Antioxidant status and lipid oxidation in fresh Argentine beef from pasture and grain-fed steers with vitamin E supra-nutritional supplementation

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Background

Vitamin E, tocol and tocotrienol derivatives exhibiting the biological activity of α–tocopherol (αT), is an antioxidant commonly used to improve beef quality by increasing oxidative stability during storage (Liu et al., 1995). Since Vit E cannot be synthesised by animals, its presence in animal tissues depends on the dietary availability. Its principal role, in relation to meat quality, is to prevent lipid oxidation by quenching lipid hydroperoxide free radicals. Nevertheless, in addition to αT content in muscle, it should be considered some other factors that influence muscle oxidation stability. For example, contribution of content of highly oxidation susceptible polyunsaturated fatty acids (PUFA>18:2) to balance of pro-oxidant/antioxidant compounds (Jensen et al., 1998). Besides, β-carotene (βC) is another important fat soluble antioxidant that quench sites localised in the hydrophobic region, complementing αT scavenging of reactive oxygen species close to the membrane surface (Fukuzawa et al., 1998). Therefore, although βC is much less reactive than αT, both antioxidants can exert a cooperative antioxidant activity in different positions of the membrane (Tsuchihashi et al., 1995). Dietary antioxidant supplementation of meat producing animals is mainly associated with Vit E, and many authors had reported its benefits on stored meat colour improvement concurrent with lipid oxidation retardation. The objective of cattle supplementation with supra–nutritional levels of Vit E is to deposit sufficient α–tocopherol in muscles to maximise the protection of muscle lipids against peroxidation. Argentine beef is traditionally produced on pasture. However, to comply with some markets requirement, consumer's preference for feedlot meat, this system is becoming more common among producers.

Objective

The aim of this work is to characterise the relation of pro-oxidant to antioxidant in meat from cattle fed with different dietary content of vitamin E and to determine its influence on nutritional quality and organoleptic parameters during storage.

Materials and methods

Forty crossbreed steers were finished (>120 days), using the following diets: **a-**Pasture: 20 steers were reared on natural pasture at a forage rate of 1000/2000kg dry weight/Ha. Randomly, 10 steers were used as control (P) and the others 10 steers (PE) received 500 UI Vit E/day (Rovimix E 50 Ads,Vitamin Division,Productos ROCHE Argentina) with wheat brand as vehicle. **b-**Grain: 20 steers were grain fed for 120 day and then separated in two groups of ten animals each. One group, used as control, was individually fed with 5kg corn/day/animal+6kg hay/day/animal (G), and the other was fed with the same basal diet, but supplemented with 500 UI Vit E/day (GE). **Plasma** was collected at the begining and immediately before the slaughter. All animals were slaughtered at 480kg. Twenty-four hours after slaughter ***Psoas major* muscles** (PM) from both sides of an individual carcass were excised, trimmed and cut into two longitudinal pieces. The PM pieces were vacuum packaged using *Sealed Air Argentina* films, immediately refrigerated at 2±1°C and randomly distributed among different storage times (0, 30,60, 90 days). In this presentation, only will be reported determination performed at zero time. **Thiobarbituric-reactive substances** (TBARs) were measured by the acid extraction method as modified by Pensel (1990). **Plasma αT** was extracted with hexane and determined as described by Mac Murray & Blanchflowers (1979) without saponification step. **Muscle αT and βC** samples were saponified and extracted as indicated by Butriss & Diplock (1984). HPLC run was resolved with a mobile phase of 90:10 EtOH: MeOH. Simultaneous detection of αT and βC was obtained with a fluorescence detector at 296-330 nm and UV-VIS detector at 445 nm respectively. **Fatty acids composition** was determined using GC with WCOT fused silica 50mx25mm coating CP-SIL 88 capillary column at 190°C.

Results and discussion

No differences were found between supplemented and control groups in relation to production parameters as indicated in Table 1. Before slaughter plasma αT level was higher ($p<0.05$) for P steers and for PE and GE groups (Figure 1). As it was expected, grain fed controls maintained αT concentration along the finishing period. And these animals were considered the αT depleted group. On the other hand, GE group responded to vitamin E supplementation, achieving concentrations comparable to the initials found in P animals. No differences were detected between P and PE animals. αT augmented in both, supplemented and non-supplemented groups at the same rate. Therefore, diet supplementation with vitamin E produced a significant increase on plasma αT levels in depleted animals, whereas pasture fed cattle presented no differences. These results are in agreement with previous studies, which reported that the increment on plasma αT levels was highly dependent on the basal dietary Vit E content and the animal's Vit E status before the supplementation was given (O'Grady et al., 1998). As expected, basal diet was the responsible for higher βC uptake in muscles of P group, as P/PE meat presented 10 times higher amounts than G/GE samples (Figure 2). Supplementation with Vit E did not influence the βC content of meat. Analogous to the levels of plasma vitamin E intake, higher amounts of αT were found in P/PE muscle. Despite the lack of difference in plasma levels between PE and P, PE group incorporated slightly higher amounts than its respective control P ($p>0.05$). Although plasma intake within GE group was higher than in G control, this difference was not reflected in *Psoas major* αT levels. Therefore, animal fed grain based diet did not show concordance between plasma and muscle αT levels. A possible explanation could be that even plasma αT level for GE was similar to P, the tissue saturation was not accomplished in the finishing time. Lipid oxidation values (Table 2), were similar for G and GE. Although GE was slightly lower than G the difference was not significant ($p>0.05$). Likewise, P and PE oxidation values were equivalent. Since P/PE groups were significantly higher than G/GE, there is a direct relationship between basal diet and lipid oxidation. No differences were observed in saturated fatty acids content. G/GE animals presented higher amounts of monounsaturated fatty acids (MUFA) than P/PE. Although, PUFA were similar for all treatments, PUFA with more than two double bonds (PUFA>2db) content was higher for P/PE groups. As expected the higher content of Vit E resulted in lower TBARs. As shown in Figure 3, the content of vitamin E against lipid oxidation permitted the differentiation of two groups that are coincident with basal diet disregarding supplementation. The same grouping was observed after measurement of aroma

