THE RATE OF OXYGEN ABSORPTION OF FOUR COMMERCIALLY AVAILABLE OXYGEN SCAVENGERS AT REFRIGERATED TEMPERATURES

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Background

The colour of beef steaks is an important motivating factor in meat purchasing. A bright red colour is associated with superior quality by customers. The gaseous atmosphere in which the steaks are stored is critical to colour acceptability. MAP packaging equipment may reduce the residual oxygen in packs to 1% (Gill, 1991). However, the rate of oxidation of myoglobin to metmyoglobin increases with decreasing oxygen pressure (Renerre, 1990), Rousset and Renerre (1990) have shown that residual oxygen levels of 0.3 - 0.4% result in oxidation of myoglobin to metmyoglobin and the discolouration of meat. For optimum colour retention anoxic conditions (oxygen concentration less than 0.1%) need to be established rapidly in MAP packs. This may be achieved through the use of oxygen scavengers. The rate of oxygen absorption at room temperature (20ºC) in air of oxygen scavengers is freely available from manufacturers but it is acknowledged that the rate of absorption at room temperature is much faster than that at refrigerated temperatures, as the reaction mechanism is an exothermic one.

Objective

The objective of this study was to determine the oxygen consumption rate of oxygen scavengers at refrigerated temperatures.

Materials and Methods

Oxygen scavengers:

Four commercially available oxygen scavengers were used in this study: Ageless SS200E (Mitsubishi Corporation, Japan), Atco® HV210 (Standa Industrie, France), Desiccare O_2-busters® FT-200 (Desiccare, Inc. Pomona, CA, USA) and Freshpax™ R200 (Multiform Dessicants Inc., Buffalo, NY, USA).

Preparation of Samples:

Individual oxygen scavengers were placed in 300mm X 300mm bags (20/70 PA/PE) with an oxygen transmission rate of 40-50cm^3/m^2 at 1 atm, 23ºC, and 75% r.h. The bags were triple vacuum and gas flushed using an A300 CVP packaging machine (CVP Systems Ltd., England). Initial oxygen concentrations were 1, 2, 6, 12 and 22% oxygen. In all experiments the standard deviation associated with initial oxygen concentration was less then 5%. The bags were stored at 3 ± 0.5ºC. The pack atmosphere was sampled hourly for the first 8 hours and at 16, 20 and 24 hours. The samples were taken using a 60ml gas tight syringe and by insertion of a needle into the pack. The treatments were carried out in triplicate.

The gas samples were analysed using a gas chromatograph (Gow-Mac Spectra 250, Gow-Mac Instrument Company, Ireland). The equipment was calibrated using 40% CO_2, 5% O_2 and the balance N_2 (BOC Gases Ireland Ltd.) for scavengers packed at 1, 2 and 6% oxygen, and 40% CO_2, 20% O_2 and the balance N_2 (Air Products Ireland Ltd.) for scavengers packed at 12 and 22% oxygen.

Measurement of pouch volume:

The volume of the pouch was measured using the method of displacement. A container of known volume (0.0147m^3) was filled with pearl barley and weighed (a). The factor F was determined by dividing the volume of the container by the weight of the pearl barley. The container was emptied and a gas filled pouch was placed in it. The container was then filled with pearl barley and weighed (b). The volume of the pouch was determined by using the formula: $(a – b) * F$.

The data were analysed using one way classification ANOVA (Systat version 5.0, Systat, Inc.)

Results and Discussion

The average volume of the pouches was determined to be 22.4cc ± 1.4cc:

The oxygen absorption rate of Atco scavengers was significantly higher ($p < 0.001$) than the other scavengers at all oxygen concentrations and most storage times (figures 1-5). Differences between the other three brands were generally not significant. Two main exceptions were at 1% oxygen concentration where the higher consumption rate of Atco scavengers was not significant up to 4 hours storage and at 24 hours, and at 22% oxygen concentration where Ageless scavengers had a higher consumption rate over 24 hours than Desiccare and Freshpax. The oxygen consumption rate increased as the initial oxygen consumption increased so that at any given storage time the four brands of scavenger recorded their highest absorption rate at either 12 or 22% oxygen.

All oxygen scavengers had a capacity of 200cc with the exception of Atco, which had a capacity of 210cc. The purpose of the scavenger is to reduce the level of oxygen within the packs to below the critical level of 0.1% oxygen, the level above which metmyoglobin formation occurs. At a 1% initial oxygen concentration none of the scavengers reduced the oxygen below the critical level, however Atco scavengers almost acquired it, achieving 0.13% from 1.01% in 24 hours, which was the equivalent to absorbing 22cc of oxygen in 24 hours.

Gill and McGinnis (1995) and Tewari *et al.*, (2002) suggested that there is a significant variation in the rate of oxygen absorption by individual scavengers of the same type. In this study we found no differences between replications for Atco HV210, Ageless SS200E and Desiccare FT-200 scavengers (table 1). However for Freshpax 200R there was a significant variation between repetitions ($P < 0.05$). This may indicate differences between individual scavengers of this type.

