OBJECTIVE AND SUBJECTIVE CHARACTERISATION OF DARK COLOURED BEEF WHICH HAS NORMAL ULTIMATE PH

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Background

The presence of dark firm dry (DFD) beef, which is characterised by high pH, has been a cause of concern to the beef industry resulting in significant economic losses in many countries (Tarrant, 1981). However, in recent years, a new phenomenon of dark coloured beef with a normal pH is also proving to be a quality problem for the beef industry. As the ultimate pH is not abnormally high, meat from these carcasses is not classified as unacceptably dark prior to excising the individual muscles in the boning hall. Hedrick et al. (1994) stated that one of the most important factors in the selection of a meat product is colour. While DFD beef has been well characterised in terms of quality, causes and muscle characteristics, to our knowledge, there has been no research published on this dark coloured beef of normal pH. There is a need to further characterise this beef in our efforts to determine the causative factors and to provide the industry with methods for detecting the problem prior to the carcass entering the boning hall.

Objectives

To characterise the inherent quality of bovine M.*longissimus dorsi* (loin) (LD) muscles which are of dark colour but with a normal ultimate pH.

Materials and methods

Bovine LD muscles were identified as being of dark or normal colour, by experienced industrial personnel, as the rib section was removed from the carcass in the boning hall. After this visual identification, the pH was recorded on all muscles to exclude DFD meat. During the sampling period control samples, which were of normal colour and normal pH, were also collected. Surface colour measurements (TS) were recorded in the factory after selection by visual inspection and pH analysis. Colour was assessed on the CIE L*a*b* scale using a HunterLab Miniscan XE. A total of 10 dark and 10 normal (control) LDs were collected for further analysis.

The muscles were removed to The National Food Centre for all further analysis. The ability of the muscles to 'bloom' was examined. Steaks (2.54cm) were excised from each muscle. CIE L*a*b* readings were taken immediately after excision (T0), and after 3hr (T3) and 24hr (T24) exposure to air at 4°C. This analysis was conducted both at 2 days and at 7 days postmortem. Two forms of standard reference methods were conducted for subjective colour measurements to assess differences between dark and normal beef after 3 hours and 24 hours of 'blooming' at both times postmortem. Firstly a triangular test (BS 5929) was performed using 18 trained panellists to decide if they could detect a difference between the samples at each time point (3h & 24h). Secondly, a paired comparison test (BS 5929) was conducted using 30 untrained panellists, to determine the preferred type of beef.

Conductivity was measured using a Pork Quality Meter (PQM). Warner Bratzler shear-force (WBSF) was carried out according to the procedure of Shackelford et al. (1991) using the Instron Model 5543. Driploss was carried out according to Honikel and Hamm (1994) and cook loss was determined by measuring the weight of the steak before and after cooking and then expressed as a percentage of its original weight. Sarcomere length was determined according to the laser diffraction method (Cross *et al.*, 1980). The myoglobin content was determined using a method by Krzywicki (1982).

Results and discussion

As muscles were selected on the basis of visual colour and pH there was no significant difference observed between the classes for pH. As expected significant differences were observed, between the dark coloured muscles and the normal muscles, for the surface colour measurements (L*a*b*) (Table 1). Beef classified as dark and of normal pH had significantly lower L*, a* and b* values than control meat. At 2 days and 7 days post-mortem, beef classified as dark had consistently lower L* values than normal meat on excision (T0) and after 3 hours (T3) and 24 hours (T24) 'blooming' (Table 1). At 7 days post-mortem lower b* values were recorded in the dark meat at T3 and T24, while lower a* values were noted after at T24. No changes were noted in L* values over a 24 hour period of 'blooming' for either quality class. Both a* and b* values increased from T0 to T3 and slightly decreased between T3 and T24. Wulf and Wise (1999) reported that bloom time had a lesser effect on the CIE L* value than it has on a* and b* values. Although Renerre and Mazuel (1985) indicated that the b* value was not an important indicator of meat blooming, its importance up to T24 is clear from these results . It was interesting to observe that the development of colour in both quality types (dark and normal) occurred in a similar manner on exposure to oxygen.

Trained sensory panellists (Triangle test) noted a significant observable difference ($P \leq 0.05$) in colour, between the two quality classes, after 3 and 24 hours of blooming, at 2 days postmortem. A significant difference ($P \leq 0.05$) was also noted between both meat quality types at 7 days postmortem after 24 hours 'blooming' but not after 3 hours (Table 2). A significant preference of the normal coloured beef was expressed by the 30 untrained panellists (Preference test).

