OPPORTUNITIES FOR GENETIC MANAGEMENT OF THE RETAIL COLOUR STABILITY OF LAMB MEAT

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SUMMARY

The colour of meat during retail display is an important visual cue for consumers and aids their decision purchases. An analysis of data from the Australian Sheep CRC Information Nucleus flock (INF) on colour stability for meat during retail display was performed. The aim of the analysis was to understand the relationship between the surface colour of the meat (oxy/met ratio) and display time for the purpose of describing heritable traits. Muscle samples from the loin of 3389 lambs grown at 5 sites over 3 years were subjected to simulated retail display conditions for 3 days. The oxy/met ratio was measured 4 times during this period using a Hunterlab spectrophotometer in order to quantify the change from red to brown. The relationship between oxy/met and time of display varied and this variation was categorised into one of ten different types. This variation is discussed in relation to the description of a standard trait for colour stability.

INTRODUCTION

A major purpose of the INF (van der Werf *et al.* 2010) is to estimate genetic parameters for novel meat quality traits and colour stability is such a candidate. Meat changes in hue of colour during retail display, from red to brown, due to formation of metmyoglobin (Faustman 1990). Metmyoglobin forms near the surface, at the junction of the oxygenated and deoxygenated layers, and can be derived by calculations based on measurement of light reflectance at the wavelengths of 630nm and 580nm (Hunt 1980). For pure myoglobin, oxy/met values that are close to 5 (high) are consistent with myoglobin being in the oxymyoglobin form and those that are close to 1 (low) indicate myoglobin is in the metmyoglobin form (Hunt 1980). These values serve as a guide only because meat contains pigments other than myoglobin and has translucent properties; hence values outside of the range 1-5 may occur with meat.

Morrissey *et al.* (2008) found that consumers perceive lamb meat to be brown (and unacceptable) in colour when oxy/met falls below 3.5, and that a large proportion of consumers (40%) chose not to purchase meat when they perceive it to be brown. In a larger study, Khliji *et al* (2010) found that a value for oxy/met of 3.3 represented the benchmark for consumer acceptance on average, although a higher value in the order of 6 was found to be the threshold required before at least 95% of consumers considered lamb meat colour to be acceptable .

However a quantitative definition for colour stability is lacking in the literature. In fact Tapp *et al.* (2011) made the conclusion that a standard definition of fresh colour measurement in general is required as a matter of urgency. The word stability implies quantification of a rate, but so far oxy/met at one time point (day 3), has been used in analyses of the INF colour data (Mortimer *et al.* 2010); on the premise that colour at this time point is of interest to retailers. King *et al.* 2010 calculated heritability for colour difference (chroma, K/S 575/525) between day 0 and day 6 for beef *longissimus thoracis* steaks. McLean *et al.* (2009) used *a** value indicating relative redness of the meat, after 7 days of display in meat aged for 8 weeks. The aim of the current study was to

understand the relationship between oxy/met and display time, using phenotypic data from the INF, for the purpose of describing a quantitative colour stability trait, for which genetic parameters could be calculated.

MATERIALS AND METHODS

On the day after slaughter, a 5 cm length of muscle was cut from the cranial end of the short loin (*m. longissimus lumborum*) and each sample was then packed in an individual vacuum sealed gas impermeable plastic bag. On day 5 post slaughter, each sample was removed from the vacuum bag, re-sliced to a thickness of 3cm to provide a fresh surface and overwrapped with polyvinyl cling material of 15µm thickness on black Styrofoam trays (12X12 cm). Samples were allowed to bloom for 30 minutes at a temperature of 2-6°C before wrapping and colour measurement. Samples were placed in a cool room for 4 days with the air temperature kept in the range of -2 to 6°C. During this time the samples were exposed constantly to an overhead light source provided by 58W Nelson Fluorescent Meat Display BRB Tubes of 1520mm in length. This light source was suspended above the meat at a sufficient height to provide a light intensity of ~1000 Lux at the table level. A Hunter Lab Mini Scan(tm) XE Plus (Cat. No. 6352, model No. 45/0-L, reading head diameter of 37 mm) was used to measure light reflectance. The light source was set at "D65" illuminant with a standard observer of 10°. The instrument was calibrated on a black glass then a white enamel tile, as directed by the manufacturer's specifications. At each reading the measurement was replicated after rotating the spectrophotometer 90° in the horizontal plane.

Oxy/met was calculated by dividing the percentage of light reflectance at wavelength 630nm by the percentage of light reflectance at wavelength 580nm. Measurements were taken on day 0, day 1, day 2, and day 3 after wrapping, with the cling-wrap intact. Data from 3389 lambs collected over 3 years (2007, 2008 and 2009 drops) from 5 INF flocks (at Cowra, IN03; Trangie, IN02; Hamilton, IN05; Rutherglen, IN04; and Katanning, IN08) were used in the analyses. The design of the INF has been described in detail by van der Werf *et al.* (2010).

Simple straight line regression models were fitted to oxy/met and display time data for each sample using the R statistical system (R Development Core Team, 2011). Three categories were constructed (0-1, 1-10, 10-40) for each of the total sums of squares (TOTss) and the deviation from the line sums of squares (DEVss); as well, 2 categories were constructed based on the sign of the difference between oxy/met values on day 1 and 0, A for negative <=0, B positive >0. Data were described for 10 of the possible categories as seen in Table 1.

