EFFECTIVENESS OF MASTER BAG SYSTEM PACKAGING WITH LOW RESIDUAL OXYGEN TO EXTEND THE SHELF LIFE OF BISON MEAT

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I. INTRODUCTION

Numerous technologies have been used in bison meat to extend its shelf life because it is inherently darker and discolours more promptly than beef [1,2]. However, few techniques, such as nitrite film packaging, have stabilized its meat colour significantly, although it still needs regulatory approval in Canada [1]. Master bag packaging with CO2/N2 modified atmosphere with low residual O2 is used to enhance the shelf life of beef [3], but this technology's effect has not yet been proved in bison meat. This study aims to determine the effect of CO2/N2 modified atmosphere and low residual oxygen on the colour stability, lipid oxidation, and bacterial growth of bison meat during storage and retail display.

II. MATERIALS AND METHODS

Bison striploins (n = 20) were purchased, 180 steaks (9 steaks per striploin) were obtained and placed on a foam tray with a soaking pad and overwrapped with polyvinyl chloride film (one steak per tray) and were distributed randomly to the following treatments: master bag (MB) with oxygen scavenger (MBOSC; n = 80 steaks), MB without oxygen scavenger (MBNoSC; n = 80 steaks), and control (never stored in MB; n = 20 steaks). The treatments were prepared as follows: two trays were placed into a MB (gas mixture 30% CO_2 and 70% N_2), and 40 MB out of 80 bags received one O_2 scavenger (Multisorb® FreshPax CR). The prepared MB were assigned to one of two dark storage times (7 and 14 d) at 4°C. Also, one steak was placed into a vacuum bag as a control steak and stored for 7 and 14 d at 4°C. Residual oxygen (RO) was determined at 0.5, 1, 7 and 14 d dark storage on different MB. Instrumental colour evaluation [2] was performed during storage in the MB at 1, 7 and 14 d before and after blooming (4°C for 1 h to allow the blooming process). At 7 and 14 d, MB were opened, and one tray was used for microbial analysis (coliforms, lactic acid, and psychrophilic counts) [1] and lipid oxidation (malondialdehyde: MAD) [2], and the other tray was placed in the coffin-style retail display cabinets for colour evaluation for 5 d under LED lighting with intensity 1240 lux at 4°C. At the same time, the control steak bag was opened, overwrapped, and placed in the retail display along with the MBOSC steaks. The MBNoSC steaks were not used for retail display simulation for presenting a completely oxidized surface at the end of storage. The statistical model was a completely randomized design with a split-split-plot arrangement.

III. RESULTS AND DISCUSSION

The MBOSC absorbed and maintained the RO below 0.11% for 14 d of storage, while the RO in MBNoSC was above 2.45% ($P < 0.01$). In the instrumental colour evaluation at each storage time, MBOSC samples presented higher *a**, *b**, Chroma values and lower Hue values before and after blooming that indicates a more stable red colour of the steaks than MBNoSC ($P < 0.01$; Table 1). In the retail display simulation, MBOSC showed higher *a**, *b**, and Chroma than control samples ($P < 0.01$; Table 2). MBOSC samples presented less MAD than MBNoSC during storage ($P = 0.05$; 0.97 vs. 1.56 mg/kg; respectively). Also, *Psychrophilic* bacteria presented the highest count in MBNoSC at

14 d of storage (P = 0.03; 5.64 log_{10} cfu/cm^2); but other spoilage bacteria count were not affected by the packaging treatment (P > 0.05; Lactic acid: 3.71 - 5.95 log_{10} cfu/cm^2; Coliforms: 0.01 - 0.20 log_{10} cfu/cm^2). In agreement with our results, two experiments [3, 4] reported that samples (beef steaks and beef patties; respectively) from MBOSC presented RO values not detectable by the instrument (i.e. < 0.08%) after 24 h of storage and maintained lower for 10 or 21 d than MBNoSC. Also, those studies [3,4] indicated that MBOSC evidenced a more vivid red colour than MBNoSC samples after storage and at the retail levels. A study [3] indicated that MBOSC presented less MAD and less mesophilic and lactic acid bacteria growth for the entire storage period (21 d).

Table 1. Objective colour traits of steaks stored in master bags with and without scavengers after storage, before and after blooming in bison steaks.

	MBNoSC		MBOSC			P-value		
Variable	BB	AB	BB	AB	SEM	PT	BT	PT x BT
Lightness (L^*)	42.0	41.8	41.0	41.8	0.66	0.30	0.42	0.28
Redness (a^*)	9.86 ^{a}	11.3 ^{a}	14.2 ^{b}	19.3 ^{c}	1.02	< 0.01	< 0.01	0.01
Yellowness (b^*)	4.70 ^{b}	5.73 ^{c}	2.54 ^{a}	7.33 ^{d}	0.34	0.25	<0.01	<0.01
Chroma	11.1 ^{a}	12.7 ^{a}	14.5 ^{b}	20.7 ^{c}	0.97	<0.01	<0.01	<0.01
Hue	26.8 ^{a}	28.2 ^{a}	10.7 ^{b}	21.3 ^{c}	2.06	< 0.01	< 0.01	<0.01

Packaging type (PT) = MBNoSC: Master bag without oxygen scavenger; MBOSC: Master bag with oxygen scavenger. Blooming time (BT) = BB: before blooming; AB: after blooming; SEM: Standard error of mean.
^{a,b,c} Least squares means within a row lacking a common superscript letter differ (P < 0.05).

Table 2. Objective colour traits of bison steaks during retail display from conventional vacuum bags and master bags with scavengers.

	Control		MBOSC			P-value		
Variable	7	14	7	14	SEM	PT	ST	PT x ST
Lightness (L^*)	41.5	41.9	40.0	41.1	0.38	<0.01	<0.01	0.13
Redness (a^*)	11.8 ^{a}	11.9 ^{a}	13.7 ^{c}	12.6 ^{b}	0.30	<0.01	0.01	<0.01
Yellowness (b^*)	5.06 ^{a}	5.34 ^{ab}	5.86 ^{c}	5.51 ^{b}	0.18	<0.01	0.76	0.01
Chroma	12.9 ^{a}	13.1 ^{a}	14.9 ^{c}	13.8 ^{b}	0.33	<0.01	0.03	0.01
Hue	24.5	25.6	24.6	25.2	1.36	0.76	0.08	0.62

Packaging type (PT) = Control: conventional vacuum bags; MBOSC: Master bag with oxygen scavenger; SEM: Storage time (ST) = 7 days and 14 days of dark storage at 4 °C. Standard error of mean.
^{a,b,c} Least squares means within a row lacking a common superscript letter differ (P < 0.05).

IV. CONCLUSION

The MBOSC ensures proper conditions for preservation in storage, favouring the blooming process and improving colour and oxidative stability in fresh bison meat under retail display conditions.

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