratory. Four panelists were requested to evaluate the visual quality every two days for discoloration (5 points graduation) and appearance acceptance, 3 being the limit of commercial acceptabili (5 = extremely desirable ; 1 = extremely undesirable). Colour evaluation was done with CR300 chromameter and L*, a*, b* were calculated in the CIELAB system. Surface metmyoglobin was calculated with a spectrophotometer by the method of Kryzywicki (1979). Meat discoloratio was determined by measuring reflectance differences : R630-R580 (Renerre and Mazuel, 1985).

RESULTS AND DISCUSSION

Wathever the duration (45 or 125 days), zootechnical performances and carcass characteristics were not affected by a 1600 mg / head / da vitamin E supplementation. These results are according to previous observations such as those of Arnold *et al.* (1992). After a 45 days vitamin E supplementation, α-tocopherol concentration in supplemented muscles was increased, comparatively to control samples, by a factor near o 2. After a 125 days vitamin E supplementation, the increase in α-tocopherol in muscles was between 2 and 3 fold (figure 1). Consequently, increasing the supplementation from 45 to 125 days is not really beneficial : the differences in vitamin E content, in function of the supplementation duration, were only significant for the first rearing (figure 1). It must be also noted that the increase in vitamin E content in the second rearing (control / supplemented) was not consequent because the vitamin E content of control samples was high for reasons which were not elucidated. Nevertheless, the differences in α-tocopherol content, between C and S samples, were similar enough to those of the literature (Mitsumoto *et al.*, 1991 ; Sherbeck *et al.*, 1995).
When meat was stored in modified atmosphere, after a short storage in air, it was observed, by visual appreciation, that vitamin E supplementation, whatever the duration, delayed the discoloration of meat, comparatively to controls, by 4.6 days (figures 1 and 2). These results are quite similar to those of Chan *et al.* (1996) who used a supplementation in vitamin E of 1204 IU/ head/ day for 122 days. With doses of 360 or 1290 IU /head / day, Arnold *et al.* (1993) showed that retail conditions were also increased 4.6 days comparatively to controls and found also that the increase was independent of the dose of vitamin E. By spectrophotometry, it was also observed that MetMb% was about 27% after 15 days of storage for S samples and more than 40% for C ones (figure 3). It is well admitted that about 40% is the critical proportion of MetMb on meat surface above which meat is unsaleable (Renerre and Mazuel, 1985). It was also observed (results not shown) that the vitamin E supplementation, whatever the duration, induced a large decrease in the concentration of TBA-RS, compared to controls. After 7 days of storage, the TBA-RS values of control samples were about 3 fold higher than those of supplemented ones, results in accordance with the dose of vitamin E which was found in the muscles. These results also confirmed the relationships between lipid and myoglobin oxidation.
When meat was first vacuum packaged and then overwrapped in oxygen permeable film, supplementation in vitamin E had a low effect on visual appreciation : the benefit of acceptability was of 0.7 day only (figure 1). Moreover the difference between control and supplemented samples was observed at day 8-9 of storage when, surprisingly for *LD* muscle, oxidation at the meat surface was already enough important and meat difficult to sell (figure 4). It was also observed that MetMb % was equal to 33% after 11 days of storage, for the control samples and only 27% for the supplemented ones : the discoloration was significantly more prononced in control samples (figure 5). The values observed for the different measurements were independant of the duration in vitamin E supplementation (45 days / 125 days). The results obtained with this last packaging mode are not easy to explain. One of the reasons is probably linked to the packaging mode : meat deterioration occured quickly under PVC permeable film, so that effect of vitamin E supplementation was too late to improve very much commercial acceptability. Another reason is that the dose of vitamin E in control animals was high, comparatively to supplemented animals (figure 1). Moreover, we have worked, voluntarily, in difficult conditions of meat display life, with elevated temperatures (7/9°C) during the day, favouring oxidation of myoglobin. Consequently, it is likely that a too low vitamin E supplementation didn't reduce the oxidative processes.

CONCLUSION

This work confirms, partially, our knowledge on the beneficial effect of vitamin E on meat colour. In this experiment, a supplementation in vitamin E generally allowed to prolong the meat shelf-life. Whatever the storage mode of meat (modified atmosphere / PVC overwrapped meat), the beneficial results of a supplementation in vitamin E were about identical whatever the supplementation duration : 45 or 125 days with 1600 mg / head / day. In our specific conditions, the use of vitamin E, to prolong the meat shelf-life, was well observed, and measured, when meat was packaged under modified atmosphere. When meat was overwrapped in permeable film, the benefit of a vitamin E supplementation appeared very low because the meat was judged almost undesirable even if, by objective measurements, the meat from supplemented animals was less oxidized than the meat from control ones.

