Title:: THE RELATIVE IMPORTANCE OF TEMPERATURE, WAVELENGTH AND INTENSITY OF LIGHT ON THE COLOUR DISPLAY LIFE OF FRESH AND AGED BEEF CUTS.

Authors:: MacDougall, D.B* and Powell, V.H**.
Institution:: * Dept of Food Science & Technology, The University of Reading, Whiteknights, Reading, Berks, RG6 6AP, UK
** Powell International Technologies Pty Ltd, 58 Duncan St, Wynnum West, Brisbane, 4178 Australia

Introduction

Australia exports nearly 200,000 tonnes of chilled, vacuum-packaged beef cuts per year. In overseas markets, Australian (long) aged products have to compete for sales against local fresh meat. The ageing period for the local product may be from one to three weeks, while the imported Australian product may have been aged for as long as 12 weeks. There are many questions from exporters and the scientific literature concerning the differences in the display life of "fresh" and "aged" beef, e.g. the contribution of light intensity, wavelength and cabinet temperature on the colour stability of the various cuts of meat while in the retail display cabinet.

Ledward, **et al.**, (1986) reported on the objective analysis of "fresh" and "aged" meat cuts from stimulated and non-stimulated carcases and stated that calorimetry could distinguish between the treatments over a three day display period. Powell and MacDougall (1993) found that very rapid chilling of hot-boned primals yielded "fresh" meats which were dark in the display case but "aged" meats which were identical in display life to that for conventional, chilled cold boned fresh meats. Powell, **et al.**, (1996) reported that over 1000 consumers could not tell the difference between the above ES and non-ES "fresh" and "aged" meats of Ledward, **et al.**, (1986) over the same three day display period. No comparative study has yet been reported on the relative effects of fresh verses aged meats displayed at different meat temperatures and under lights of different wavelengths and intensities.

Materials and Methods

Ten Hereford cross animlas were slaughtered at the abattoir of the A.F.R.C. Meat Research Institute, Langford. The carcases which averaged (321 kg) were chilled overnight to an average mid loin temperature of 2 - 4^{0}C and a deep butt temperature of about 15^{0}C . At 24 h post slaughter the sides were deboned. From each carcase the M longisimus dorsi (LD), Psoas major (PM), and the M semimembranosis (outer (OSM) and inner (ISM) sections) were vacuum packed; pH for all meats ranged from 5.5 to 5.7 . The "fresh" primals, were selected from one side of each carcase in a random manner. They were aged for five days at 0^{0}C. From the remaining sides the "aged" primals were vacuum packed and stored for three weeks and five days at 0^{0}C before they too were prepared for simulated retail display. Eight steaks from each primal (fresh and aged) were cut about 20 mm thick and packed in conventional overwrapped polystryene trays. Two steaks from each primal were allocated to each display treatment.

Simulated display cases were prepared in two chillers, operating at 1^{0}C and 6^{0}C. Banks of fluorescent tubes were fitted within each chiller; one bank had Artificial Daylight (AD) tubes fitted while the other bank was fitted with DeLuxe Natural (DN). Both lamps have excellent colour rendering properties but AD has a high UV content because it is used for critical colour matching. AD is cool in appearance and DN is warm and more attractive.

L*, C* and h* values were recorded on an Instrumental Colour Systems Spectrophotometer at 2 and 8 hours post-cutting and thereafter twice a day up to eleven days. The trays of meat were exposed to ten hours of light each day.

Results and Discussion

In Figs 1 and 2 are the overall mean lightness (L*), Chroma (C*) and hue (h*) for all the fresh and aged muscles. The lightness of the fresh beef increases with time up to seven days, i.e. 12 days after slaughter; and then decreases. The fall in L* after 12 days post-slaughter could be because ageing denaturation had approached completion and decrease in lightness from metmyoglobin development now becomes the dominating cause for the change in lightness. The lightness of the aged beef starts at a higher level than the fresh because of denaturation due to ageing which increases light scatter Powell and MacDougall (1993).

As with lightness, the hue and chroma for fresh and aged meats start at different values (Fig. 2). For h* the aged is lower initially. However, as the display time increases the aged becomes more yellow in hue, ie more brown, both faster and to a greater extent than the fresh. For C*, there is large difference in starting value; the aged is considerably greater than the fresh which indicates a more intense red due to greater depth of penetration of oxygen in the aged over the fresh. The fall in C* is faster in the aged than the fresh. (A difference in C* of 2 units can be remembered).

Thus the aged meats have a lighter, brighter more red appearance initially but during display after about three days the advantage is rapidly lost. C* can therefore be used as a measure of colour change, i.e. loss of redness and experimental variables are reported as C* graphs.

Fig 3 shows the change in C* for the fresh and aged LD and PM. The PM fades much faster than the LD. For the fresh LD there is an increase in the C* during the first day as the meat continues to oxygenate. There is a hint of this also for the aged LD. If one looks at the difference after two days of display, a reasonable time to make commercial judgements, the difference between LD and PM is >2 C* units fresh and 5 C* units aged.. The initial improvement in redness intensity (increase in C*) by ageing is about 4 C* units.