RESULTS AND DISCUSSION

Samples that were stable (TOTss 0-1) were uncommon being 3% and 4% of all samples for sign A and B categories respectively (Table 1**Error! Reference source not found.**). The most common category, except for flock IN08 in 2007, was sign A, moderately unstable (TOTss 1-10) with a small deviation from the line (DEVss 0-1). This accounted for 57% of samples in total. Flock was confounded with instrument and measuring conditions, such as temperature at blooming. However, because they occurred in all flocks, B sign responses seem valid and within the range to be expected with this measurement protocol.

For sign B samples, "blooming" appears to have been extended beyond the 30 minute period allowed before measurement on day 0 (Figure 1), and may have taken as long as 24h. The cause of this is unclear, as are the relative contributions of the different components of meat colour, such as the depth of the oxygenated layer and the rate of oxidation to metmyoglobin at the junction between the layers. The potential for several factors to be involved makes definition of a genetic trait potentially difficult, without further understanding of these factors and the mechanisms behind them. Whatever the reason, this advantage persisted for sign B compared to sign A samples through the display period (Figure 1). Oxy/met values were above and below the benchmark value

of 3.3 for sign B and A samples respectively by day 3(Khliji *et al*. (2010). Young *et al.* (1999) indicated that blooming can be influenced by rigor temperature and may take as long as 36h in lamb meat. By comparison both Mortimer *et al.* (2011) and King *et al.* (2010) reported heritability estimates for *a** value to be low when measured at day 0 and higher when measured after a period of simulated retail display, although the length of this period varied between studies. This might support the argument that variation associated with blooming time due to animal production or processing factors complicates the measurement of colour early in the simulated retail display period and initial colour measures a different trait to later colour. This seems to be the case, as Mortimer *et al.* (2011) have estimated the genetic correlation between oxy/met on day 0 and day 3 to be reasonably high at 0.52, but significantly less than unity, while the genetic correlation between values on day 2 and day 3 was estimated to be 0.98.

Table 1: The number of samples as a percentage of the total in each flock and drop combination in each category (sign A, B; TOTss 0-1, 1-10, 10- 40; DEVss 0-1, 1-10, 10-40)

			Category									
			A					*B*				
			TOTss									
			0-1	1-10	1-10	10-40	10-40	0-1	1-10	1-10	10-40	10-40
			DEVss									
Flock	Year	n	0-1	0-1	1-10	0-1	1-10	0-1	0-1	1-10	1-10	10-40
IN02	2008	219	10	57	7	0	1	9	16	0	0	0
	2009	199	1	71	9	1	4	0	10	5	0	0
IN03	2007	290	12	79	1	0	0	1	6	1	0	0
	2008	156	3	68	5	0	1	3	6	14	0	0
	2009	199	2	62	30	0	4	1	1	2	0	0
IN04	2007	296	0	74	21	1	2	1	1	0	0	0
	2008	213	1	73	23	0	0	0	2	0	0	0
	2009	208	0	44	38	0	17	0	0	0	0	0
IN05	2007	197	4	87	7	0	0	0	3	1	0	0
	2008	194	2	59	30	0	7	0	2	1	0	0
	2009	175	0	83	12	1	0	0	2	2	0	0
IN08	2007	412	4	15	7	0	4	9	16	44	0	0
	2008	402	4	34	1	0	0	14	10	29	2	6
	2009	229	3	42	32	0	22	0	0	0	0	0

CONCLUSIONS

An opportunity exists to improve the colour of lamb meat because it commonly is unstable over a simulated retail display period of 3 days. Unexplained variation in the shape of the oxy/met by time response complicates statistical analyses of colour change during simulated retail display. Different mechanisms may influence the change in lamb meat colour; hence a need exists to describe the basis of colour stability traits. Improving the accuracy of fresh colour measurement at the commencement of a display period, could reduce variation in the relationship between oxy/met and time.

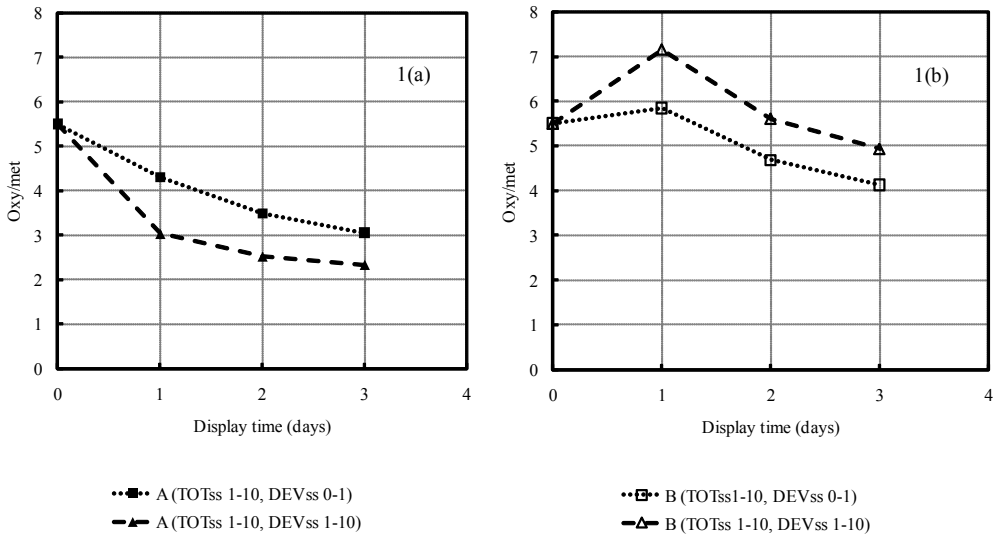

Figure 1. Mean oxy/met value in each sign category A (1a) and B (1b) at each display time for all flocks and all years (values are means) relative to the day 0 mean value, for each TOTss and DEVss category containing more than 5% of the data.

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