Oxidative stability of argentine beef during ninety days of storage: supra-nutritional supplementation with vitamin E on grain and pasture production

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Background

Vitamin E is a commonly used antioxidant for improvement of beef quality and oxidative stability of stored meat (Liu et al., 1995). Supra-nutritional supplementation with vitamin E has shown to reduce lipid oxidation, that is one of the primary non–microbiological processes involved in meat deterioration, under simulated retail conditions (Arnold et al., 1993). Benefits of vitamin E supplementation is also well documented concerning to the improvement of beef colour (Faustman and Cassens, 1990). β-Carotene (βC), another fat-soluble vitamin with antioxidant properties can exert a co-operative antioxidant activity with α–tocopherol (αT) in a different location of the cell membrane (Fukuzawa et al. 1998). However, antioxidant dietary supplementation strategies for meat production strongly relay on vitamin E. Both natural antioxidant vitamins, among other natural free-radical scavenger compounds (as vitamin C) are present in pasture, which is the traditional feeding regime in Argentina beef production. To ensure that Argentine meat will be competitive in distant markets, it is necessary that its quality remain unaltered during distribution and marketing. Despite vacuum packaging allows reducing oxidation rate, the final oxidation level in meat will be related to its oxidative stability. This stability is the result of the balance between pro-oxidant and antioxidant substances.

Objective

The aim of this work is to characterise oxidative stability of argentine beef containing different levels of α–tocopherol, as well as its influence on nutritional quality and organoleptic parameters in vacuum packaged meat stored up to 90 days.

Materials and methods

Vitamin E supplementation: 120 days, 500UI*/animal/day (*Rovimix E 50 Ads, Vitamin Division, Productos ROCHE Argentina). **Animal diets** [pasture (P), pasture+Vit E (PE), grain (G), grain+Vit E (GE)], **meat samples and biochemical determination** of αT, βC and TBARs were performed as described by Descalzo et al. (2000). Meat samples were vacuum packaged using *Sealed Air Argentina* films, randomly distributed among different storage times (0, 30,60, 90 days) and stored in common ageing conditions at 2±1°C without illumination. **Microbiological analysis:** Seven samples for each dietary treatment were analysed. From each sample, a slice of 14.73cm x 3mm depth was aseptically removed, placed in a stomacher bag containing 50 ml of 0,1% peptone water, and homogenised for 2 minutes. Total vial counts (TVC) were performed by platting 0.02 ml of serial 1/10 dilutions and further incubation at 28 °C for 2 days. **Objective colour determination:** Sample slices were subjected to objective colour measurements in a BYK Gardner Colorimeter with large view area, illuminant D65 and 10° observer geometry was used. *L*, *a* and *b* parameters were measured. **Statistical Analysis:** Data were analysed using MIXED procedure of the statistical software SAS.

Results and discussion

Lipid oxidation in vacuum packaged samples showed a strong effect of treatment and storage time ($p<0.0001$). Along the studied period, the interaction between time and treatment was also significant ($p<0.05$). Results shown in Figure 1, indicate that progress in lipid oxidation (TBARs) was different among experimental groups. P group slowed oxidation development below the levels found for G group. On the other hand, supplemented groups PE and GE presented similar estimated curves, in spite of the different initial TBARs levels between them ($p<0.05$). P and G groups presented similar behaviour between them, but different from the supplemented groups. As presented in Figure 1, both, GE and PE meat, reached the levels of their respective control levels after 60 days. These results indicate that supplementation of basal diet retarded the oxidation. However, this is more meaningful for G samples, because Vit E supplementation determined that GE meat had the same TBARs values of P after day 30 of storage. This means that without supplementation samples from grain diet are more susceptible to oxidation from the beginning of ageing, leading to a shorter shelf life.

αT consumption along storage time showed that treatment, time and interaction (treatment x time) effects were significant (Figure 2). P and PE meat maintained a 2:1 ratio in αT concentration above G and GE levels throughout the 90 days of storage ($p<0.0001$), indicating a strong basal diet effect over the muscle content of αT. Concerning supplementation, αT content of PE was higher ($p<0.05$) than for its control only at day 0, and both, P/PE, decreased after 30 days of ageing ($p<0.05$). Thereafter, both groups remained unaffected by storage conditions. G and GE groups started with similar αT levels at initial time. But, αT consumption in GE samples is significantly slower ($p<0.05$) than its control G up to 90 days. These results would indicate that supplement Vit E is consumed in a different way than the endogenous αT in G muscles.