Price and Schweigert (1978) state that DFD beef will not bloom. It is clear from these results that this dark coloured beef has undergone a 'blooming' process in a similar manner to the control meat. Results of compositional analysis show no differences between quality classes for fat, moisture and protein content (results not shown). No differences were detected in drip loss, cook loss or conductivity values between classes (results not shown). While WBSF values did not differ at 2 and 7 days after slaughter, the darker coloured beef was significantly tougher at 14 days post-mortem (Table 3). Sarcomere lengths were not significantly different, suggesting a similar degree of muscle shortening in both groups. Myoglobin levels were significantly higher in the dark coloured beef indicating this problem may be due to the pigment level in the muscle (Table 3). Further analysis will be conducted to confirm the WBSF and myoglobin results.

Conclusions

As regards objective analysis of colour the dark coloured beef of normal pH had consistently higher CIE L* values than normal, control beef after different lengths of time 'blooming' and at different times postmortem. CIE L*a*b* values revealed that both quality classes responded in a similar manner to 'blooming' at 2 and 7 days postmortem. Differences were detected by sensory panellists and preference was expressed the normal control beef over the darker coloured beef. The darker beef had significantly higher levels of myoglobin and the beef was tougher after 14days of ageing but not at 7 days of ageing. No differences were observed in other quality attributes. Further analysis will be conducted to confirm the myoglobin and WBSF results.

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Table 1. Mean CIE L*a*b* values for normal and dark LD steaks. Reading were taken on the surface of muscle (S) 1 day after slaughter and after excision (T0), 3 hours (T3) and 24 hours (T24) of blooming 2 days (D2) and 7 days (D7) after slaughter.

		Normal	Dark	s.e.	n
Surface Day 1	**L* S**	30.22^{x}	26.14^{y}	1.68	20
	a* S	16.72^{x}	14.27^{y}	1.82	20
	b* S	13.42^{x}	10.59^{y}	1.92	20
Day 2	**L* D2T0**	30.47^{xa}	26.71^{ya}	1.91	20
	L* D2T3	30.50^{xa}	28.66^{ya}	1.52	20
	L* D2T24	30.99^{xa}	28.18^{ya}	1.77	20
	a* D2T0	14.34^{xa}	14.60^{xa}	1.29	20
	a* D2T3	21.05^{xb}	20.61^{xb}	1.99	20
	a* D2T24	17.29^{xc}	17.14^{xc}	2.06	20
	b*D2 T0	11.75^{xa}	11.08^{xa}	1.32	20
	b*D2 T3	17.66^{xb}	16.81^{xb}	1.26	20
	b*D2 T24	16.27^{xc}	15.69^{xc}	1.18	20
Day 7	**L* D7T0**	32.06^{xa}	28.48^{ya}	1.72	20
	L* D7T3	31.03^{xa}	27.60^{ya}	1.65	20
	L* D7T24	31.43^{xa}	28.17^{ya}	1.75	20
	a* D7T0	15.08^{xa}	14.68^{xa}	1.29	20
	a* D7T3	26.10^{xb}	24.68^{xb}	2.46	20
	a* D7T24	22.69^{xc}	20.68^{yc}	2.11	20
	b*D7 T0	13.43^{xa}	13.43^{xa}	1.45	20
	b*D7 T3	22.20^{xb}	20.05^{yb}	2.09	20
	b*D7 T24	18.15^{xc}	16.21^{yc}	1.48	20

Different superscripts x-y, within each row, imply significant differences between 'normal' and 'dark' meat, P≤0.05. Different superscripts a-c, within each column and within each measurement, stand for significant differences due to excision time, P≤0.05. s.e.: standard error.

Table 2. Mean values for number of assessors to subjectively assess the normal and dark LD steaks

	Normal	Dark	s.e.	n
Triangular Test D2T3	13.00^{x}	5.00^{y}	0.11	18
Triangular Test D2T24	10.00^{x}	8.00^{y}	0.11	18
Triangular Test D7T3	9.00^{x}	9.00^{x}	0.11	18
Triangular Test D7T24	11.00^{x}	7.00^{y}	0.11	18
Paired Comparison Test	26.00^{x}	4.00^{y}	0.11	30

Different superscripts x-y, within each row, stand for significant differences between 'normal' and 'dark' meat, P≤0.05. s.e.: standard error.

Table 3. Mean values for myoglobin and Warner Bratzler shear force (WBSF) measurements for normal and dark LD steaks

	Normal	Dark	s.e.	n
Myoglobin content (mg/g)	7.17^{x}	9.57^{y}	0.58	20
WBSF D2	70.80^{x}	92.00^{x}	25.08	20
WBSF D7	54.00^{x}	64.40^{x}	19.93	20
WBSF D14	45.20^{x}	70.10^{y}	16.34	20

Different superscripts x-y, within each row, stand for significant differences between 'normal' and 'dark' meat, P≤0.05. s.e.: standard error.