Argentine beef: Lipid and protein oxidation and its relationship with natural antioxidants during refrigerated retail display

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Background

There are physical and chemical changes during the conversion of muscle to meat and its post-mortem storage that alter the meat quality, including discoloration, development of off-flavour and textural changes (*Mc Millin, 1996*). The mayor factors involved in quality deterioration are due to biological membrane disruption and oxidative processes.
The meat biological compounds that are most affected by oxidative processes mediated by free radicals, include unsaturated fatty acids in lipids, heme groups in pigments, amino acids in proteins and conjugated double bounds in vitamins. These oxidation processes produce chain reactions that are favoured by light and air (oxygen) (*Mc Millin, 1996*).
Concentrations of endogenous antioxidants are a function of animal species, muscle type and in some cases diet (*Decker & Mei 1996*). There are several reports on the benefits of supplementing cattle diet with vitamin E. But, since feeding cattle with fresh forage might determine muscle α-tocopherol saturation (*Houben et al., 2000; Liu et al., 1995)*, its important to consider if the level in basal diet is enough to minimise the susceptibility to oxidation.

Objectives

The aim of this work is to determine the effects of traditional argentine basal diet (intensive pasture system) compared with feedlot, on lipid and protein oxidation during retail display storage (without ageing) of *Psoas major.*

Methods

Animals and sample preparation: ten crossbred steers were reared on pasture. Five of them were randomly assigned to remain on this diet, and the other five were finished on feedlot system (without Vitamin E supra-nutritional supplementation) during 110 days prior to slaughter. The middle part of each *Psoas major* muscle was cut into 10 slices of 2.5 cm. The slices were randomly distributed among different storage times (1, 3, 5, 7 and 9 days). Two slices of fresh meat were packaged on Polyfoam trays and over-wrapped with an oxygen-permeable polyvinylchloride film. Samples were storage under simulated retail display conditions: illumination (1900 Lx) and refrigeration temperature (2 ± 1°C). Lipid oxidation was determined for all storage times. Determination of α-tocopherol, β-carotene and carbonyl content (protein oxidation) were performed in samples with 1 and 9 days of storage. To keep the conditions of retail display at the sampling time, these samples were wrapped in aluminium foil, vacuum packaged and frozen at -20°C until analyses were performed.

Lipid oxidation: Thiobarbituric Reactive Substances (TBARs) were determined according to Pensel, N. (1990). Calibration curves were performed using TEP (1,1,3,3 Tetraethoxypropane, Sigma Chemical co, St. Louis. USA). Percentage of recovery was 94 %.
Determination of α-tocopherol and β-carotene: protocols adapted from *Buttriss and Diplock. (1984)* were used. Analyses were carried out in HPLC system with a quaternary solvent pump, autosampler and fluorescence and uv-vis diode array detectors, using an Alltima C18 column (5μ, 250 x 4.6 mm) and Ethanol:Methanol 90:10 as the mobile phase.
Protein oxidation: the reaction between 2,4 DNPH and protein carbonyls was performed as proposed by *Levine et al. (1990)* with modification according to *Reznick & Packer (1994).* The modification consisted in adding the reactive before protein precipitation (in solution).
Statistical analysis: analysis of Repeated Measures using mixed models (SAS System software, SAS Institute, 1996).

Results and discussion

Meat samples from pasture fed steers (P) presented lower level and different lipid oxidation progress pattern than those meat samples from feedlot fed steers (F) (figure 1,table I). After 3 days of display, F samples showed a significant increment in lipid oxidation ($p<0.01$), while in P it was evidenced after 7 days ($p<0.01$) (table I). The delay in oxidation development for P muscles may be supported by its higher α-tocopherol content ($p<0.01$), and the consumption rate that was 1.9 times higher than for F. Moreover, the β-carotene level resulted higher for P samples ($p<0.01$), and there was significant decrease after 9 days of storage, that was not observed in F samples (figure 2, table II). These results are in agreement with Simonne, et al. (1996), who found different content of β-carotene in animals finished with forage or feedlot diets, and with *Tsuchihashi, et al.* (1995) who suggested that, *in vitro,* the degree of consumption of β-carotene is dependent of its initial concentration. Yin & Cheng (1997) reported an additive antioxidant effect between α-tocopherol and β-carotene when β-carotene concentrations were similar to those found in the P samples analysed in this study.
In spite of the similar initial levels for P and F, protein oxidation, measured as carbonyl content, was higher for F ($p<0.05$) after 9 days of storage. On the contrary, there was no evidence of a significant progress in protein oxidation for P samples at the same time of storage (table III). The correlation between carbonyl content and lipid oxidation was not high, however the tendency of carbonyl content showed a direct relationship with TBARs and an indirect relationship with α-tocopherol (figure 4). These results are in agreement with *Mercier et al. (1995),* who also found a poor correlation with TBARs.

Conclusions

A better antioxidant status is achieved when cattle are fed on intensive pasture system. This situation confers to muscle tissue less susceptibility to oxidative deterioration processes involving lipid and protein compounds.

Literature

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Table I: TBARs values in *Psoas Major* muscles (mg MDA/kg tissue)

Diet/days	1	3	5	7	9
Feedlot	0.48 Aa	0.56 Aa	0.98 Ab	1.18 Ac	1.20 Ac
Pasture	0.13 Ba	0.21 Ba	0.22 Ba	0.25 Ba	0.41Bb

Table II: Antioxidants values in *Psoas Major* muscles (µg/g tissue)

	α-Tocopherol		ß-Carotene	
Diet / days	1	9	1	9
Feedlot	0.79 Aa	0.34 Ab	0.17 Aa	0.16 Aa
Pasture	2.06 Ba	1.21 Bb	0.74 Ba	0.56 Bb

A, B within each column shows significant difference (treatments)
a, b within each file shows significant difference (time)

Table III: carbonyl content values in *Psoas Mayor* muscles (nmol/mg prot.)

Diet / day	1	9
Feedlot	0,98 Aa	1,91 Ab
Pasture	0,66 Aa	1,15 Ba