INVESTIGATION INTO THE USE OF A MICRO-PERFORATED FILM IN A LOW OXYGEN MOTHER PACK STORAGE SYSTEM FOR BEEF CUTS.

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Background

Shelf life extension of retail beef cuts can be achieved by storage under very low O_2 conditions followed by aerobic display (Isdell *et al.*, 1999). Beef steaks were MAP packed in retail trays with O_2 scavengers, which were placed in a mother pack and stored until required for display for display.

With this system it is critical that upon pack closure the level of residual O_2 is < 0.1% to prevent the formation of metmyoglobin and browning on the steak surface during storage (Jeremiah, Penney & Gill, 1992b). Therefore the virtual absence of O_2 during storage is critical, however the situation is the reverse upon display. Consumers are attracted to steaks which are bright red in colour, as opposed to the purple form found during storage. Therefore oxygen must be introduced during display to oxygenate the purple myoglobin to the cherry red oxymyoglobin. Oxygen can be introduced into the retail pack through the lidding film. Oxygen permeable film is available for tray overwrapping, however research by Beggan *et al* (2001) proved unsuccessful in sourcing a lidding film, due to insufficient O_2 permeability at display temperatures (0-4°C). Films tested were also very weak when used on the packaging machine. As an alternative a micro-perforated film was sourced which was sufficiently strong and permeable for use with this packaging system.

Objectives

The objective was to examine the use of micro-perforated film as a lidding film in a low O_2 mother pack storage system for M. *longissiums dorsi* (LD), M. *semimembranous* (SM) and M. *psoas major* (PM) muscles.

Methods

This trial was carried out in two stages. The initial trial used LD muscle and consisted of 8 treatments. The most successful treatments from this trial were used with SM and PM muscles. Muscles were excised from commercial steers at 48h post mortem. For LD muscles, 4 low O_2 mother pack treatments were set up, while SM and PM muscles were packed under 2 low O_2 mother pack treatments. Each barrier mother pack (oxygen transmission rate (OTR) 35cm^3 m^{-2} $24h^{-1}$ atm^{-1}, CVP systems Ltd, England), contained 6 steaks packed in laminated polystyrene trays (Linpac 2-37 EPS trays), gas flushed with 60% N_2 /40% CO_2, <0.1% residual O_2 and sealed with a micro-perforated film. Oxygen scavengers were placed in some of the retail trays and mother packs as described in Table 1. For two treatments the micro-perforations on the lidding film were covered over with tape, effectively transforming the film into a gas barrier film. For the LD muscle 10 steaks were packed in retail laminated polystyrene trays, gas flushed with 60% N_2 /40% CO_2, <0.1% residual O_2 and sealed using this film. Five of these packs contained an Atco HV 210CC oxygen scavenger (treatment 5) and 5 did not (treatment 6, LD only). SM and PM treatment 6 was omitted. The remainder of the primal was vacuum packed. All meat packs were stored in darkness for 18 days at 0°C. After storage all packs were displayed in a retail display cabinet (3-3.5°C). For treatments 1-4, retail packs were removed from the mother packs and displayed. The tape on treatment 5 & 6 was peeled back prior to display. Vacuum packed primal portions were opened, from which 6 steaks (approx. 25mm in thickness) were cut. Five steaks were MAP packed under 80% O_2 / 20% CO_2 (treatment 7). This treatment represents what is currently in common use in the meat packaging industry. The remaining steak, the control, was overwrapped in a highly O_2 permeable film (OTR 20,000 cm^3 m^{-2} $24h^{-1}$ atm^{-1}, Omnifilm, Huntsman, Germany) and displayed. Packs were displayed for 4h, 24h, 48h, 72h & 96h. CIELab colour measurements were taken using a HunterLab Ultra Scan XE spectrophotometer from which saturation was calculated. The results were analysed using one way ANOVA at each display time. The trail was replicated 6 times for each muscle type.

Table 1: Summary of MAP storage treatments and muscle stored in each treatment.

Treatment No.	Mother Pack	Retail tray	Muscle used
1	+ scavenger	+ scavenger	LD, SM, PM
2	- scavenger	+ scavenger	LD
3	- scavenger	- scavenger	LD
4	+ scavenger	- scavenger	LD, SM, PM
	Tape with perforations covered		
5	+ scavengers		LD, SM, PM
6	- scavengers		LD

