CO_2 Emitter Pads as an Alternative to Gas Flushing: Microbial and Meat Quality Evaluation

Seyed Mohammad Hassan Mortazavi [a]*, Mandeep Kaur [a], Asgar Farahnaky [a], Peter J. Torley [a], A. Mark Osborn [a]

[a] Discipline of Biosciences and Food Technology, RMIT University, Bundoora VIC 3083, Australia.

*Corresponding author email: hassan.mortazavi@outlook.com.au, peter.torley@rmit.edu.au

I. INTRODUCTION

Modified atmosphere packaging (MAP) is a common food preservation tool, and it has found wide-spread application within the meat industry. The choice of packaging gas varies depending on the nature of the product, but enhanced levels of CO_2 (20 to 30%) are commonly used to provide an extended microbial shelf-life of fresh meat. One factor limiting the use of MAP in smaller locations is the capital cost of suitable gas-flush packaging equipment. A strategy that may prove more useful in these sorts of situations is the use of CO_2 emitter pads. Inclusion of an absorbent pad in packaged meat is a common practice as it absorbs the drip produced by meat during storage [1]. The CO_2 emitter pad concepts involves using this drip to cause a chemical reaction resulting in CO_2 release. Typically the reaction involves citric acid and sodium bicarbonate reacting together when exposed to water or meat drip, resulting in CO_2 production.

There are a number of parameters that could affect the suitability of CO_2 emitter pad technology in the meat industry, including the time taken to reach the target CO_2 level, maintenance of the target CO_2 level, impact on packaging performance (package swell or collapse) and the effect that the CO_2 level that is achieved has on meat quality attributes. To address these points, this study compares the effect of two types of CO_2 active pads (absorbs moisture, CO_2 production) with passive pads (absorbs moisture, no CO_2 production) used with conventional gas flush technology.

II. MATERIALS AND METHODS

The meat used in the study were from bovine semitendinosus (2 cm thick, approximately 250 g). The active (CO_2 producing) pads were: Vartdal Plast (VP; 10 cm ×15 cm) and McAirlaid's (MA; 8 cm ×13 cm). The packaging treatments were: P1, 1x VP pad with air; P2, 1x MA pad with air; P3, 2x MA pads with air; P4, 1x passive pad with air; P5, 1x passive pad with 30% CO_2, 20% O_2, 50% N_2; P6, 1x passive pad with 30% CO_2, 70% O_2. The appropriate pad were placed in the bottom of clear polypropylene trays (170 x 223 x 40 mm; Cryovac® Barrier Trays). Beef slices were weighed and placed on the pad(s). The trays were transferred to the gas packer (T-200 Multivac), flushed with the appropriate gas mixture, and sealed with biaxially oriented polyamide/ethylene vinyl alcohol copolymer polyethylene film (LID-AEE-AP-45, Multivac). The performance of the different packaging system were assessed using headspace gas measurement (O_2 and CO_2; Quantek Model Q2, USA), meat pH (surface meat sample homogenized in distilled water and measured [Oakton pH 700 Benchtop Meter]), meat color (CIE *Lab* system; Chroma Meter, CR-400, Konica Minolta, Japan), meat drip loss (weight change), and total aerobic microbial counts (enumerated using 3M™ Petrifilm Rapid Plates codes 6478). Samples were analyzed on days 0, 3, 7, 10, 14, 17 and 21. Triplicate samples were analyzed for each combination of packaging treatment and sampling time. The experimental design consisted of 108 trays (comprising 6 treatments × 6 sampling times × 3 replicates).

III. RESULTS AND DISCUSSION

The headspace gas composition changed during the storage time (Figure 1), reaching a maximum of approximately 60% CO_2 in emitter pads P1 and P3, and 50% in emitter pad P2. Importantly, the CO_2 concentration of P1 and P3 had exceeded 30% before the earliest sampling time (day 3), indicating that the emitter pad technology was capable of rapidly producing a microbially inhibitory environment. Further work on the production of CO_2 in the first few days of storage would clarify the time taken for inhibitory levels of CO_2 to be achieved.

The effect of meat contact with the pad or the headspace gas was considered for pH and color. As expected, the meat pH changed during storage, showing an initial increase, and then declining. The pH of the passive pad samples showed minimal difference in pH between the two surfaces. In contrast, the emitter pads showed larger differences, with the pad contact pH being higher than the gas contact surface.