Conclusions

Of the four brands of oxygen scavengers examined Atco scavengers had a higher oxygen consumption rate at all oxygen concentrations. The oxygen consumption rate increased as the initial oxygen concentration increased. No significant variation was found between the performance of scavengers of the same type, with the exception of Freshpax scavengers ($p<0.05$).

References

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Acknowledgements

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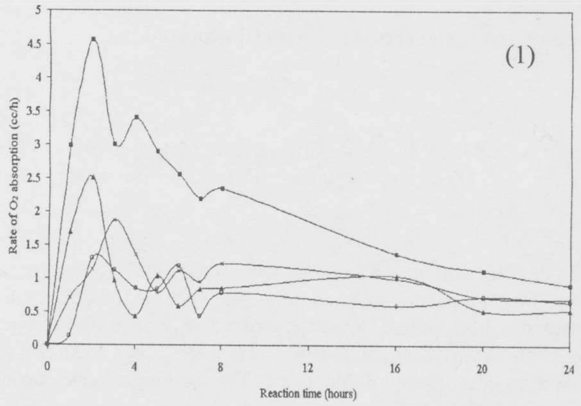
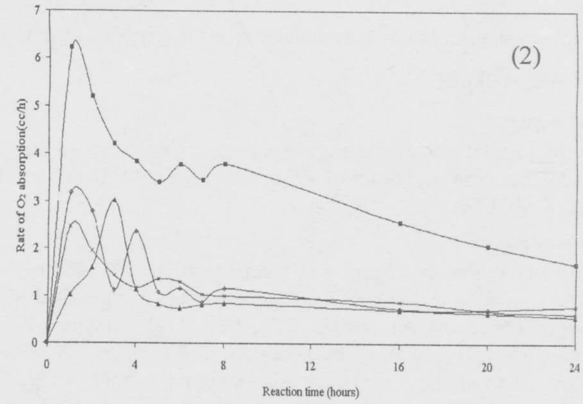
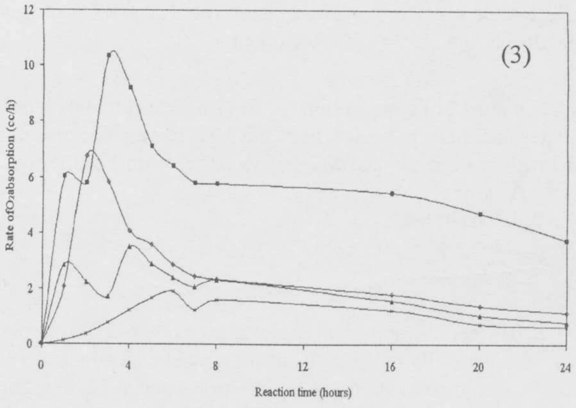
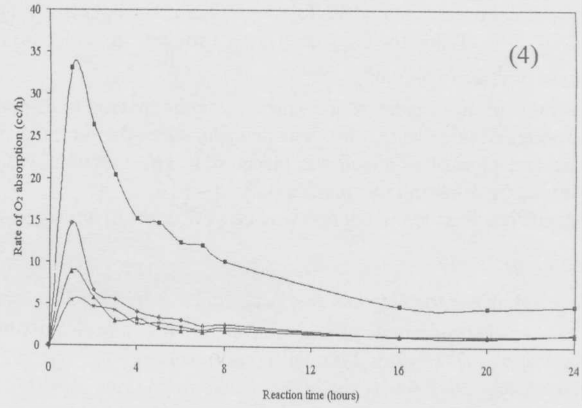
Figures 1- 5: The rate of oxygen absorption of scavengers at 1, 2, 6, 12 and 22% respectively.









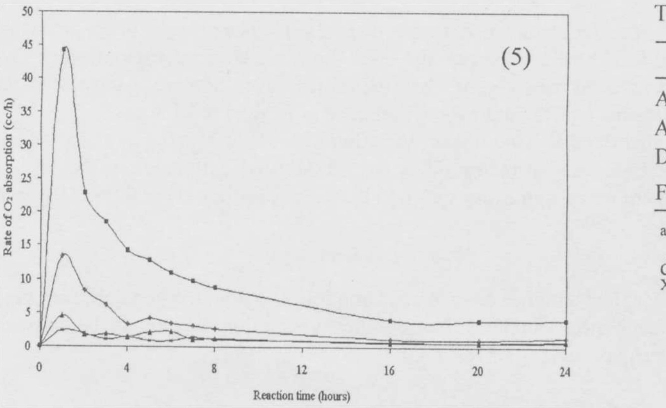


Table 1: Differences between replicates

	xNo.	Rep 1	Rep 2	Rep 3	SED	Sign
Ageless SS200E	165	2.394	3.150	3.026	0.634	ns
Atco HV210	163	8.490	8.319	7.892	1.626	ns
Desiccare FT-200	165	1.660	2.108	1.578	0.362	ns
Freshpax R200	165	0.947[b]	1.775[a]	1.940[a]	0.366	*

[a,b]Means on the same line not bearing common superscripts differ significantly ($p<0.05$)
[x]Total number of scavengers used.