The oxygen concentration required in modified atmosphere packaging to maintain meat colour over retail display

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I. INTRODUCTION

Meat colour is an important factor influencing the purchasing decisions made by consumers [1]. Modified atmosphere packaging (MAP) is widely utilised by the retail industry to display meat, as high oxygen concentration sustains the cherry-red colour of meat for a longer period of time compared to traditional overwrap packaging. Meat colour changes during retail display as the myoglobin pigment changes from primarily purple deoxymyoglobin, to red oxymyoglobin, and eventually to brown metmyoglobin upon the exposure to oxygen. The focus of this paper was the effect of oxygen concentration on the redness of lamb at the meat surface, measured by the ratio of reflectance of light at wavelengths 630 nm and 580 nm, also known as the oxy/met ratio [2]. An oxy/met ratio greater than 4 suggests that the majority of the pigment is the red oxymyoglobin, while a ratio approaching 1 suggests mostly brown metmyoglobin. Recent evidence has shown that beef and lamb meat displayed under high oxygen MAP (typically 70-80% oxygen) have reduced eating quality, in particular reduced tenderness [3, 4]. Therefore, there is growing interest within the industry in using a lower concentration of oxygen to eliminate the negative impact on tenderness [5]. Studies in beef have shown that reducing oxygen concentration as low as 50% had no adverse effect on meat colour during retail display [6, 7]. Further investigation in lamb meat is needed to determine whether a reduced concentration of oxygen in MAP can still satisfy the colour requirements for consumer acceptability, before examining the impact on meat tenderness. On this basis, we hypothesised that a MAP mixture containing 60% oxygen or higher will have a similar oxy/met ratio as the standard high oxygen MAP (80% oxygen), while oxygen concentrations of 40% or lower will have a lower oxy/met ratio during simulated retail display.

II. MATERIALS AND METHODS

Male castrate and female Merino lambs (n = 50) from the Meat and Livestock Australia genetic resource flock, Katanning, Western Australia were used in this study. After slaughter all carcasses were electrically stimulated with medium voltage. Loin (*M. longissimus lumborum*) samples were collected from the carcasses 24 hours post-slaughter. Samples were cut 50 mm in length, 50 mm in width and 30 mm in depth, vacuum packed, and then stored at 2°C for 5 days. Loins were then butterflied and topsides re-sliced 1mm before samples were repackaged in MAP containing 0, 20, 40, 60 or 80% oxygen (MAP0, MAP20, MAP40, MAP60 or MAP80), 20% carbon dioxide, and the balance met by nitrogen gas. They were then placed under simulated retail display for 2, 6 or 10 days at 2°C. MAP packaging was then removed so the surface meat colour could be instrumentally measured using a Hunterlab MiniScan EZ. Oxy/met ratio was determined using the ratio of reflectance of light at wavelengths 630 nm and 580 nm, established by Hunt [8]. The oxy/met ratio was analysed using a linear mixed effect models (SAS Version 9.1, SAS Institute Cary, NC, USA) with retail display time (2, 6 or 10 days) and oxygen concentration group as fixed effects, and animal ID within Sire ID as random terms.

III. RESULTS AND DISCUSSION

There were significant effects ($P<0.001$) between oxygen concentration and retail display time for oxy/met ratio (Figure 1). As oxygen concentration increased the oxy/met ratio also increased ($P<0.05$) up to the 60% oxygen inclusion, with little further improvement between 60% to 80% oxygen inclusion. This aligns well with our hypothesis that levels of 60% oxygen or higher are required to maintain meat colour. In contrast, the MAP0 treatment had consistently high oxy/met ratios during retail display. Due to the low oxygen environment in MAP0 it suggests the samples were not necessarily redder but were less brown. This could drive a higher oxy/met ratio found with the MAP0, compared to MAP20 and MAP40 samples.

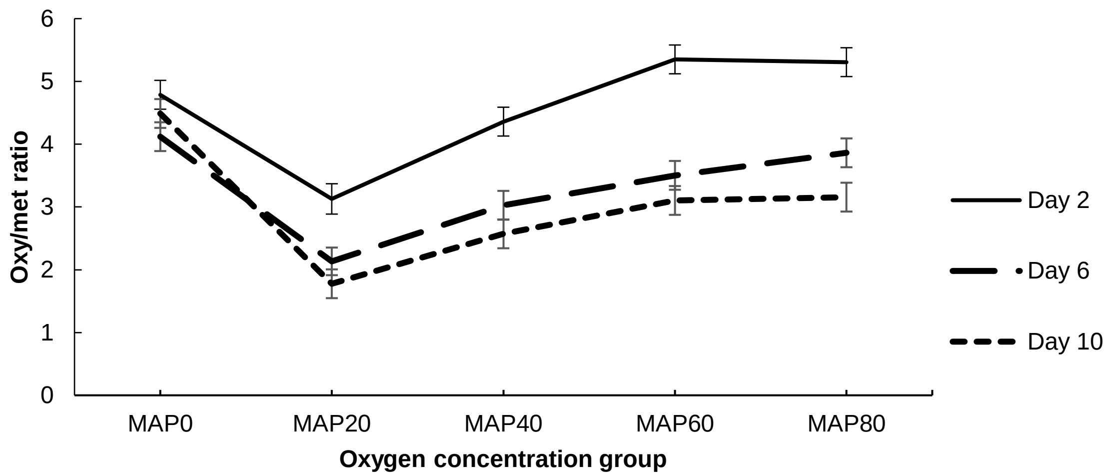

Figure 1. The effect of oxygen concentration (MAP0, MAP20, MAP40, MAP60 or MAP80) on the oxy/met ratio after retail display times of 2, 6 or 10 days.

IV. CONCLUSION

Reducing oxygen concentrations in MAP from 80% to 40% resulted in a lower oxy/met ratio which depicts less red meat. Further testing can investigate where the threshold lies between 40 and 60% oxygen to maintain meat redness and then test the impacts of this lower oxygen MAP mixture on meat tenderness.

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