Anoxic packaging of retail cuts of pork

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Introduction

Mother pack systems used to extend the shelf life of retail cuts of meat for several weeks are generally composed of gas atmospheres containing carbon dioxide (CO_2) or mixtures of CO_2 and nitrogen (N_2). The exclusion or reduction of oxygen (O_2) to very low levels in these systems is a critical factor in terms of maintaining colour stability (Penney & Bell, 1993) and retarding bacterial growth. In some systems however, it is not always possible to remove O_2 completely during the packing cycle due to entrapped air in the retail packs. Other methods, such as the inclusion of O_2 scavengers in the packaging system, are therefore required to remove residual O_2.

The aim of the current study was to investigate the effect of O_2 scavengers on residual O_2 levels in an anoxic mother pack containing retail cuts of pork, with the overall aim of determining colour stability and hence the shelf life of these samples.

Materials and methods

Two loin chops were placed in a plastic tray containing one 200 cc O_2 scavenger (Ageless SS-200, Mitsubishi Corporation) and the tray was overwrapped with a high O_2 permeability film (O_2 transmission rate (OTR) = 20000 cm^3 m^{-2} 24 h^{-1} atm^{-1}). Six trays were placed in a mother pack of low O_2 permeability (OTR = 7 cm^3 m^{-2} 24 h^{-1} atm^{-1}) containing one 2000 cc O_2 scavenger (Ageless Z-2000 PT). The mother packs were evacuated, filled with 50% CO_2/50% N_2 or 100% CO_2 and sealed using a CVP machine (Model A300, CVP Systems (UK)). They were stored at 0°C for 7, 14 or 21 days when the gas composition of mother packs and trays were analysed using a gas chromatograph (Spectra 250, Gow-Mac Instrument Co. Ltd.). The mother packs were opened and the colour of the two chops in each tray was measured (0 h) using a HunterLab Ulrascan XE Spectrophotometer (Model A60-1005-654). The trays were then placed in a display cabinet fitted with two white bulbs at 4.5±1.8°C. Colour was measured at 2, 24, 48, 72 and 96 h of display. Colour assessments were also made by a panel of six people at 96 h. Drip loss was measured by weighing each chop before packaging and again after packaging, storage and display. Drip was expressed as a percentage of the initial weight of the chop. The above procedure was repeated for control mother packs and trays which did not contain O_2 scavengers. Six replicates were set up. On the first day of each replicate, one fresh chop was overwrapped as above and colour and drip loss measurements were taken as described. A two-way ANOVA with O_2 scavenger presence and gas atmosphere composition as the main effects was carried out for each recorded variable at each display time within each storage time.

Results and Discussion

Statistical analysis: Gas atmosphere and the interaction between gas atmosphere and O_2 scavenger were generally not significant. The inclusion of O_2 scavengers however, resulted in a significant improvement on most colour measurements. Comparisons between fresh chops and those packaged with O_2 scavengers in 50% CO_2/50% N_2 or 100% CO_2 were made using the least significant difference test.

O_2 levels: Reduced O_2 levels were detected during storage in mother packs and trays containing O_2 scavengers, with residual levels of <0.8% and <0.2% occurring in 50% CO_2/50% N_2 and 100% CO_2 respectively. Penney & Bell (1993) reported that pork can withstand up to 1% O_2 during 7 days storage at -1.5±0.5°C without any obvious effects on colour.

Colour: The redness of chops packaged with O_2 scavengers was as good as fresh after 7 and 21 days storage (Table 1). Indeed, after 21 days, chops packaged in 50% CO_2/50% N_2 with O_2 scavengers were redder than fresh chops at 2 h of display. After 14 days, however, fresh chops were redder than packaged chops at 0 and 48-96 h in 50% CO_2/50% N_2 ($P<0.05$); and at 96 h in 100% CO_2 ($P<0.01$). Increased metmyoglobin formation, as indicated by higher hue angles, were generally observed for chops packaged in 50% CO_2/50% N_2 with O_2 scavengers compared to fresh, at 0 and 48-96 h of display after 7, 14 and 21 days ($P<0.01$) (Table 2). Higher hue angles were also noted for chops packaged in 100% CO_2 with O_2 scavengers compared to fresh at 0 h of display after 7 days ($P<0.05$); at 0, 48 and 96 h of display after 14 days ($P<0.05$); and at 72-96 h after 21 days ($P<0.05$). The panellist examination of colour showed that chops packaged in 50% CO_2/50% N_2 with O_2 scavengers were less acceptable than fresh after 7 and 21 days ($P<0.01$) (Table 3). There were no differences after 14 days. The colour acceptability of chops packaged in 100% CO_2 with O_2 scavengers, however, was as good as fresh after each storage time.

