EFFECT OF DIETARY SUPPLEMENTATION OF VITAMIN E ON CHARACTERISCS OF LAMB MEAT OF AIR AND MODIFIED ATMOSPHERE PACKAGED

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Introduction

Meat color is one of the most important qualities that customers use to purchase meat. Meat color affects the perception of freshness and determines the retail shelf life of meat. Extending this period should improve retail salability. The color of meat depends of many factors such as concentration of haeminic pigments, principally of myoglobin, and the chemical state of these pigments. The color of meat is due to a balance between oxymyoglobin, which is thought to indicate freshness and considered attractive to the consumer, and metmyoglobin, which is brown and unattractive (Renerre, 1990).

Change in meat color is closely associated with lipid and pigment oxidation (Buckley et al., 1995), as well as with bacterial load. Nevertheless, for meat packed under aerobic conditions lipid oxidation is not a limitation for storage because it occurs at a slower rate than discoloration and microbial growth (Jakobsen et al., 2000). Meat packed under high-oxygen modified atmosphere in refrigeration retards significantly the undesirable formation of metmyoglobin and the surface oxymyoglobin layer is thicker and the meat appears redder (Taylor et al., 1990) and prevents microbial growth of anaerobic pathogens (Ogrydziak et al., 1982). A disadvantage is that lipid oxidation increases and is one of the primary causes of quality loss in meat during such storage (Renerre et al., 1993).

Dietary supplementation with antioxidants produces an increase in lipid and pigment stability. Vitamin E is the primary lipid-soluble antioxidant in biological systems, since it breaks the chain of oxidative processes. Dietary supplementation with vitamin E increases the amount of α-tocopherol deposited in muscle and fat tissue (Jensen et al., 1998). The deposition of α-tocopherol in cell membranes allows it to act directly and effectively in control of lipid oxidation and, indirectly, in color deterioration in many species (Faustman et al., 2000).

Objectives

The aim of this study was to analyze whether the supplementation with vitamin E in the diet of lamb during the whole or in the last two weeks of the fattening period had an

effect on meat color, pigments content and lipid oxidation under air and modified atmosphere packaged.

Methodology

Twenty-two weaned male Manchego breed lambs were randomly assigned to two experimental groups of 11 lambs each. The dietary regimes of the lambs were: 1) concentrate diet supplemented with 270 mg of vitamin E/kg feed during the whole fattening period (32.2 ± 0,7 days), from an initial live weight of 14.5 ± 0.2 to a slaughter weight of 26.1 ± 0.3 kg; 2) concentrate diet containing 20 mg of vitamin E / kg feed since 14.7 ± 0.2 kg until lambs weighed 20.7 ± 0.1 kg, 18.7 ± 1 days, after that lambs received the supplemented diet with 270 mg of vitamin E/kg feed until animals reached the slaughter weight of 26.6 ± 0.3 kg, 14.3 ± 0.8 days. The lambs were housed in individual pens (1 m_2). Feed, water and barley straw were offered *ad libitum*. Twice per week, feed intake and live weight were recorded. When animals reached the fixed slaughter weight between 26 and 27 kg, lambs were slaughtered in a commercial abattoir. After 24 h postslaughter, m. *longissimus dorsi* from the left-half carcass was dissected and cut in 7 slices which were randomly assigned to each types of packaged, air and modified atmosphere and each storage times, 2, 6 and 12 days. The seventh slice was vacuum packed and frozen at -20ºC for subsequent α-tocopherol analysis. Muscles slices in air packaged were placed on fiberboard trays and overwrapped with oxygen permeable (10,000 cm_3 O_2/m_2/24 h) polyvinyl chloride (PVC) film. Muscle slices in modified atmosphere packaged were packed using BB41 Pounches (150 µm, polyamide/polyethylene, 50/100, Cryovac) with low gas permeability (7 cc/m_2/24 h O_2, 150 cc/m_2/24 h CO_2, water vapor transmission rate was 1.5 g /m_2/24 h) and flushed with 70 % O_2 and 30 % CO_2 with a 2:1 gas volume to meat ratio in each pack, using a packing machine type EV-15-1-CD-SC (Tecnotrip, S. A. Barcelona Spain). Meat samples were stored in darkness at 2 ± 1ºC.

The concentration of α-tocopherol in muscle was determined using the procedure of Cayuela et al. (2003). The results were expressed in mg α-tocopherol / kg muscle. Color measurements were done by reflectance using CM-2600d spectrophotometer (Minolta). The results were expressed as lightness (L*), redness (a*) and yellowness (b*). The relative content of myoglogin, oxymyoglobin and metmyoglobin was calculated according to Krzywicki (1979). Lipid oxidation in meat samples was assessed by the 2-thiobarbituric acid method of Maraschiello et al. (1999), evaluating thiobarbituric reactive substances (TBARS). The results are expressed in mg of malonaldehyde (MDA) / kg muscle.

Data were analyzed statistically using PROC MIXED of SAS version 8.2. (SAS Inst. Inc, Cary, NC). A factorial design was used in which dietary regimen was examined as main factor and type of packaged and storage time, a repeated measurement. The lowest Bayesian Information Criterion (BIC) was used to choose the matrix of the error structure. The matrix of error used was compound symmetry and unstructured, since they displayed the lowest BIC.

