EFFECT OF A PROPRIETARY OXYGEN ABSORBER AND PACKAGING FILMS ON THE COLOUR OF CHILLED BEEF AND LAMB PACKAGED UNDER A SATURATED CARBON DIOXIDE ATMOSPHERE

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Introduction

For Southern Hemisphere processors to be able to supply chilled meat to Northern Hemisphere markets, the packaging must ensure that the meat has a long effective storage life with sufficient residual resilience to meet customer fabrication, distribution, display and home storage requirements. The packaging must therefore limit the growth of spoilage microorganisms and psychrotrophic pathogens, and preclude the adverse chemical effects, including colour deterioration, associated with the exposure of raw meat to atmospheric oxygen (Penney and Bell, 1993).

The saturated carbon dioxide packaging systems now being used to deliver chilled New Zealand meat to the major markets of the Northern Hemisphere currently minimise oxygen-mediated deterioration through the use of very high barrier aluminium foil laminate or double metallised packaging films (Gill, 1989). Replacement of these films by transparent plastic films with lower barrier properties could prejudice colour stability through oxygen ingress accelerating metmyoglobin formation, thereby causing the meat to become brown during extended storage.

This study was conducted to determine whether the inclusion of a proprietary oxygen absorber within a saturated carbon dioxide pack could, in respect to meat colour stability, compensate for the use of packaging materials that allow some oxygen transmission.

Method

Thirty 500 g pieces of beef striploin and 30 lamb short loins were individually placed in foil laminate bags with an oxygen transmission of 0cc/m^2/24 hr at 20°C. A proprietary oxygen absorbing sachet, Ageless™ Type Z-100GA capable of absorbing 100 ml of oxygen (Mitsubishi Gas Chemical Company, Tokyo, Japan), which contains an iron powder, was added to 15 packs of each meat type before the packs were flushed with 1 litre of carbon dioxide and sealed using a Securepack10 controlled atmosphere packaging machine (Securefresh Pacific, Auckland, New Zealand) capable of producing an initial pack atmosphere containing less than 300 ppm residual oxygen.

The same packaging procedure, with and without proprietary oxygen absorbing sachets, was then repeated using a packaging film with a stated oxygen transmission rate of <5 cc/m^2/24 hr at 21°C and a conventional vacuum pack barrier film with a stated oxygen transmission rate of <50 cc/m^2/24 hr at 21°C. All 180 packs, 90 of beef and 90 of lamb were stored in cartons at -1.0 ± 0.5°C. After 6, 8, 10, 12 and 14 weeks storage, three control packs (foil laminate without an oxygen absorbing sachet) and three packs of each treatment were taken from storage for evaluation.

For colour evaluation meat samples were removed from their packagings, assigned a random number, held for 30 min at 4°C to allow the meat to bloom, then assessed by a 20-member panel trained to differentiate meat colours.

Results

Colour panel comparisons between control beef and lamb packs (foil laminate packs with no sachet), and the test packs (foil laminate containing Ageless™, high barrier and conventional vacuum barrier packs with and without Ageless™) are summarised in Figures 1 (beef) and 2 (lamb). With all treatments, discoloration of beef was generally more noticeable than that occurring with lamb. This difference may reflect the more intense pigmentation of beef and/or the relative efficiency of the metmyoglobin reductase activity (Hagler *et al.*, 1979) in the two meats.

It was expected that for both beef and lamb the colour differences between foil only (control) and foil plus an oxygen absorber would, if anything, reflect a slight superiority of the test treatment. While this was true in some cases, meat from packs containing an oxygen absorber was often uneven in colour, which tended to detract from its overall appearance.

In high barrier packs (<5 cc/m^2/24 hr) with no Ageless™, both meat types showed a progressive, probably metmyoglobin-reductase mediated, colour improvement up to 10 weeks storage followed by colour deterioration. Introduction of the oxygen absorber into this type of pack produced different and contradictory changes to the colour deterioration pattern in the two meat types. With beef (Fig. 1) the presence of Ageless™ produced more extensive early discoloration followed by full colour recovery. Lamb, on the other hand, showed a reduced early discoloration followed by progressive deterioration, suggesting increasing inactivation of the Ageless™ and/or a cessation of metmyoglobin reductase activity. Colour stability with conventional vacuum barrier film, with or without an oxygen absorber present, was unsatisfactory for prolonged chilled storage of beef. Lamb in these medium barrier packs (< 50 cc/m^2/24 hr) showed marginal colour stability and this was only slightly improved by the presence of the oxygen absorber.

