Aperture size considerations when measuring colour stability of lamb cuts

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Abstract

Consumers find the browning of meat caused by metmyoglobin unappealing. The formation of metmyoglobin can be studied by measuring the reflectance of light from the surface of meat and deriving the wavelength ratio at 630nm/580nm. Some have suggested that consumers of lamb discriminate against the meat when the ratio value falls below 3.5. However, others have reported a lower acceptability threshold which also varied according to the cut. Aperture size was recently reported to affect reflectance measurements in pork meat and this may explain the difference between the lamb studies. Such differences have important implications for National programs where meat is being compared across laboratories. Slices of lamb loin (n = 65) and topside (n = 54) were held under display conditions and measured with 2 Hunter Lab meters (25 or 5 mm aperture) and the ratio value at 630nm/580nm derived. The relationship between days on display and the ratio of reflectance could be described by a polynomial model for both cuts and meters. For the 25 and 5 mm aperture meters, 43 and 33% of the variance was explained respectively for loins and for the topside it was 69 and 51% respectively. There was a clear difference between aperture sizes with the smaller aperture meter having ratio values less than the suggested critical 3.5 at time zero for both loin and topside slices, whereas for the larger aperture meter the initial values were well above 3.5 and took 2.5 days to reach this level. The measures taken with a larger aperture size will provide a better indication of overall colour given the larger area of muscle measured and will reflect more accurately consumer thresholds and is therefore recommended.

Introduction

Yancey & Kropf (2008) reported recently that the reflectance measurements from pork meat differed according to the aperture size of the Hunter Lab colour meter. The wavelength ratio at 630nm/580nm is important because this provides the best indication of the formation of metmyoglobin (Hunt *et al.*, 1991) which causes the discolouration of meat under retail display. It was suggested by Jacob *et al.* (2007) that once the ratio value falls below 3.0 in lamb cuts that consumers of lamb discriminate against the meat and it is considered unappealing, whereas Toohey & Hopkins (2006) reported a lower acceptability threshold than 3.0 that varied according to the cut. More recently Morrissey *et al.* (2008) has suggested the threshold should be 3.5. Given that Jacob *et al.* (2007) and Morrissey *et al.* (2008) used a Hunter Lab meter with a 25 mm aperture, but Toohey & Hopkins (2006) used a Hunter Lab meter with a 5 mm aperture it is likely that the difference is due to a variation in aperture size. Such differences have important implications for National programs where meat is being compared across laboratories. Data comparing the change in light reflectance expressed as 630nm/580nm ratio values for lamb loin and topside slices held under simulated retail display conditions and measured with 2 Hunter Lab meters with either a 25 or 5 mm aperture were obtained and the results are presented here.

Materials and methods

The m. *longissimus thoracis et lumborum* (LL) was removed from the left side of 65 lamb carcases between the lumbar-sacral junction and the 12th rib at 24 h post-mortem. At the same time, the m. *semimembranosus* (SM) was removed from the hindleg. The lambs had all been run together and slaughtered as one group. Sections (3-4cm) from the cranial end of the LL and from the distal end of the SM were removed by slicing across the muscles and these samples were vacuum packed and kept at 3-4°C for 5 days. After the ageing period the samples were removed from the vacuum bags, placed in a cutting guide, sliced to a uniform thickness of 3 cm and then placed individually on black foam trays (13.5 cm x 13.5 cm) and over wrapped with PVC food film wrap (15 µm thickness). After a blooming period of 30-40 min, each sample was measured with 2 Hunter Lab meters (Models 45/0-L and 45/0-S) with the former instrument having an aperture size of 25 mm and the latter an aperture size of 5 mm. Each instrument was calibrated with black and white tiles using Illuminant D-65, with 10 degree standard observer. Samples were displayed in a chiller at 3-4°C underlighting (1390 lux for loins and 1000 lux for topsides) and measured 5 times over

2.5 days. Each sample was measured twice at each measurement time and the values averaged. Non-linear modelling was applied to the data to derive the relationship between ratio values and time on display using Genstat (2007) for each meter and cut. Linear models were also examined and not found suitable for the 25 mm aperture meter and spline analysis was also investigated. Predicted values are shown at specified time intervals in Figure 1 based on polynomial models.

