THE IMPACT OF NEW GENERATION PRE-DRESSING MID-VOLTAGE ELECTRICAL STIMULATION ON COLOUR STABILITY

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Introduction

Consumer decisions at the point of purchase are influenced by meat colour more than any other quality factor as consumers use the degree of discolouration as an indication of freshness (Mancini and Hunt 2005). For this reason it is economically important for retailers to ensure colour is desirable for consumers. A key ingredient in prolonged meat colour stability is the rate of metmyoglobin formation. The formation of metmyoglobin begins in a band between oxygenated and deoxygenated layers. The thickness of this band increases with time and will eventually extend all the way to the meat surface leaving a brownish colour (Channon *et al.,* 2005). New generation mid voltage electrical stimulation is currently being adopted by many sheep processors in Australia because of its minimal risk to workers and the versatility of installation. As outlined by Channon *et al.,* (2005) past studies which have examined the effects of high or low voltage stimulation on meat colour have produced contrasting results. The objective of this study was to determine the impact on meat quality of "optimal current and pulse width" settings for a new generation pre-dressing mid-voltage electrical stimulation unit with an emphasis on meat colour. The operation principles of the new unit have been outlined by Hopkins *et al.,* (2005).

Materials and Methods

In total, 80 lambs from 11 different consignments were assessed. The lambs were killed over two days with 40 killed on day one and 40 killed on day two. Of the 40 killed on each kill day there were two stimulation treatments (20 stimulated and 20 unstimulated). Each individual consignment had equal numbers of animals stimulated and unstimulated. The lambs in the different consignments were of varying backgrounds and breed and represented lambs purchased by the abattoir. In the stimulated treatment, carcases were exposed to a current of 800mA and pulse width of 0.5ms using a pre-dressing mid voltage electrical stimulation unit. The stimulation treatment was applied for approximately 60s. Carcases were trimmed according to the specifications of AUS-MEAT. Hot carcase weights were recorded and the GR measured (total tissue depth over the 12th rib, 110 mm from the midline) using a GR knife. The carcases were chilled at a mean temperature of 4.2°C. Carcase pH and temperature measurements were taken 30 mins after death and every hour after that to give 7 measurement times. A 28h pH and temperature measurement was also recorded. The pH and temperature measurements were taken in the left portion of the *M. longissimus thoracis et lumborum* muscle at the caudal end over the lumbar/sacral junction. From kill 1, 40 chumps and loins were removed from the left side of the carcase at 24h post-mortem. From each of the chumps and loins a sample for colour measurement (3 cm slice) and a 1g sample for final pH (5 day aged) were taken. Additionally in kill 2, 40 left legs were taken and gas flushed with a Secure Fresh – secure pack 15.2 gas flush machine using 100% CO_2 and then the legs were aged for 14 days. From these legs, the chumps and rounds were removed and a sample was taken for colour measurement (3cm slice) and a 1g sample for final pH (17 day aged) for each cut. In kill 2 the loin was also sampled the same as for kill 1. pH was determined using an iodoacetate method. The meat colour reflectance of the loin and chump from the first kill and the loin from the second kill were measured with an initial colour measured at 24h post-mortem followed by measurements taken twice a day (am/pm) for 5 days resulting in 10 measurements per sample. For the initial measurement a fresh surface was prepared by cutting in a transverse direction across the sample and after 30min a colour reading was measured. Samples were then positioned randomly on black plastic trays and over-wrapped with polyvinyl chloride clear film and placed under continuous lighting (1190 Lux) in a chiller at 4°C. A Hunter Lab MiniScan XE spectrophotometer was used to measure colour dimensions (Hunter Associates, Reston, VA, Model D45/0-s 6 mm port with 5mm area viewing set for L (lightness), a (redness) and b (yellowness) with a D65 at 10 degrees illuminate). The MiniScan was calibrated using both white and black tiles. Every slice of each cut was scored for colour acceptability by 2 people using the scoring system of Channon *et al.,* (2005). The loin and chump slices were scored at the start and end of the 5 day display period. Colour measurements were also taken from the chump and round which had been gas flushed and aged for 14 days. The initial measurement was taken on the 14th day in the afternoon and further measurements were taken twice a day (am/pm) for 3 days resulting in 7 measurements on these samples which were displayed at (1110 Lux) in a display cabinet at 4°C. For these cuts visual scores were given 4 times during the display period (0, 24, 46 and 72 hours) by 2 people. Traits were analysed using a residual maximum likelihood (REML) procedure (Genstat 7.1, 2004) which contained a fixed effect for treatment (stim or no stim), to estimate the means and standard errors of the differences with kill day and consignment as a random terms. The relationship between visual

colour scores and objectively measured colour traits (ratio at 630nm/580nm, L and a values) was derived using linear and non-linear regression analysis. The ratio 630nm/580nm is a good indicator of the formation of metmyoglobin.