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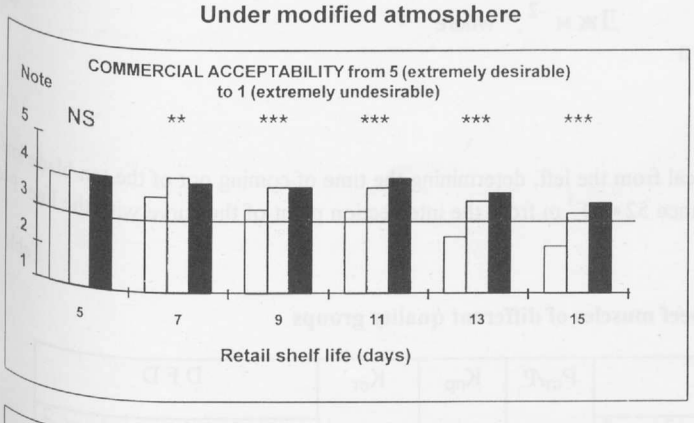
Figure 1 : Effect of dietary supplementation on zootechnical performances and carcass and meat characteristics (results of variance analysis and contrasts tests)

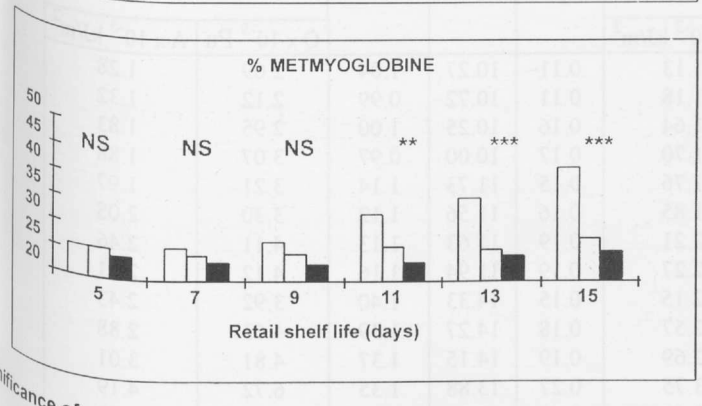
	FARM 1			FARM 2		
	C	S1	S2	C	S1	S2
Time of supplementation (d)	0	45	125	0	45	1252
Growth rate during the study (g/d)	1 117 a	1 102 a	1 116 a	1 322 a'	1 277 a'	1 346 a'
Carcass yield (%)	55,2 a	54,2 a	55,0 a	55,3 a'	55,3 a'	55,0 a'
LD vitamin E content (mg./kg)	1,55 a	3,40 b	4,60 c	2,54 a'	4,13 b'	4,79 b'
Meat retail shelf-life (d)	11,23	15,05	16,48	7,45	7,98	8,38

a, b (farm 1) et a', b' (farm 2) : different values on the same line indicate significant differences between batches for each farm ($p \leq 0.05$)

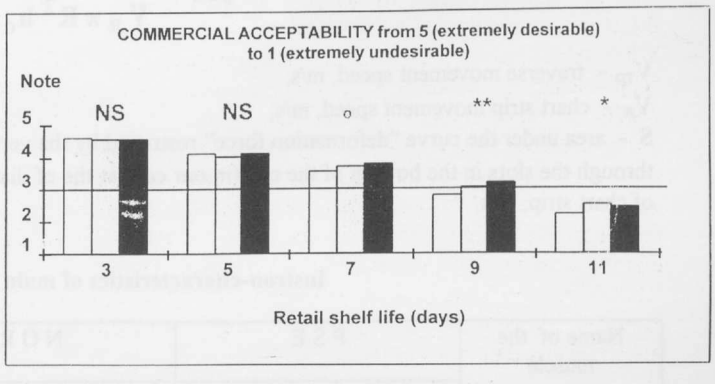
FIGURES 2 to 5 : COMMERCIAL APPEARANCE and COLOR OBJECTIVE CONTROLS

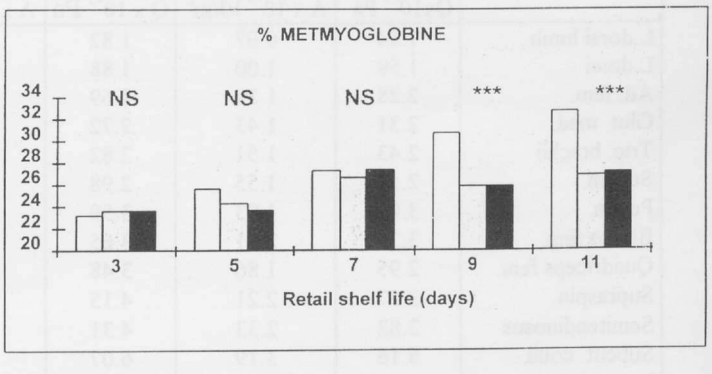
Under modified atmosphere





Under oxygen permeable film





Significance of supplementation effect (C compared to S1 or S2) : NS = P > 0.10 ; o = 0.05 < P ≤ 0.10 ; * = 0.01 < P ≤ 0.05 ; ** = 0.001 < P ≤ 0.01 ; *** = P ≤ 0.001

C S1 S2 Commercial acceptability limit = 3