EFFECT OF OXYGEN SCAVENGERS AND VITAMIN E SUPPLEMENTATION ON COLOUR STABILITY OF MAP BEEF

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BACKGROUND

The colour of fresh beef is an important criterion in the decision to buy with a bright red colour due to oxymyoglobin being associated with freshness (Egan et al., 1990). In the presence of oxygen beef loses its redness due to the conversion of oxymyoglobin to metmyoglobin thereby limiting its display life. Packaging systems for retail cuts of beef must ensure that the meat has a bright red colour at the initial time of display and that it maintains this for several days. In the UK some retailers have moved away from in-store cutting and packing to centralised operations delivering retail cuts in overwrapped trays. Several trays are enclosed in a large bag (mother pack) which is filled with a high oxygen atmosphere to ensure good colour. The storage life of such packs is limited to about 7 days because of the presence of oxygen. A similar system with a longer storage life might be useful to an exporting country such as Ireland, since it would allow the retail preparation and packing to be done within the exporting factory with implications for added value and increased employment. Replacing the oxygen in the mother pack with carbon dioxide reduces considerably the rate of bacterial spoilage, but low oxygen concentrations due to trapped air within the trays and mother pack cause discolouration since the rate of metmyoglobin formation is maximal at low concentrations. Oxygen scavengers within the trays and mother pack are able to reduce the residual oxygen to below the critical level and result in striploin steaks (*Longissimus dorsi*, LD) which have been stored for up to 4 weeks having as good a colour as fresh steaks (Sanchez Molinero and Allen, 1993). Results with other less colour stable muscles were not as good (pers. comm.). The antioxidant properties of vitamin E and its effect in slowing the rate of metmyoglobin formation are now well documented (Faustman et al., 1989; Vega et al., 1996). In this work we were interested to see if the antioxidant effect of vitamin E would be expressed in this type of packaging system, particularly for the *psoas major* (PM) which has poorer colour stability than the LD (O'Keeffe and Hood, 1982).

OBJECTIVES

To determine the colour stability of LD and PM steaks stored for up to 4 weeks in a mother pack system with or without oxygen scavengers. To determine whether supplementing animal feed with 2000I.U. vitamin E per day for 40days prior to slaughter would have any effect on colour stability.

METHODS

Vitamin E supplementation: 5 Friesian steers were fed a diet of silage plus concentrates supplemented with vitamin E (2000 I.U./ day) for 40 days prior to slaughter. A further 5 were fed the same diet without vitamin E supplementation.
Packaging : Steaks, approximately 2.5 cm thick, were placed in expanded polystyrene trays together with a 200cc oxygen scavenger (Ageless SS200, Mitsubishi Corporation) and overwrapped with a high oxygen permeability film. Six trays were placed in a high barrier mother pack together with a 2L oxygen scavenger (Ageless 2000 PT). The mother packs were then evacuated and flushed with 50% CO_2 : 50% N_2 (triple cycle) using a CVP300 gas flushing machine (CVP Systems(UK) Ltd, Uxbridge) and stored at 0°C for 2 or 4 weeks. Control packs were made up without oxygen scavengers. All packs contained steaks from a single steer and a full set were made up for each steer so that all combinations of vitamin E and oxygen scavenger treatments were represented at each storage time.
Colour : After storage the colour of steaks was determined immediately after opening the packs and also at fixed times up to 7 days of display in a lighted cabinet at 5°C. Redness (a value) was measured on a Hunterlab Ultrascan Spectrophotometer.

RESULTS AND DISCUSSION

An ANOVA with vitamin E presence and oxygen scavenger presence as main effects and their interaction was carried out at each combination of storage time and display time. In all cases, the effect of vitamin E on redness and the interaction with the oxygen scavenger effect was not significant ($p<0.05$). This may be attributable to the fact that the actual vitamin E levels in the muscles were very variable within supplemented and control groups, to the extent that in a companion paper studying the effect of muscle vitamin E level on lipid and oxymyoglobin oxidation, the samples were divided into high and low groups rather than supplemented and control (O'Grady et al., 1996).
The redness of steaks during display for up to 7 days (168 hours) is shown in Figure 1 for each muscle at the two storage times. The usual pattern of rapid blooming on exposure to air followed by a gradual decline in redness is evident, apart from unexpectedly low values at 48h for all samples stored for 2 weeks. The results for the LD were similar to those previously reported by Sanchez Molinero and Allen (1993). The effect of the oxygen scavengers was to enhance the redness of LD steaks compared to controls. This

difference was significant ($p<0.05$) at all times except 48h for steaks stored for 2 weeks and at all times except 72 and 168h for steaks stored for 4 weeks. As expected, the PM did not become as red as the LD. Otherwise this muscle showed a similar pattern to the LD with respect to the effect of oxygen scavengers on colour stability. The effect was significant ($p<0.05$) at all times except 0, 2 and 96h for 2 weeks storage and at 168h for 4 weeks storage.

For both muscles, the colour stability of steaks stored for 4 weeks was poorer than those stored for only 2 weeks. This may have been expected since colour stability declines with time post mortem, but this was not evident in the earlier work (Sanchez Molinero and Allen). Steaks stored for the longer period did not reach as high an a value and declined in redness quicker than those stored for only 2 weeks.

CONCLUSIONS

Supplementation with 2000I.U. of vitamin E per day for 40 days had no effect on the colour stability of LD or PM steaks stored at 0°C with or without oxygen scavengers in an atmosphere of 50%CO_2 : 50%N_2 in a mother pack system for 2 or 4 weeks. Oxygen scavengers significantly improved the colour stability of both LD and PM steaks stored in this way compared to controls.

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Fig. 1: a values recorded for LD and PM muscles during retail display for up to 168 h, after storage at 0°C with and without O_2 scavengers in an atmosphere containing 50% CO_2:50% N_2, for 2 and 4 weeks.

* P<0.05; ** P<0.01; ***P<0.001; NS=non significant