Results and Discussion

There was no difference between stimulated and unstimulated carcases for weight or GR. Differences were found between treatments for initial pH, rate of pH decline and predicted temperature at pH 6.0 where stimulated carcases had a lower initial pH, faster rate of pH decline and a higher predicted temperature at pH 6.0 (24.8°C as opposed to 13.9°C for unstimulated carcases). On average across both kills 67.5% of stimulated carcases hit pH 6.0 above 18°C opposed to 25% of unstimulated carcases. There was no significant difference ($P > 0.05$) between stimulated and non stimulated loin and chump meat colour after 5 days of display based on ratio, L, a or b values. However there was a difference ($P < 0.05$) between the initial a values of the loin (1 day post-mortem) with stimulated carcases having a higher value. The chump had higher initial values for the ratio 630nm/580nm compared with the loin and was redder than the loin. As can be seen for the loin there was no difference in the rate of formation of metmyoglobin based on the ratio values between treatments.

Table 1: Predicted means and standard error of difference (s.e.d) between stimulated and non stimulated carcases for kill 1 chump initial and final ratio, L, a, b values, kills 1 and 2 loin initial and final ratio, L, a, b values and gas flushed chump and round initial and final L, a, b and ratio values (kill 2).

	Initial (fresh)			Final				Initial (gas flushed)			Final (gas flushed)		
	Stim	No stim	*av. s.e.d*	Stim	No stim	*av. s.e.d*		Stim	Non stim	*av. s.e.d*	Stim	Non stim	*av. s.e.d*
Chump							Chump						
L	31.4a	31.7a	*1.25*	38.5a	38.3a	*1.26*	L	32.8a	32.7a	*0.81*	34.7a	35.0a	*0.78*
a	9.20a	8.81a	*0.56*	7.51a	7.94a	*0.37*	a	11.70a	11.99a	*0.54*	7.05a	6.45a	*0.50*
b	11.14a	10.97a	*0.49*	10.89a	11.40a	*0.61*	b	13.92a	14.11a	*0.48*	11.22a	10.47a	*0.47*
ratio	3.6a	3.5a	*0.19*	1.7a	1.9a	*0.09*	ratio	4.3a	4.4a	*0.17*	1.9a	1.7b	*0.10*
Loin							Round						
L	30.5a	31.3a	*0.93*	38.3a	39.4a	*0.91*	L	41.2a	40.4a	*0.78*	36.5a	35.8a	*0.88*
a	7.80a	7.11b	*0.32*	6.42a	6.13a	*0.25*	a	6.76a	7.20a	*0.32*	7.65a	7.25a	*0.49*
b	8.81a	8.39a	*0.38*	9.38a	9.04a	*0.31*	b	11.47a	11.98a	*0.36*	10.78a	10.66a	*0.50*
ratio	3.2a	3.0a	*0.14*	1.6a	1.6a	*0.04*	ratio	2.6a	2.8a	*0.08*	2.1a	2.0a	*0.09*

Means followed by a different letter in a row (a, b) are significantly different ($P < 0.05$).

There was no difference ($P > 0.05$) between stimulated and non stimulated chump and round colour values (L, a, b) at initial measurement or at final measurement after 3 days on display. The only difference for the ratio values was for the chump at the final measurement, where stimulated chumps had a higher ratio (less brown) than non-stimulated chumps ($P < 0.05$). There was an interaction between cut type and visual scores ($P < 0.001$) for ratio (630nm/580nm), L and a values, with the chump exhibiting a greater range in ratio and a values than the round. Visual colour scores and cut type explained 65% ($R^2 = 0.65$) of the variation in ratio values, whereas for L and a values only 33% and 36% of the variation could be explained based on linear modelling respectively. It is apparent that visual scores are more useful for detecting colour changes in the chump than the round and that visual scores are less useful for detecting changes in lightness (L) and redness (a) irrespective of the cut type. Based on the fitted models if chumps have measured ratio values less than 3.3 then they would be considered unacceptable (browny red) and for rounds the ratio value is 2.6.

Conclusions

From the results it can be concluded that using a new generation pre-dressing mid-voltage electrical stimulation unit set at 800 mA and a pulse width of 0.5 ms the rate of pH decline will increase and reduce the number of carcases entering rigor at cold temperatures. The use of new generation pre-dressing mid-voltage electrical stimulation had minimal effects on meat colour traits, with no indication of any detrimental affects.

References

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