The chroma for the SM cuts are illustrated in Fig 4. The fresh OSM (least denaturated) has a somewhat similar rate of fall of C* as fresh LD. The aged OSM starts brighter than the fresh but fades faster than the fresh OSM. Because of its denatured structure, the fresh ISM blooms brighter than the fresh and aged OSM. This is because of deeper penetration of oxygen in the fresh ISM. The aged ISM has a similar C* value as the fresh ISM. Both fade faster than the fresh OSM. Thus Figs 3 & 4 show quite clearly the effect of chilling, ageing on muscle type and muscle structure.

Fig 5 shows the effect of temperature (and time) on C*. This change is the largest effect of all and cannot be over-emphasised. As expected, aged fades faster than fresh but the difference in fading as affected by the 5^0C difference is such that the greatest benefit is rewarded by low temperature control. The decrease in the C* for the fresh over the first two day period at 1^0C is just over 2 units while at 6^0C the decrease is almost 6 units. The difference between the C* for the meat at day 2 (C* 1^0C - C*6^0C) is 3 units. For the aged the decrease is about 4, 6 and 3 units respectively.

Fig 6 & 7 illustrate the effect of illumination level and lamp type. Clearly 1000 lux makes the meat fade faster than 500 lux by about 1 C* unit in two days for either fresh or aged. The AD lamp was chosen because of its UV content while the DN was chosen because it was designed to enhance red colours, e.g, red meat but without the red cast of some "red" distorting lamps (Kropf, 1980). During display, because of the nature of the colour of the lamps, the DN "looks" better than the AD display but this difference largely disappears when the AD and DN samples are viewed side by side when measured. AD caused faster fading but not to the extent anticipated when compared with temperature and illumination levels. The difference due to AD over DN was less than 1 C* unit, ie about half that of the effect of the illumination level.

Summary

- Ageing increases brightness initially but aged meat fades faster than fresh.
- Different muscles behave differently; both intrinsic differences (LD and PM) and chilling rate on denaturation (OSM and ISM).
- Meat temperature in the display case has a very large effect - keep meat as cold as possible and sell it quick.
- Illumination level is important but less so than the absolute temperature. If the meat temperature is low then it is clearly the most important factor.
- Lamp type affects the rate of C* loss when calculated to the same lux. The UV can be considered the cause, but less important than illumination level.

References

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Figure 1

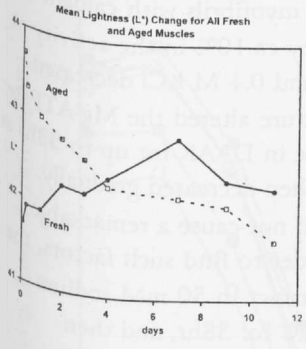

Figure 2

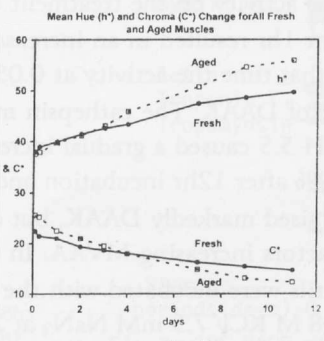

Figure 3

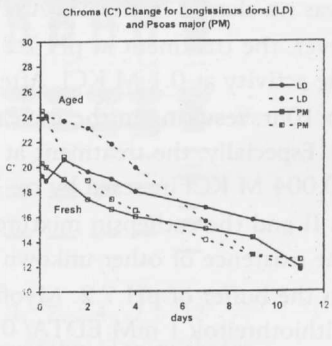

Figure 4

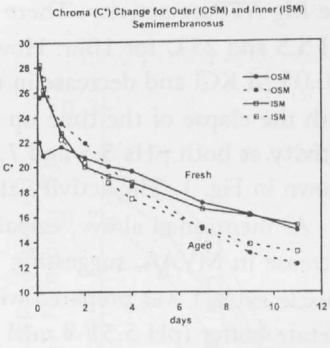

Figure 5

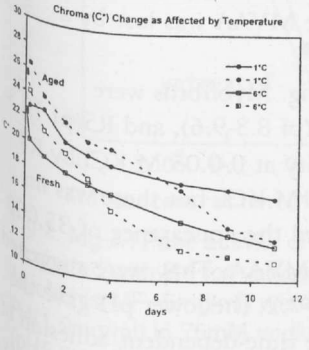

Figure 6

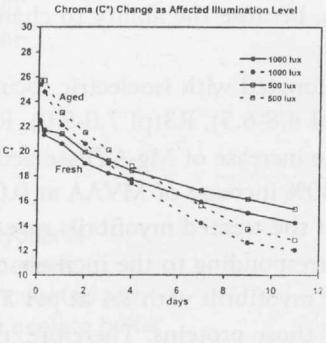

Figure 7