THE EFFECT OF PACKAGING ON COLOUR, OXIDATION AND MICROBIOLOGICAL STATUS OF BEEF FROM VITAMIN E SUPPLEMENTED CATTLE

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Background

The deterioration of fresh meat quality is brought about by physical, biochemical and microbiological mechanisms which act solely or in combination with each other (Church, 1993). The development of modified atmospheric packaging (MAP) has provided a new approach to controlling such damaging mechanisms, thus, extending the shelf-life of fresh meat products (Hood and Mead, 1993). The use of MAP for fresh red meats usually involves the utilisation of high concentrations of oxygen to maintain or produce a deep layer of bright red oxymyoglobin and lower concentrations of carbon dioxide to delay the aerobic deterioration of the meat by the proliferation of meat spoiling bacteria. Dietary α-tocopheryl acetate supplementation in cattle diets has been shown to improve lipid and colour stability in beef held under retail conditions (Faustman et al., 1989; Arnold et al., 1993). The objective of the present study was to determine the effects of aerobic packaging and MAP on colour stability, lipid oxidation and microbiological status of steak cores from *M. gluteus medius* following vitamin E supplementation to crossbreed Fresian cattle.

Methods

Fresian crossbreed (Fresian x Romagnola) steers (n=6) were divided into two groups (n=3) and fed diets containing 20 (basal) or 2000 (supplemented) IU/head/day for 50 days prior to slaughter. Following slaughter, the carcasses were chilled overnight and *M. gluteus medius* removed from each carcass. The muscles were vacuum packed and frozen (-20°C x 5m).

Steaks (3 cm thick) were cut from each muscle and duplicate cores (2.5 cm diam.) were taken from each steak. These were placed on polystyrene/EVOH/polyethylene trays and overwrapped with oxygen permeable (6000-8000 cm^3/m^2/24 h) polyvinyl-chloride film for aerobic packaging and low oxygen permeable (8-12 cm^3/m^2/24 h) polystyrene/EVOH/polyethylene film for MAP with gas combinations consisting of 60:40, 70:30, 80:20 and 90:10 oxygen to carbon dioxide. All packaged cores were held in retail display conditions for 10 days at 4°C under fluorescent lighting (616 lux).

Lipid oxidation in meat samples was assessed by the 2-thiobarbituric acid method of Ke et al. (1977). Measurement of tristimulus colour coordinates (L, a, b) of muscle were recorded using a Perkin-Elmer (Lambda 2) spectrophotometer. Metmyoglobin content was determined by the method of Krzywicki (1979). The α-tocopherol content in the muscle tissues was determined using the extraction procedures of Bieri et al. (1975) with the modifications of Buttriss and Diplock (1984) and quantified by the HPLC method of Sheehy et al. (1993). Bacteriological analysis was carried out using the procedures of Gill and Penney (1985) for total bacterial counts and selective Pseudomonaceae, Enterobacteriaceae and Lactic acid bacteria counts.

Results

There were significant ($p < 0.01$) differences in α-tocopherol levels between supplemented and basal groups. Of the four MAP treatments, the 80:20 oxygen to carbon dioxide mixture was the most beneficial with respect to colour, lipid oxidation and microbiological status. The differences in Hunter 'a' values (Fig. 1a) and the proportion of metmyoglobin (Fig. 1b) between supplemented and basal meat samples in the 80:20 MAP gas mixture were significantly ($p < 0.05$) different after 6, 8 and 10 days of retail display at 4°C. There were no significant differences in Hunter 'a' values and the proportion of metmyoglobin between supplemented and basal meat samples under aerobic packaging, however, meat from the supplemented group was more stable and metmyoglobin accumulation occurred at a slower rate. Supplemented meat had lower (though not significantly) TBARS than meat from the basal group, both in aerobic and 80:20 MAP. The 80:20 MAP system resulted in higher (though not significantly) TBARS than observed under aerobic conditions (Fig. 1c). No significant differences were observed in the total counts and microbial counts on selective media between meat samples from the supplemented and basal groups under 80:20 MAP or aerobic conditions. However, trends would indicate that bacterial numbers were higher in all cases for meat from the basal group. The log numbers of Pseudomonaceae and Enterobacteriaceae increased over time under aerobic packaging while 80:20 MAP prevented proliferation of these groups. Both packaging regimes resulted in an increase in the lactic acid bacteria.

