COMBINATION OF VACUUM-SKIN PACKAGING AND OXYGEN ABSORBER FOR THE ENHANCEMENT OF COLOR STABILITY IN WET-AGED BEEF

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I. INTRODUCTION

Wet aging of beef has been found to enhance meat quality in terms of tenderness, juiciness, and flavor [1]. However, it has been observed that vacuum packaging may cause a change in meat color due to the conversion of oxymyoglobin (OMb) into metmyoglobin (MMb) resulting from the oxidation of myoglobin under a low partial pressure of oxygen [2]. This color change may negatively impact consumer acceptance. Hence, many methods have been proposed to reduce oxygen pressure within the packaging, such as vacuum-skin packaging and the use of oxygen absorbers [3]. Despite this, little is known about the effect of combining vacuum-skin packaging and oxygen absorbers on the color stability of meat during wet aging. Therefore, we aimed to evaluate the effect of packaging methods and oxygen absorbers on meat color and explore the optimal packaging method for wet-aged beef.

II. MATERIALS AND METHODS

Meat blocks (80 × 50 × 25 mm; length × width × thickness), were prepared from beef rump obtained from a 34-month-old Korean native cattle (Hanwoo) steer. These blocks were randomly assigned to four groups (*n* = 6 for each group) in a 2 × 2 factorial arrangement that involved two packaging methods {NY, vacuum-packaged with nylon film; EV, vacuum-skin packaged with three-layers of ethylene-vinyl acetate/ethylene-vinyl alcohol/ethylene-vinyl acetate (EVA-EVOH-EVA) film} and the presence of oxygen absorbers (O, with; none, without). For NY and NY-O, the meat blocks were vacuum-packaged (HFV-600L, Hankook Fujee Machinery Co., Ltd., Hwaseong, Korea) using low-density nylon bag (oxygen transmission rate of 20-30 cc/m^2/24 h at 0°C, 80 μm thickness; Packplus, Gwangju, Korea) with absorbent pads. For EV and EV-O, the meat blocks and absorbent pads were placed on a plastic tray and vacuum-skin packaged (Multivac T305, Multivac, Wolfertschwenden, Germany) using EVA-EVOH-EVA film (oxygen transmission rate of 8 cc/m^2/24 h at 0°C, 100 μm thickness; Sunrise Packaging Material Co., Ltd., Jiangsu, China). The wet aging process was carried out at 4°C, and samples were collected on days 7 and 14. At each day, the meat samples were unpackaged, bloomed for 30 min, and analyzed for surface color, relative myoglobin percentage, metmyoglobin reducing activity (MRA), and oxygen consumption rate (OCR) using established methods [2]. Statistical analyses were performed using analysis of variance (SAS 9.4, SAS Institute Inc., Cary, NC, USA).

III. RESULTS AND DISCUSSION

Wet-aged beef showed significantly lower CIE *a**- and *b**-values but higher *L**-value compared to fresh beef (data not shown). However, with an increase in the aging period from day 7 to 14, redness and yellowness significantly increased, which might result from decreased %OCR and increased %OMb (Table 1) [2]. Depending on the packaging method, EV showed a better %MRA than NY ($p < 0.05$). The use of an oxygen absorber during wet aging resulted in increased CIE *a**- and *b**-values with higher %OMb of beef than oxygen absorber-absent groups ($p < 0.05$). The interaction between the aging period and packaging method was significant for %DMb, whereas that between the aging period and oxygen absorber affected every factor except CIE *L** and %OCR ($p < 0.05$). Especially, NY-O and EV-O exhibited significantly higher %MRA compared to NY or EV (data not shown). EV-O showed higher CIE *a**- and *b**-values, %OMb, %MRA and lower %DMb compared to NY (data not shown). The visual appearances of NY and EV-O on day 14 were clearly distinguishable (Figure 1).

Table 1. Meat color, relative myoglobin percentage, and meat color-associated factors of beef with wet aging periods and different packaging methods.

Treatment		*L**	*a**	*b**	%MMb	%DMb	%OMb	%MRA	%OCR
Fresh beef		30.3	20.1	12.6	25.8	9.9	64.3	32.9	36.8
Aging period	7	32.1^{b}	8.5^{b}	7.3^{b}	48.8^{a}	9.6	41.7^{b}	14.6^{a}	48.0^{a}
(T)	14	34.0^{a}	11.0^{a}	9.7^{a}	41.8^{b}	9.3	48.9^{a}	11.6^{b}	38.3^{b}
Packaging	NY	32.7	9.3	8.2	46.6	8.7^{b}	44.7	11.7^{b}	43.1
(P)	EV	33.4	10.3	8.8	44.0	10.2^{a}	45.9	14.5^{a}	43.2
Oxygen	With	33.4	10.9^{a}	9.2^{a}	42.5^{b}	8.9^{b}	48.6^{a}	16.8^{a}	40.5
absorber (O)	Without	32.7	8.6^{b}	7.8^{b}	48.1^{a}	9.9^{a}	42.0^{b}	9.3^{b}	45.8
p value	T	0.00	0.01	0.00	0.01	0.45	0.01	0.00	0.00
	P	0.16	0.25	0.33	0.28	0.00	0.63	0.01	0.97
	O	0.21	0.02	0.03	0.03	0.02	0.02	0.00	0.05
	T × P	0.95	0.22	0.42	0.50	0.00	0.12	0.21	0.49
	T × O	0.06	0.01	0.01	0.03	0.00	0.01	0.00	0.27
	P × O	0.31	0.54	0.60	0.24	0.77	0.24	0.02	0.37
	T × P × O	0.30	0.72	0.89	0.49	0.00	0.98	0.13	0.02
SEM		0.35	0.60	0.40	1.68	0.27	1.74	0.61	1.77

SEM, standard error of the mean ($n = 24$). ^{a,b} Different letters within the same column in each single factor indicate significant differences ($p < 0.05$). DMB, deoxymyoglobin; MMb, metmyoglobin; MRA, metmyoglobin reducing activity; OCR, oxygen consumption rate; OMb, oxymyoglobin.

Figure 1. Representative pictures of NY (left) and EV-O (right) on day 14.

IV. CONCLUSION

This study found that the combination of vacuum-skin packaging with oxygen absorber was the best way to delay the discoloration of beef wet-aged for 14 days.

REFERENCES

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