Results and Discussion

Young *et al.*, (1999) reported that both *a** and b* values increase during blooming, and for that reason blooming is well represented by saturation ($\sqrt{(a^{*2} + b^{*2})}$). Saturation results will therefore be discussed here. Results for the LD clearly indicate the requirement for O_2 scavengers in this packaging system. The most successful treatments for the LD were mother pack treatment 1 (mp1), mother pack treatment 2 (mp2), treatment 5 (tape with scavenger), the control and treatment 7 (high O_2). Saturation levels of all remaining treatments were generally < 20 for the entire display periods, and were significantly lower than the control ($P<0.001$). The slower blooming of mp1 and treatment 5 resulted in significantly lower saturation values for these treatments at 4h display ($P<0.001$) compared to the control. However, by 24h display, these

steaks were fully bloomed and reminded similar to the control for the rest of the display period. Steaks from mother pack treatment 2 took ever longer than mp1 to completely bloom and saturation values for these steaks were not similar to the control until 48h display. Saturation values for treatment 7 (high O_2 MAP) were significantly higher than all other treatment for the entire display period, as was expected due to the higher O_2 concentration in the packs. Storage of SM and PM steaks in mp 1 and mp 4 were not as successful with saturation values for both treatments < 20 throughout. The only successful low O_2 treatment was treatment 5 (tape with scavenger) for PM steaks. Steaks from this treatment had similar saturation values to the control at 4h display and for most of the remaining display life. Generally saturation values for SM and PM steaks from treatment 4 (high O_2 MAP) were significantly higher than all other treatments throughout the display period. The results indicate that upon pack closure, the levels of residual O_2 (> 0.1%) in the mother packs were > 0.1% O_2. The tray packaging machine reduced O_2 levels in retail trays to below the critical 0.1% level. However, the perforations in the film probably allowed sufficient oxygen to enter the pack between the time of removal of the pack from the tray packaging machine to sealing of the mother pack and caused discoloration. For the LD steaks with scavengers metmyoglobin formation was prevented. However, for the less colour stable SM and PM steaks metmyoglobin formed during storage, even in the presence of scavengers, thus preventing blooming on display. PM steaks were successfully stored under treatment 5 (tape with scavenger), in which the residual O_2 was approx. < 0.1%. SM steaks stored under the same treatment were brown after storage and thus more sensitive to residual O_2 levels than the PM.

Conclusion

This micro-perforated film is suitable of use in a low O_2 mother pack system with LD steaks provided O_2 scavengers are used. This system is not suitable for the SM or PM steaks. However, PM steaks can be stored successfully if the perforations on the film remain covered during packing and storage. SM steaks are more sensitive to residual O_2 than PM steaks.

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Table 2: Mean CIELab Saturation for the LD steaks at each display time (following storage under various treatments).

	Treatment No									
Display time / h	Mother Pack 1	Mother Pack 2	Mother Pack 3	Mother Pack 4	No 5 (Tape with scav)	No 6 (Tape, no scav)	No 7 High O_2	Control	SED	Significance
4	21.0^{cd}	19.4^{d}	15.3^{e}	16.4^{e}	21.8^{c}	17.0^{e}	29.7^{a}	26.4^{b}	0.920	P<0.001
24h	22.8^{bc}	20.7^{cd}	16.8^{e}	18.6^{de}	23.9^{b}	18.9^{de}	29.0^{a}	25.2^{b}	1.551	P<0.001
48	21.8^{bc}	22.0^{bc}	16.8^{de}	19.1^{de}	21.7^{bc}	19.8^{cd}	27.3^{a}	23.8^{b}	1.204	P<0.001
72	21.5^{b}	21.9^{b}	18.1^{c}	18.7^{c}	22.5^{b}	18.96^{c}	26.0^{a}	22.4^{b}	1.0	P<0.001
96	22.0^{bc}	19.8^{bcd}	18.0^{d}	19.0^{cd}	22.7^{b}	20.3^{bcd}	26^{a}	20.3^{bcd}	1.506	P<0.001

[a-d] Treatments means are different (P<0.05) if they have no common superscript letter.

Table 3: Mean CIELab Saturation for the SM and PM steaks at each display time (following storage under various treatments).

	Treatment No						
Display time / h	Mother Pack 1	Mother Pack 4	No 5 (Tape with scav)	Control	No 4 High O_2 display	SED	Significance
	SM muscle						
4	16.733c	13.928d	16.535c	26.871b	29.266a	0.753	P<0.001
24	19.241b	14.9c	17.576b	24.416a	25.655a	1.7267	P< 0.001
48	18.639b	15.455c	18.748b	21.503ab	24.668a	1.927	P<0.01
72	15.230c	14.649c	18.742b	20.067b	23.357a	1.179	P<0.001
96	14.424	13.615	16.993	17.641	20.871	2.204	NS
	PM muscle						
4	16.067c	14.309c	22.106b	24.911b	28.797a	1.5641	P<0.001
24	17.324b	14.474c	16.420b	22.149a	22.666a	2.132	P<0.05
48	15.038b	16.554b	14.987b	17.99b	24.888a	2.4055	P<0.05
72	14.955b	12.218b	13.670b	16.033b	20.581a	1.93	P<0.05
96	13.888b	11.165c	13.811b	14.995b	21.489a	1.0125	P<0.001

[a-d] Treatments means are different (P<0.05) if they have no common superscript letter.

Reference

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