Results & Discussion

Tissue accumulation of α-tocopherol in vitamin E-supplemented animals appears to occur in a dose- and duration-dependent manner (Gatellier et al., 2001). Lambs fed 270 mg of vitamin E /kg of feed during the entire fattening period had a concentration of α-tocopherol in muscle of 2.59 ± 0.16 mg / kg muscle, which was higher ($P<0.001$) than lambs fed 270 mg / kg during last two weeks of fattening period, that had a concentration of α-tocopherol of 1.87 ± 0.17 mg / kg. Turner et al. (2002) reported that longissimus α-tocopherol concentration from lambs fed 300 IU of vitamin E /kg of DM for 21 days was higher than that from lambs fed 300 IU/kg for 7 days. Their longissimus α-tocopherol concentrations (2.89 and 1.91 mg / kg muscle for 21 and 7 days, respectively) were similar to our results, though the time of supplementation was lower the weight of the lambs was twice the our experiment (47 kg).

The meat color parameters, pigments content and TBARS for the dietary regimes and types of packaged during storage time are presented in figure 1. The significance of the main effects and interactions in the full model are presented in table 1. The L* color (a higher number indicates more white than black) was affected by dietary regimen ($P< 0.05$). Lambs supplemented during whole fattening had higher value than the other group. Besides, a* (indicating an increase in green color relative to red) and b* (indicating an increase in blue color relative to yellow) were also higher for lambs supplemented during whole fattening. This results showed that meat from lambs supplemented during whole fattening period was clearer and redder than those supplemented in the last half of the fattening, it could be the higher concentration of α-tocopherol in meat of lambs supplemented the whole fattening, increases color stability and maintains more suitable color of meat (Turner et al., 2002). There was a significant interaction for a* ($P<0.05$) and b* ($P<0.001$) between type of packaging and storage time, MAP reduced lightly a* and b* parameters during storage, whereas air packaged meat increased these values during storage.

In relation to pigments content, metmyoglobin was not affected by dietary regimen and showed a significant interaction ($P<0.01$) between type of packaging and storage time, increasing more rapidly in air-packed meat than in MAP, independently of dietary regimen. Oxymyoglobin content also had a significant interaction ($P<0.05$) between type of packaging and storage time. Its proportion was higher in MAP than in air packaged. MAP maintained the proportion of oxymyoblogin during storage whereas air packaged increased its proportion during storage. In this sense, Kerry et al. (2000) reported that MAP with high oxygen proportion improved color of meat, reducing metmyoglobin formation and maintaining the desirable bright-red color of meat due to oxymyoglobin. In air-packaged, the oxygen penetration inside meat is lower, because the oxygen pressure is lower than MAP, and the accumulation of metmyoglobin is enhanced (Ledward, 1970).

Although TBARS showed a significant effect of dietary regimen and storage time, it also showed a significant interaction ($P<0.001$) between both effects. The lipid oxidation was only lower after 12 days of storage in meat from lambs supplemented during the whole fatting period than in the other dietary regimen (figure 1). These results agree with Formanek et al., (1998) who reported that TBARS values in α-tocopherol acetate-supplemented minced beef were reduced in aerobic and MAP packs compared to not supplemented beef following refrigerated storage for 10 days. Gatellier et al., (2001) observed lower TBARS at the end of storage time such as air-packaged as MAP in beef

supplemented with 1000 mg α-tocopheryl acetate/animal/day for 111 days before slaughter respect to not supplemented beef.

Conclusions

Increase of tissue accumulation of α-tocopherol in vitamin E supplemented lambs appears to occur in a duration-dependent manner. The dietary regimen of vitamin E supplementation did not affect the general characteristics of meat, though meat from lambs supplemented during the whole fattening period had a light color and reduced the lipid oxidation at the end of storage. MAP prolonged a desirable color of meat during storage whereas air packaged induced lower color stability in meat during storage.

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Tables and Figures

Table 1. Summary table of the significance of the main effects and their interactions for meat color parameters, pigment content and TBARS.

	Main effects in the full Model						
	Dietary	Type of	Storage				
	regimen	packaging	time				
Variables	(DR)	(TP)	(ST)	DRxTP	DRxST	TPxST	DRxTPxST
Color							
L*	*	NS	NS	NS	NS	NS	NS
a*	**	***	**	NS	NS	*	NS
b*	*	***	NS	NS	NS	***	NS
Pigments (%)							
Metmyoglobin	NS	***	***	NS	NS	**	NS
Myoglobin	**	***	***	NS	*	NS	NS
Oximyoglobin	**	***	NS	NS	NS	*	NS
TBARS							
(mg MDA/ kg muscle) ***	NS	***	NS	***	NS	NS	

NS: No significant; * P<0.05; ** P<0.01; *** P<0.001

Figure 1. Evolution of meat color parameters, pigment content, TBARS and meat discoloration for the dietary regimes and types of packaged during storage time (mean ± S.E.)