Performance of the oxygen absorber (Ageless™ Z type) may be impaired in the presence of elevated concentrations of carbon dioxide (private correspondence, Mitsubishi Gas and Chemical Company). Company data were inconclusive but suggest that oxygen absorption is slowed rather than prevented in the presence of carbon dioxide.

Conclusions

The use of iron powder based oxygen absorbers with high barrier films (<5 cc/m^2/24 hr) may afford some advantage in respect to beef colour after 12 weeks storage but offers no advantage with lamb. With conventional vacuum packaging barrier film (<50 cc/m^2/24 hr) there may be some colour advantage with lamb stored for up to 8-10 weeks, but the presence of oxygen absorbers offers no advantage with beef irrespective of storage period.

The inconsistent results using transparent high barrier films, even with the presence of an iron powder based oxygen absorber does not appear to give a commercially viable packaging process for the extended storage of chilled red meat. However, ongoing commercial development of oxygen absorbers whose activity is not compromised by high concentration of carbon dioxide is expected to rectify the situation.

The visual quality limitations imposed by the entry of oxygen into saturated carbon dioxide atmosphere packages over the long storage time required to get New Zealand product to Northern Hemisphere markets is now well recognised commercially. In the current 1995-1996 season, the New Zealand lamb industry is expected to use ultra high barrier foil laminates or double metallised films with saturated carbon dioxide to package approximately half of the chilled lamb it exports to overseas markets, including Europe, the United States and the Middle East.

References

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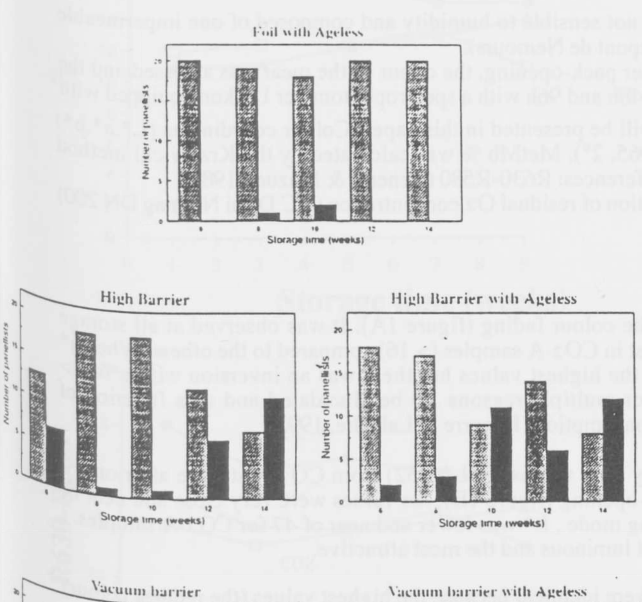

Figure 1. Comparison of beef colour in test packs with that in foil laminate packs. Number of panellists noting little or no difference (shaded) or moderate to large difference (solid).

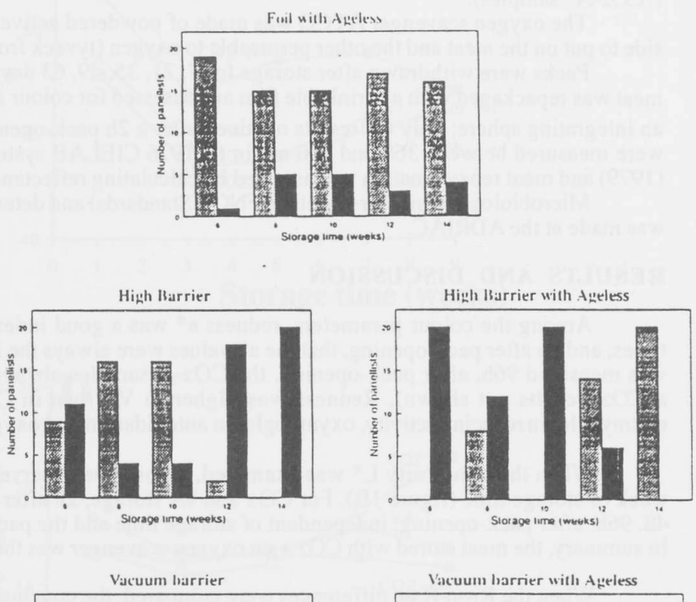

Figure 2. Comparison of lamb colour in test packs with that in foil laminate packs. Number of panellists noting little or no difference (shaded) or moderate to large difference (solid).