Drip loss: Significantly higher levels of drip loss were recorded for packaged chops compared to fresh chops at 7, 14 and 21 days ($P<0.001$) (Table 4). Drip losses of 5.6-6.3% and 6.2-7.1% were calculated during storage for chops packaged with O_2 scavengers in 50% CO_2/50% N_2 and 100% CO_2 respectively. Sørheim *et al.* (1996) noted similar levels for pork loin sections stored in 50% CO_2/50% N_2 (6.3%) and 100% CO_2 (6.9%) at 1°C for 22 days, and subsequently cut into chops and displayed in O_2-permeable film at 3°C for 3 days.

Conclusion

A retail shelf life of 2, or 3-4 days, was observed at *ca.* 4.5°C for chops packaged with O_2 scavengers in 50% CO_2/50% N_2 and 100% CO_2 respectively, following storage at 0°C for 21 days. This assessment was based on the colour measurements redness (*a*) and hue angle.

References

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Sørheim, O., Grini, J.A., Nissen, H., Andersen, H.J. & Lea, P. (1995) Pork loins stored in carbon dioxide. Colour and microbiological shelf life. Fleischwirtsch., 75:5:679-681.

Table 1: Redness (*a* value) of chops packaged with O_2 scavengers in (1) 50% CO_2/50% N_2 and (2) 100% CO_2.

Storage time (days)										
		7			14			21		
Display (h)	Fresh	1	2	sed [a]	1	2	sed	1	2	sed
0	3.8	3.4	3.5	0.3	3.2*[b]	3.9	0.2	4.3	4.0	0.5
2	5.2	5.3	5.6	0.3	5.1	5.6	0.3	6.2*[c]	6.0	0.4
24	5.7	6.0	6.1	0.3	5.5	5.8	0.3	6.3	6.3	0.4
48	5.8	5.7	5.8	0.3	5.0***	5.5	0.2	5.7	5.9	0.4
72	5.6	5.4	5.5	0.3	4.5***	5.3	0.3	5.2	5.2	0.4
96	5.2	4.6	5.2	0.3	4.1***	4.6**	0.2	4.6	4.7	0.4

[a]sed = standard error of the difference; [b]level of significance for comparisons between fresh and packaged chops *P<0.05; **P<0.01; ***P<0.001; [c] 50% CO_2/50% N_2 + O_2 scavengers significantly higher than fresh.

Table 2: Hue angle values recorded for chops packaged with O_2 scavengers in (1) 50% CO_2/50% N_2 and (2) 100% CO_2.

Storage time (days)										
		7			14			21		
Display (h)	Fresh	1	2	sed [a]	1	2	sed	1	2	sed
0	64.0	70.3***[b]	68.4*	1.6	71.3***	68.2**	1.3	66.8	68.0	1.9
2	60.7	62.2	60.2	1.3	62.8	60.8	1.3	59.5	59.8	1.4
24	59.2	60.4	58.4	1.2	61.6	60.2	1.6	59.5	58.9	1.3
48	58.6	61.9**	60.1	1.1	63.4***	61.4*	1.1	61.8**	59.8	0.9
72	59.8	62.9**	60.8	1.0	65.9***	62.3	1.2	63.8**	63.4*	1.3
96	61.6	66.5**	62.8	1.2	68.2***	64.7*	1.5	66.4**	65.2*	1.5

Table 3: Mean percentage of the total number of chops packaged with O_2 scavengers, in 50% CO_2/50% N_2 and 100% CO_2, which were considered acceptable in terms of colour at 96 h of display.

Storage time (days)	7		14		21	
Packaging treatment	Mean	s.d.	Mean	s.d.	Mean	s.d.
50% CO_2/50% N_2 + O_2 scavengers	64.8	4.2	73.3	4.2	63.3	5.1
100% CO_2 + O_2 scavengers	73.6	4.1	74.4	4.4	70.8	5.0

Mean percentage of fresh chops which were considered acceptable in terms of colour at 96 h of display = 81.9.

Table 4: Mean percentage drip loss during storage and display from chops packaged with O_2 scavengers in 50% CO_2/50% N_2 and 100% CO_2.

Storage time (days)	7		14		21	
Packaging treatment	Mean	s.d.	Mean	s.d.	Mean	s.d.
50% CO_2/50% N_2 + O_2 scavengers	5.7	0.2	5.6	0.2	6.3	0.2
100% CO_2 + O_2 scavengers	6.2	0.2	7.1	0.2	6.5	0.2

s.d.= standard deviation; mean percentage drip loss recorded for fresh chops during display = 4.4.