βC determinations for the four experimental groups showed that P/PE meat levels were approximately 10 times higher ($p>0.0001$) than G/GE meat (Figure 3). As expected, no variation attributable to supplementation was observed for any of the basal diets. And, βC concentrations remained stable throughout the storage time and do not seem to be significantly consumed under the vacuum storage conditions studied. It should be taken into account that βC has shown to be a potent antioxidant under low–oxygen pressure conditions (Tsuchihashi et al., 1995). Therefore, βC role is important for designing of antioxidant strategy for vacuum–packaging storage.

Microbiological data indicated that total viable count (TVC) increased as expected during storage time (Table 1). All values remained below 8 Log CFU/cm², which is considered as the spoilage limit for vacuum packaged meat (Eagan and Shay, 1982). The greater variability at day 0 could be attributed to random conditions on different slaughter and fabrication days. This variability decreased throughout experimental time, thus showing no effect of dietary Vit E supplementation on the total flora growth. This agrees with Cabedo et al. (1998), who did not find any effect of Vit E supplementation on TVC of vacuum–packaged beef stored at 4°C.

G/GE samples presented higher deterioration of colour than P/PE samples indicated by lower redness (*a* parameter). However, it is important to remark that none of the groups fall outside the acceptance range determined for consumer. This result is in agreement with previously reported data (Liu et al., 1996), where samples with higher levels of αT presented better retention of red colour (*a* value) and chroma.

Conclusion

Vacuum packaged beef did not presented objectionable alterations after 90 days of vacuum storage. Despite Vitamin E supplementation retarded lipid oxidation, pasture diet presented higher contribution to muscle tissue antioxidant defence than grain diet.

Literature

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Figure 1: TBARs

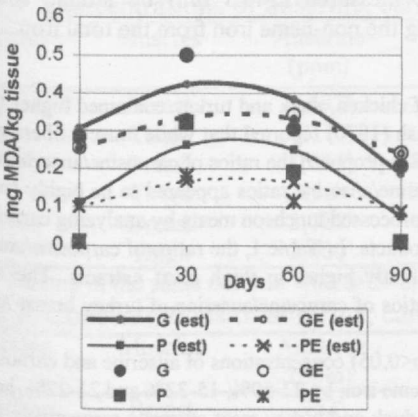


Figure 2: α-tocopherol

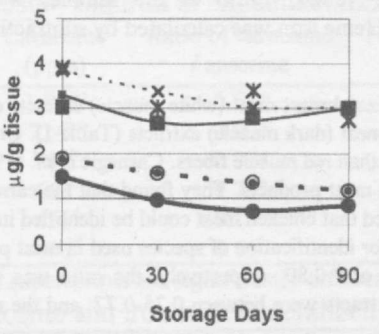


Figure 3 : β-carotene

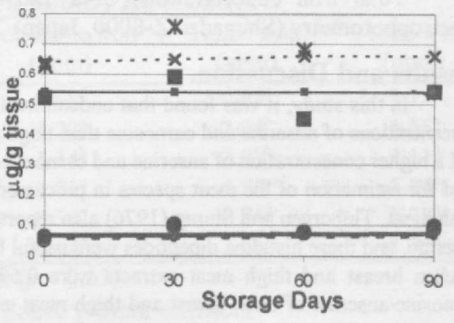
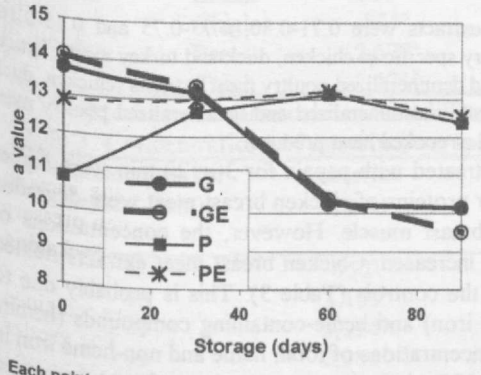


Figure 4: Colour a Value



Each point represent the mean value of ten samples

TABLE 1: Mens(SD) Total Viable Counts (Log CFU/ cm2)

	Storage days			
Diet	0	30	60	90
G	3.88±0.63 **a**	6.21±1.13**a**	6.95±0.10**a**	7.32±0.31**a**
GE	3.30±0.68**ab**	6.44±0.75**ab**	7.05±0.10**a**	7.36±0.45**a**
P	2.89±0.49**b**	7.09±0.20**b**	7.48±0.32**a**	7.64±0.29**a**
PE	4.90±1.52**c**	6.91±0.25**ab**	7.41±0.36**a**	7.65±0.33**a**

abc Means in the same column followed by the same letter are not significantly different (p>0.05).

G: grain, GE: grain with vitamin E supplement,
P: pasture, PE: pasture with vitamin E supplement.