Effect of High O_2 and N_2 Atmospheres on Strawberry Quality

D. Stewart
Unit of Plant Biochemistry, Department of Cellular and Environmental Physiology
Scottish Crop Research Institute, Dundee, DD2 5DA, Scotland, UK d.stewart@scri.sari.ac.uk

Scottish Crop Research Institute

Introduction

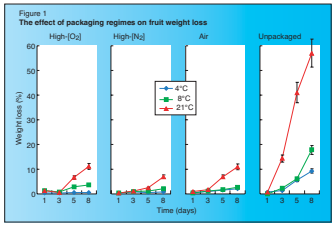
Soft fruit, in particular strawberries and raspberries, are characterized by a short shelf-life (2-3 days) normally terminated by *Botrytis cinerea* infection. Strategies to extend shelf-life can be long term, such as breeding new resistant varieties, or short term via post-harvest manipulations, such as storage in a controlled and/or modified atmosphere. Various gas mixtures have been reported for soft fruit but the effects of high $[O_2]$ (>50%) on fruit and vegetables are only now being explored. Here the preliminary results of the effect of high $[O_2]$ and $[N_2]$ atmospheres on strawberry quality are presented.

Experimental

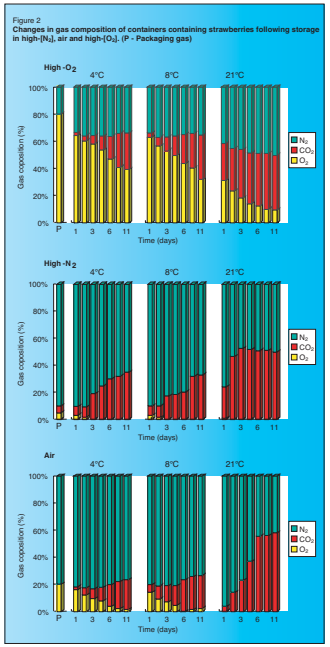
Strawberries (*Fragaria ananassa*. cv Symphony) were picked directly into plastic containers during (a wet) July-August. The fruit were packaged using a CVP Systems, double flushing, A-300 packager, impermeable polypropylene film (OPP-1) and three gas mixtures; 20% O_2: 80% N_2 (air), 5 % O_2: 5% CO_2: 90% N_2 (high-$[N_2]$) and 80% O_2: 20% N_2 (high-$[O_2]$). Test fruit was stored at 4, 8 and 21°C. Package gas composition and fruit weight loss, firmness and the activity of selected cell wall hydrolases were determined.

Results

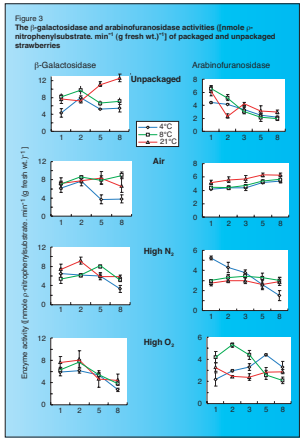
Packaging had a distinct effect on weight loss (Fig. 1) especially if stored at 21°C. The three packages produced broadly similar reductions in weight loss with, perhaps, air-packaging giving the smallest reduction. At 4 and 8°C there was little to distinguish between them.

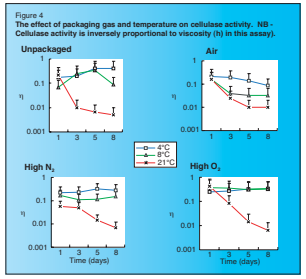


Temperature dependency was evident in the packaged gas compositions (Fig. 2) with CO_2 levels greatest in the containers stored at 21°C reflecting the increased respiration rate. In all packaged containers the O_2 levels reduce immediately (0-1 days) and in the case of those packaged in high-$[N_2]$ there was no detectable O_2 after 1 day at 21°C and 3 days at 4 and 8°C. Fruit packaged in high-$[O_2]$ experienced a steady reduction O_2 levels at 4 and 8°C but at 21°C this was preceded by a rapid respiration burst over days 0-1. These O_2 reduction were accompanied by a concomitant increase in CO_2.



β-Galactosidase (β-Gal), arabinofuranosidase (Arab) and cellulase (Cx) are known to be important in the soft fruit ripening processes, with β-Gal and Arab activities preceding extensive pectin solubilization. As before storage at reduced temperature was better resulting in reduced enzyme activities (Fig. 3). Storage in high-$[N_2]$ seemed to perform best for both β-Gal and Arab during extended storage (8-11 days). However there is little difference between the storage regimes in the initial stages of storage.





Cx activities were distinctly reduced at 4 and 8°C. However, high-$[O_2]$ packaged fruit exhibited no difference in Cx activities either between these two storage temperatures or throughout the period of storage. This is significant since cellulose, the principal structural polysaccharides in plant cell walls, and its degradation by Cx has been implicated as a factor in determining varietal differences in raspberry firmness. Firmness measurements of the packaged fruit indicated that at all temperatures and sampling periods that the fruit stored in high $[O_2]$ were the firmest (Table 1).

Table 1
Effect of packaging gas and temperature on fruit firmness.

	Air			High-$[N_2]$			High-$[O_2]$		
Time (days)	4.0°C	8.0°C	21.0°C	4.0°C	8.0°C	21.0°C	4.0°C	8.0°C	21.0°C
1.0	*****	*****	***	*****	*****	***	*****	*****	***
2.0	*****	*****	*	*****	*****	*	*****	*****	**
3.0	*****	****	*	****	****	*	*****	*****	**/*
4.0	*****	****	*	****	***	*	*****	*****	*
6.0	****	****	pulp	***	***	pulp	*****	***	*
8.0	****	***	pulp	***	**	pulp	*****	***	pulp
11.0	***	**	pulp	**	**	pulp	****	*	pulp
30.0	***/**	**	pulp	*	*	pulp	****	*	pulp

***** → * : Decreasing firmness

Conclusions

- Soft fruit benefit from storage in combined high $[O_2]$ and low temperature.
- Weight loss during storage at low temperature is low
- Cell wall hydrolytic enzymes show no significant increase during storage (0-14 days).
- Fruit firmness is maintained
- Colour and quality is maintained even over prolonged storage periods (40days, Figure 5)

Figure 5
Unpackaged and high-$[O_2]$ packaged strawberries after storage for 40 days at 4°C.

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