parameters for this samples (Griggioni et al, 2000). Considering the results from Figure 3 and Table 2, a relationship for TBARs, UFA content and αT was found as described in Figure 4. TBARs were directly related to MUFA and PUFA content, and inversely related to αT. Linear correlation was used to define the following relationship between TBARs and the other parameters: **Log (TBARs)= 0.01 x (MUFA+PUFA) - (αT) - (βC) -1.** Jakobsen & Bertelsen (2000) previously obtained similar results. This equation explains the relationship between prooxidants and antioxidants. Therefore, the balance of natural antioxidants of pasture resulted in better protection against the prooxidant effect of PUFA>2db than VitE supplementation alone.

Conclusion

The contribution of natural antioxidant found in meat from pasture fed steers was sufficient to compensate the high pro-oxidant effect of PUFA>2db. Supplementation with vitamin E contributed in lesser extent to elevate fresh meat antioxidant status. Therefore, this study confirms that basal diet is extremely important to determine the antioxidant supplementation strategy when the objective is to mimic the pasture meat antioxidant quality.

Literature

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Table 1: Production parameters

Treat	Daily weight gain (kg)	Yield	Carcass weight
G	0,708a	59,2a	122,8a
GE	0,789a	59,1a	124,4a
P	0,456b	61,1a	123,2a
PE	0,522b	60,5a	124,4a

Table 2: Lipid composition and oxidation (TBARS).

Treat	TBARs	SFA	MUFA	PUFA	PUFA>2db
G	0.284±0.098a	45.486±3.864 a	37.830±4.345 a	7.290±2.590a	2.543±1.001 a
GE	0.257±0.096 a	44.096±2.081 a	37.829±2.570 a	8.185±2.034a	2.861±0.644 a
P	0.094±0.03 b	42.853±2.900 a	34.175±1.507 b	10.311±2.254a	4.437±0.995 b
PE	0.095±0.03 b	44.328±3.780 a	32.847±3.367 b	8.679±1.703a	3.642±0.719 b

In the same colum, means with different letters are significantly different (p<0.05)

Figure1: α-Tocopherol in plasma

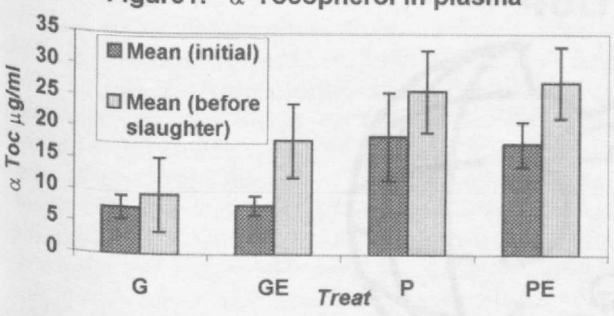

Figure 2: α-Tocopherol & β-carotene in muscle

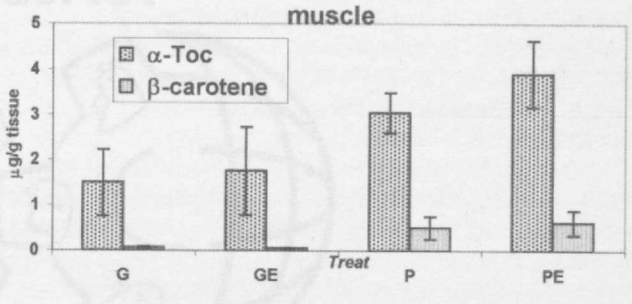

Figure 3: α-Tocopherol vs TBARs

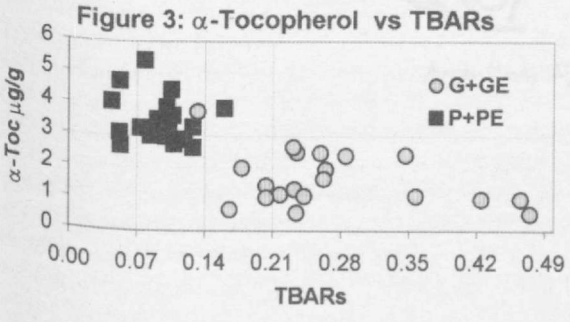

Figure 4: TBARs Pedicted vs Experimental