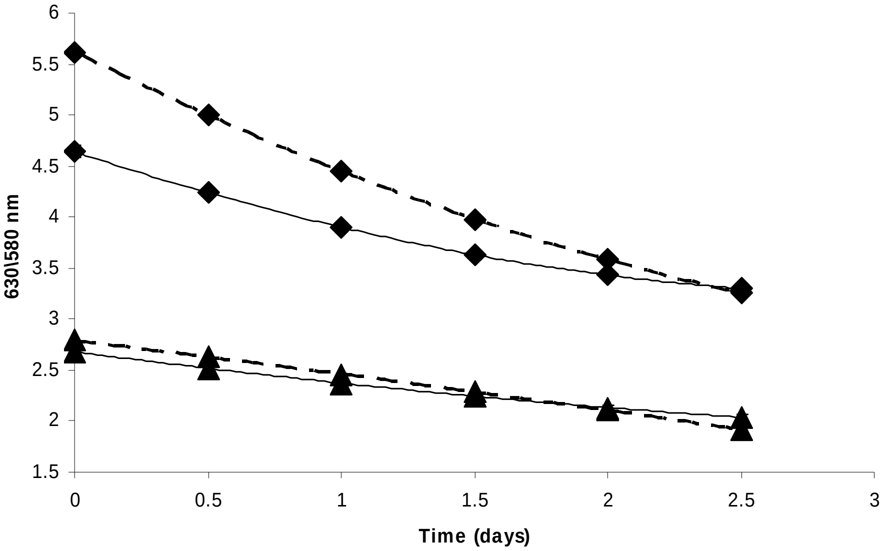

Figure 1. The relationship between days on display and the wave length ratio of reflectance at 630nm/580nm for loin (—) and topside (----) meat measured with a 25 mm aperture Hunter Lab meter (♦) and a 5 mm aperture Hunter Lab meter (▲).

Results and discussion

For both meters and both cuts the relationship between days on display and the ratio of reflectance (630nm/580nm) could be described by polynomial models (Figure 1; $P < 0.001$). In other cases a spline analysis has been used Toohey *et al.* (2008), but it did not improve the fit for the current data. For the 25 and 5 mm aperture meters, 43 and 33% of the variance was explained respectively for loins and for the topside it was 69 and 51% respectively. There is a clear difference between machines with the smaller aperture meter (5 mm) having ratio values less than the suggested critical 3.5, at all times, irrespective of the cut. The initial level for the loin (5 mm aperture meter; Figure 1) is similar to that reported by Toohey & Hopkins (2006) with these authors reporting higher levels for the chump and lower levels for the round and different rates of accumulation of metmyoglobin during display between cuts (Toohey *et al.* 2008). Jacob *et al.* (2007) concluded that differences between cuts in the rate of metmyoglobin formation were not due to differences in pH and also reported a difference in initial wavelength ratio values between cuts, with lower levels in specific muscles such as the *gluteus medius* and *rectus femoris* compared to the loin based on the LL muscle. Thus different cuts will have varying levels of stability under retail display reflecting variation in oxygen penetration and tissue respiration and the activity of reducing enzymes.

Toohey *et al.* (2008) derived relationships between wave length ratio values obtained with the small aperture machine and visual colour scores given by 2 people, which indicated that after 21 hours of display slices of the chump would be unacceptable (browny red), but for knuckles the time could be extended to 39 hours. These times are clearly relatively short and probably indicate that ratio values obtained with a small aperture machine, although suitable for within experiment comparison, do not reflect retail thresholds for discounting meat based on colour. It has been suggested that it is after 48 hours of display that retailers discount meat based on colour (Jacob *et al.* 2007). In contrast to the results with the small aperture machine, the ratio values for the large aperture machine were still above 3.5 after 2.0 days in the topside and 1.5 days for the loin (3.6 ± 0.04 each). This implies that to test for differences between animals in terms of reaching the critical 3.5 value, display times of at least 2.5 days are required for the topside and 2 days for the loin to ensure some samples are below the 3.5 threshold. Inherent differences between machines independent of aperture size are very small (R.H. Jacob unpublished data) and the fact that differences were found between machines for 2 muscles confirms the significant effect of aperture size. So as reported for pork by Yancey &

Kropf (2008), lamb also is measured as more discoloured (lower wave length ratio values) as the aperture size decreases.

Conclusions

It appears that the smaller aperture size is not useful for monitoring colour changes that relate to retail consumer tolerances even though it is more suitable for loin samples that have small measurement areas. The measures taken with a larger aperture size will provide a better indication of overall colour given the larger area of muscle measured and will reflect more accurately consumer thresholds and is therefore recommended.

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