HIGHER COLOUR STABILITY IN STEAKS OF BEEF LOIN AGED IN VACUUM COMPARED WITH HIGH-OXYGEN MODIFIED ATMOSPHERE

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Introduction

Meat colour is an important quality attribute for the consumer. Beef is often pre-packaged and displayed for several days either in air or in high-oxygen modified atmosphere (MAP). However, poor colour stability during retail display has become an increasing problem, which might be related to large variations in the age of the meat and storage atmosphere before retail packaging. The colour stability of beef, i.e. the ability to withstand accumulation of metmyoglobin (MetMb) at the meat surface, depends on respiratory and reducing enzyme activities in the muscle (Mancini and Hunt, 2005) as well as on environmental factors such as oxygen partial pressure and temperature. This study focuses on colour stability of beef loin as an effect of ageing time in vacuum or in MAP preceded by vacuum.

Materials and Methods

Ten steers from the same herd were slaughtered according to standard commercial procedures in a Swedish abattoir. At 48 hours *post mortem*, *M. longissimus dorsi* (LD) from both sides of the carcass was removed and divided into 6 parts randomly assigned to packaging in vacuum (Vac) or vacuum followed by modified atmosphere with 80% O_2 + 20% CO_2 (MAP) for ageing according to Table 1. After each ageing time, steaks (2 cm thick) were cut and the newly cut surfaces were wrapped with oxygen-permeable plastic film and displayed in air at 4°C for five days. The colour stability during display was assessed by colour measurements after 1 and 3 hours and 1, 2, 3, 4, and 5 days of display using a Minolta CR-2500d spectrophotometer (Minolta Co, Ltd, Osaka, Japan) with specular reflectance excluded, 8 mm measuring aperture, illuminant D65 and 10° Standard Observer. The measuring aperture was covered with a glass plate, and the instrument was calibrated against a white tile. The plastic film was kept on the meat during measurements. The average of 4 measurements across the surface was used. The relative contents of deoxymyoglobin (Mb), oxymyoglobin (MbO_2) and MetMb were calculated from the reflectance curve according to Krzywicki (1979). Reflectance values at wavelengths not given by the instrument (473, 525 and 572 nm) were calculated using linear interpolation. Statistical analysis was carried out with SAS ver. 9.1 using the mixed procedure with degrees of freedom estimated by the Satterthwaite method. The model included fixed effects of ageing system, display time and their interaction and random effect of animal.

Table 1: Ageing time in vacuum (Vac) and modified atmosphere with 80% O_2 + 20% CO_2 (MAP).

Ageing system/ Ageing days	Vac 0 days	Vac 5 days	Vac 15 days	Vac 25 days	Vac 5 days + MAP 10 days	Vac 15 days + MAP 10 days
Vac	0	5	15	25	5	15
MAP	0	0	0	0	10	10
Total	0	5	15	25	15	25

Results and Discussion

Ageing time significantly affected the relative contents of MetMb (P=0.001), MbO_2 (P=0.001) and Mb (P=0.001) during display in air. The most striking effect was that of LD displayed in air at 48 hours *pm* (= Vac 0 days) compared with LD aged in vacuum for 5, 15 or 25 days before display (Figure 1). More MetMb was formed during the whole display time and more MbO_2 and less Mb, i.e. more blooming, was found during the first 2 days of display. Furthermore, increasing ageing time in vacuum resulted in more MetMb and MbO_2 and less Mb. Ageing in MAP for 10 days, preceded by vacuum ageing for 5 or 15 days, further increased the content of MetMb and decreased the content of MbO_2 during display compared with ageing only in vacuum during the same time period (Figure 2). It is known that enzyme activities of the muscle related to colour changes are depleted post-mortem (Mancini and Hunt, 2005), which explains the effect of ageing on colour stability. However, the more detrimental effect of ageing in high-oxygen MAP on colour stability is more difficult to explain, since a new meat surface from the interior of the whole loin that had not been directly exposed to the high oxygen atmosphere was exposed during the display. No other studies on this effect of high-oxygen MAP was found in the literature.

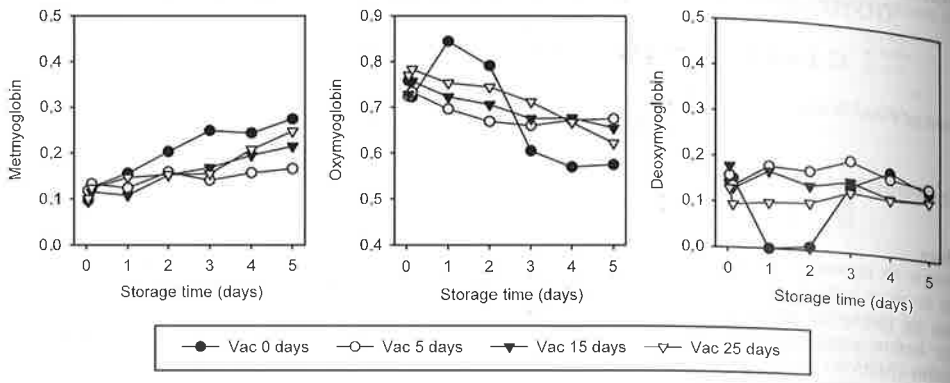

Figure 1: Changes in the relative contents of metmyoglobin (MetMb), oxymyoglobin (MbO_2) and deoxymyoglobin (Mb) during display of *M. Longissimus dorsi* in air at 4°C preceded by ageing in vacuum (Vac) for 0, 5, 15 and 25 days, respectively, at 4°C. Standard errors: 0.01 for MetMb, 0.02 for MbO_2 and 0.01 for Mb.

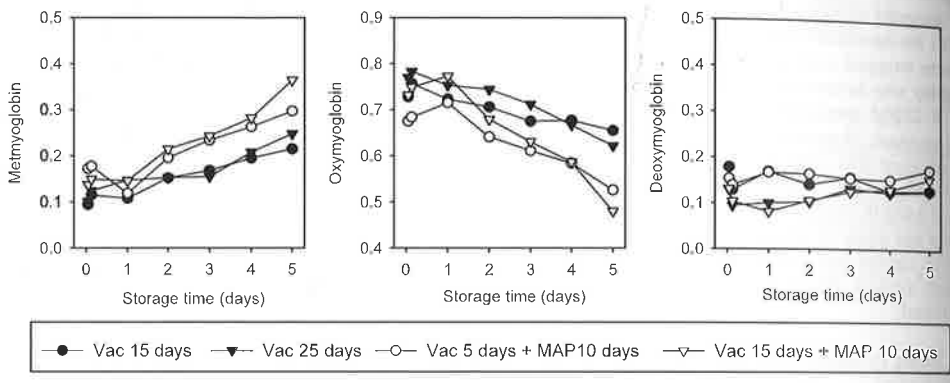

Figure 2: Changes in the relative contents of metmyoglobin (MetMb), oxymyoglobin (MbO_2) and deoxymyoglobin (Mb) during display of *M. Longissimus dorsi* in air at 4°C preceded by ageing only in vacuum (Vac) for 15 and 25 days, respectively, or in vacuum for 5 and 15 days, respectively, followed by high-oxygen modified atmosphere (MAP) for 10 days at 4°C. Standard errors: 0.01 for MetMb, 0.02 for MbO_2 and 0.01 for Mb.

Conclusions

Higher colour stability in beef loin steaks occurs

- after ageing for 5, 15 or 25 days in vacuum compared with no ageing time
- after ageing for 5 days in vacuum compared with 25 days in vacuum
- after ageing in vacuum compared with vacuum followed by high-oxygen modified atmosphere during the same total time period.

References

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