Conclusions

Dietary supplementation of beef with α-tocopheryl acetate appears to be an efficient means of improving colour in beef which was previously frozen (-20°C x 5m). The 80:20 MAP system promoted greater colour stability and slowed down the development of metmyoglobin to a greater extent than observed in meat samples held under aerobic conditions. The colour stability of α-tocopheryl acetate supplemented meat was further enhanced by 80:20 MAP. The combination of MAP and beef supplemented with α-tocopheryl acetate may be an effective means of controlling the colour of retail meat.

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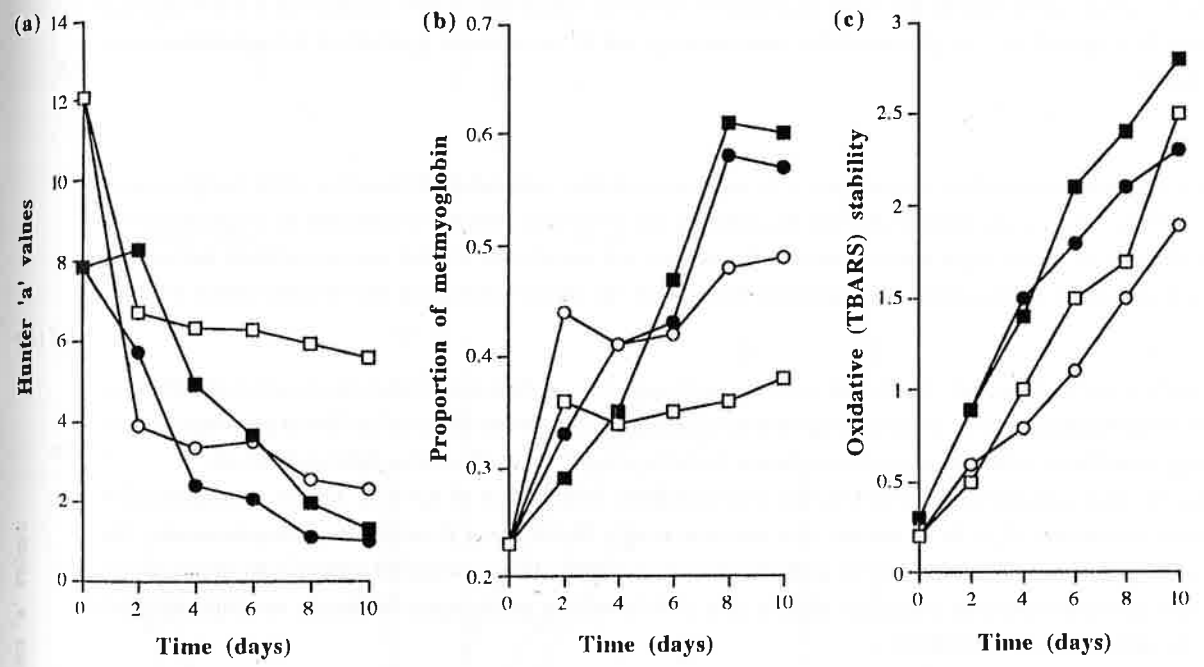

Fig. 1 Effect of dietary α-tocopheryl acetate supplementation on **(a)** Hunter 'a' values, **(b)** proportion of metmyoglobin and **(c)** oxidative stability of beef cores from *M. gluteus medius* steaks during refrigerated display at 4°C for 10 days. (■) Beef from basal group using 80:20 MAP, (□) beef from supplemented group using 80:20 MAP, (●) beef from basal group and packaged aerobically, (○) beef fed a supplemented diet and packaged aerobically