EFFECTS OF MITOCHONDRIAL FUNCTION ON BEEF COLOR STABILITY DURING EARLY POSTMORTEM

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I. INTRODUCTION

Meat color is one of the most important meat quality attributes that influences consumer's purchase decision. Myoglobin is the key pigment responsible for meat color and exists three redox forms: deoxymyoglobin (DeoxyMb), oxymyoglobin (OxyMb) and metmyoglobin (MetMb). Mitochondria can influence meat color through affecting myoglobin redox stability [1, 2]. After slaughtering of animal, mitochondrial function is disrupted as blood circulation system stops and its status is related with initial color development. The objective of this study was to investigate mitochondrial function and meat color of beef during early postmortem to assess the effects of mitochondrial on initial meat color development.

II. MATERIALS AND METHODS

Bovine *longissimus thoracis* muscles (n = 5) from two-year old Simmental crossbreed bulls were collected immediately after exsanguinating from the left side of carcasses and stored at 4 °C for 72 h. Samples were collected at 0, 4, 8, 12, 24 and 72 h ageing and divided into two parts: one part was frozen at -80 °C for oxygen consumption rate (OCR), NADH content and MetMb reductase activity (MRA) analysis, the other part was stored at 4 °C in air for 6 days for meat color measurements. Statistical analysis was carried out using the MIXED procedure in Statistical Analysis System (Version 9.2, SAS Institute, Cary, NC, US) with ageing time as fixed factor and animal as random factor. Results were presented as least squares means and standard error.

III. RESULTS AND DISCUSSION

The average pH of muscle samples at 48 h post mortem was 5.46 (SD = 0.05). Meat color stability was increased as ageing time extended (Figure 1). The L^*, a^* and b^* values were significantly different after different ageing times. The L^* and b^* values of samples aged for 72 h were higher than those aged for 0, 4, 8 and 12 h. The a^* values of samples aged for 24 and 72 h were higher than those aged for 0, 4 and 8 h. After 6 days display in air, the a^* values of samples aged for 12 and 72 h were higher than those aged for 0, 4 and 8 h, the b^* values of samples aged for 12, 24 and 72 h were higher than samples without ageing.

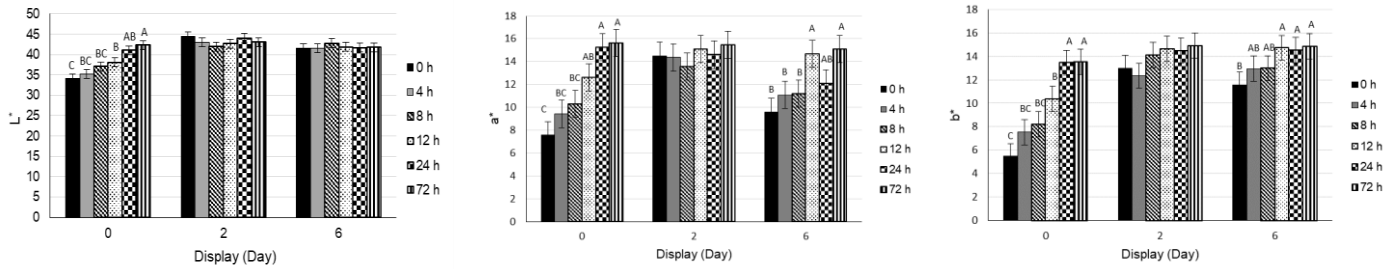

Figure 1. Meat color of beef after different ageing and display times. Different capital letters within the same display time indicated significant difference between samples of different ageing times.

The relative contents of DeoxyMb and MetMb were decreased with longer ageing time, but the relative content of OxyMb was increased (Table 1, $P < 0.05$). The relative contents of DeoxyMb were lower but the relative contents of OxyMb were higher in samples aged for 24 and 72 h than those aged for 0, 4 and 8 h.

After display for 6 days, samples aged for 12 and 72 h showed lower MetMb contents and higher OxyMb contents than those samples aged for 0 and 4 h.

Table 1 Relative contents of three redox forms myoglobin of beef after different ageing and display times

Postmortem time (h)	Display (Day)								
	DeoxyMb			MetMb			OxyMb		
	0	2	6	0	2	6	0	2	6
0	0.706 ^{A}	0.552	0.636 ^{A}	0.775 ^{A}	0.752	1.004 ^{A}	0.466 ^{C}	0.685	0.558 ^{B}
4	0.680 ^{AB}	0.554	0.582 ^{B}	0.735 ^{AB}	0.775	0.962 ^{A}	0.529 ^{C}	0.686	0.608 ^{B}
8	0.635 ^{BC}	0.565	0.572 ^{B}	0.741 ^{AB}	0.799	0.952 ^{AB}	0.546 ^{BC}	0.676	0.619 ^{AB}
12	0.630 ^{CD}	0.556	0.561 ^{B}	0.689 ^{AB}	0.734	0.832 ^{BC}	0.622 ^{AB}	0.706	0.700 ^{A}
24	0.587 ^{DE}	0.556	0.569 ^{B}	0.627 ^{B}	0.752	0.963 ^{A}	0.692 ^{A}	0.698	0.647 ^{AB}
72	0.572 ^{E}	0.551	0.559 ^{B}	0.640 ^{B}	0.709	0.776 ^{C}	0.699 ^{A}	0.711	0.702 ^{A}
SE		0.017			0.044			0.032	

Different capital letters within the same column indicated significant difference between samples of different ageing times.

Results of beef mitochondrial function which was indicated as MRA, NADH contents and OCR were shown in Table 2. The OCR was significantly different between samples with different ageing times (P = 0.022). Beef aged for 72 h had higher OCR than those aged for 0, 4 and 8 h. No difference was observed in MRA and NADH contents between samples with different ageing times (P > 0.05).

Table 2 Mitochondrial functions of beef after different ageing times

Postmortem time (h)	Parameters		
	MRA (U/g)	NADH (μg/g)	OCR (nmol/g.min)
0	129.27	88.80	57.61 ^{C}
4	107.45	79.85	71.92 ^{BC}
8	110.57	68.38	73.58 ^{BC}
12	125.84	63.73	85.75 ^{AB}
24	107.14	81.18	80.03 ^{AB}
72	87.39	73.74	96.69 ^{A}
SE	12.10	15.83	7.15

Different capital letters within the same column indicated significant difference between samples of different ageing times.

Mitochondrial respiration out competes myoglobin for oxygen which negatively influence formation of cherry red OxyMb [3]. However, the situation seems different during the initial 72 h ageing of beef in this study that the increase of oxygen consumption did not affect the increasing of meat color stability. This may be due to the availability of oxygen and the level of competition between mitochondria and myoglobin during early postmortem and it needed more evidence to elucidate.

IV. CONCLUSION

Increase of meat color stability of beef within the initial 72 h ageing was not influenced by the oxygen consumption of mitochondria in this study.

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