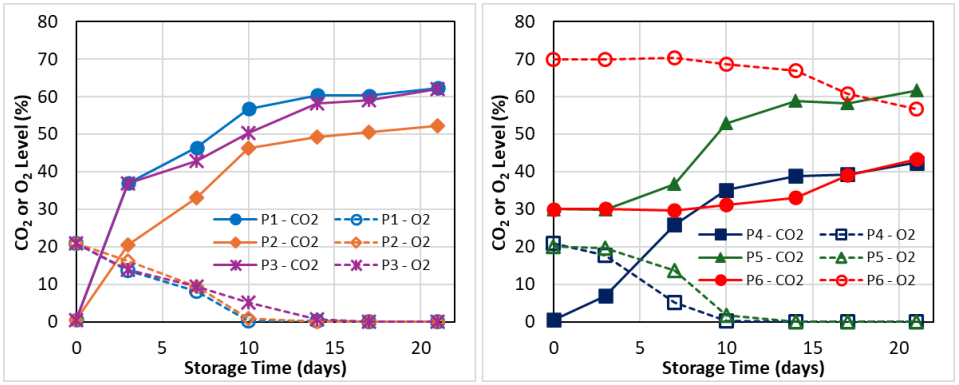

Figure 1. Levels of CO_2 and O_2 during chilled storage (4 °C) for up to 21 days in packages containing either active or passive pads.

Meat color showed a similar pattern (data not shown), with passive pads showing no significant difference between gas and pad contact surfaces for a* and b*. However, active pads showed significant differences with the active pad contact surface having a higher a* and lower b* than the gas contact surface.

The aerobic plate counts (APC) of all samples started at the same level (2.33 ± 0.15 Log cfu/cm^2). The P1, P3 and P5 controlled APC numbers with similar effectiveness (Table 2). P4 (air headspace) and P6 (30% CO_2, 70% O_2) saw less effective control of APC numbers, and had the highest counts at the end of storage. Interestingly P2 proved less effective initially (days 1 and 7), which may reflect the slower increase in CO_2 level in this treatment.

Table 1. The pH of meat surfaces in contact with the gas or pad. Selected days presented for brevity.

		Time (day)			
		0	7	14	21
P1	Gas	5.3 ± 0.02	5.7 ± 0.03	5.8 ± 0.03	5.7 ± 0.02
	Pad	5.3 ± 0.02	5.9 ± 0.02	6.0 ± 0.05	5.7 ± 0.03
P2	Gas	5.3 ± 0.02	5.7 ± 0.02	5.8 ± 0.03	5.7 ± 0.01
	Pad	5.3 ± 0.02	5.7 ± 0.03	5.9 ± 0.01	5.6 ± 0.03
P3	Gas	5.3 ± 0.02	5.7 ± 0.05	5.8 ± 0.02	5.7 ± 0.04
	Pad	5.3 ± 0.02	5.7 ± 0.02	5.9 ± 0.03	5.7 ± 0.04
P4	Gas	5.3 ± 0.02	5.7 ± 0.06	5.6 ± 0.05	5.5 ± 0.01
	Pad	5.3 ± 0.02	5.7 ± 0.05	5.6 ± 0.04	5.5 ± 0.02
P5	Gas	5.3 ± 0.02	5.6 ± 0.03	5.7 ± 0.02	5.5 ± 0.03
	Pad	5.3 ± 0.02	5.6 ± 0.03	5.7 ± 0.06	5.4 ± 0.03
P6	Gas	5.3 ± 0.02	5.6 ± 0.01	5.3 ± 0.03	5.1 ± 0.02
	Pad	5.3 ± 0.02	5.6 ± 0.01	5.3 ± 0.01	5.1 ± 0.02

Table 2. Aerobic plate count (Log cfu/cm^2) for samples during storage. Selected days presented for brevity.

	Time (day)			
	3	7	14	21
P1	2.73 ± 0.08	2.82 ± 0.19	5.05 ± 0.19	5.52 ± 0.12
P2	3.03 ± 0.18	3.12 ± 0.45	5.16 ± 0.10	5.21 ± 0.45
P3	2.44 ± 0.30	2.81 ± 0.27	5.11 ± 0.12	5.71 ± 0.43
P4	4.25 ± 0.41	4.32 ± 0.16	5.77 ± 0.11	6.28 ± 0.12
P5	2.52 ± 0.11	2.62 ± 0.11	4.71 ± 0.12	5.74 ± 0.31
P6	3.50 ± 0.14	3.48 ± 0.24	4.75 ± 0.41	6.44 ± 0.06

IV. CONCLUSION

The emitter pads used rapidly increased the CO2 levels in the samples, with P1 and P3 reaching over 30% CO_2 by day 3 of storage. P1, P3 and P5 had comparable APC numbers throughout the study. However, other attributes (pH, color) responded differently in the emitter pad samples compared to the passive pad samples. In particular, the meat surface in contact with the emitter pad differed from the surface in contact with the headspace gas. This issue did not occur with the passive pads. To fully develop this technology for application to beef, further refinement of the pad technology along with changes such as in the film composition to better manage the CO_2 levels achieved.

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REFERENCES

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