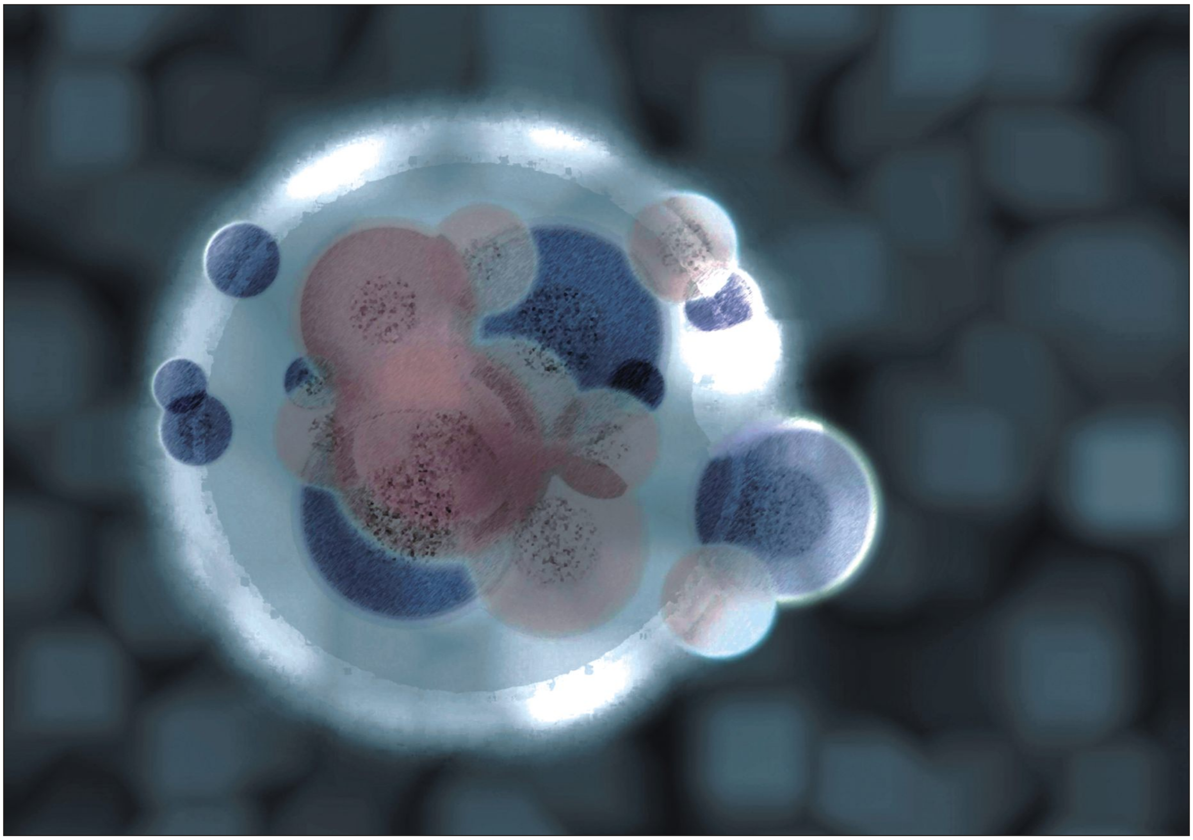

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Effect of Scuffing Damage and Curing on Diffusion Rate of CO_2 Through Citrus Fruit Peel

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Abstract: These studies were initiated to observe the effect of curing on the shelf life of damaged citrus fruits by reducing diffusion rate of CO_2. The damaged peel had a higher diffusion rate of CO_2 than undamaged fruit peel before curing. The effect of curing on peel was that the diffusion rate of CO_2 through damaged and undamaged peel was reduced after curing. The peel of cured fruits did not show any change in diffusion rate of CO_2 after 30 days of storage. Curing could be useful to reduce respiration/exchange of gases and in extending the storage life of damaged citrus fruit.

Key words: Citrus fruits, damage, curing, CO_2 diffusion, and shelf life.

Introduction

Most of the citrus fruits are spoiled during storage due to damage to the skin during harvesting and handling and thus their shelf life is reduced which effect marketing. Exchange of gases is directly concerned with fruit deterioration and if this process is reduced, the shelf life of the product can be increased. Curing is a most useful technique which reduces the diffusion rate of gases through peel of the fruit which in turn reduce the rate of respiration and this helps to store the fruits for longer times. Previous work also proved that if diffusion of gases was controlled, it reduced water loss, hence storage life can enhance as reported by Ben-Yehoshua (1969), Eaks (1961) and Kaufmann (1970).

This project was carried out to test the effect of damage and curing on the permeability of citrus fruit peel to gases (CO_2 and O_2) in order to test whether the curing process could reduce permeability and thus reducing the rate of deterioration hence extension of shelf life.

Materials and Methods

The present project was conducted in Silsoe College Silsoe Cranfield University Bedford Mk45 4DT U.K. during 1998-1999. Clementine mandarins produced in Spain and obtained from a U.K commercial source were used. Some fruits were damaged by scraping the surface with abrasive paper and then washed with distilled water. The diffusion rate of CO_2 concentration through fruit peel was measured before curing, after curing at 35°C with 95-98% RH for 48 hours and after subsequent storage at 5°C with 95% RH for 30 days.

37 mm diameter discs from scraped and unscraped citrus fruit peel were made. These discs were then fixed in the holes of the central plate of the equipment. The volume of the cylinder on each side was 700 cc. 35 cc of CO_2 were injected into one side to make 5% CO_2 concentration. The diffusion rate of CO_2 concentration was calculated by measuring the concentration of CO_2 on both sides of the disc of fruit peel after 24 hours. CO_2 concentrations were measured using a Carlo-Erba GC 8000 gas chromatography fitted with a hot wire detector. The diffusion rate of CO_2 concentrations was calculated by measuring the amount of CO_2 that passed through the fruit peel, based on (CO_2 ml cm^{-2} hou^{-1}).

The experiment was a completely randomized factorial design (2 levels of damage x 3 time periods) replicated four times.

Results and Discussion

The effects of scuffing damage and curing on the diffusion rate of CO_2 through Clementine mandarin fruit peel were as follows:

Diffusion rate of CO_2 concentrations: The results regarding the diffusion rate of CO_2 as affected by damage levels and curing indicate that the effects of damage and intervals were significant and interaction between damage and intervals were non-significant. The diffusion rate of CO_2 was higher in damaged fruit peel than in undamaged fruit peel, where the diffusion rate was lower. Computations made in this study showed that resistance to CO_2 diffusion declined in damaged fruit peel compared to undamaged fruit peel. As regards the surface of the fruit peel, if the fruit peel is damaged the diffusion rate of CO_2 will increase. The tissues of the fruit peel became softer due to damage which increased the diffusion rate of CO_2. In previous work it was shown that rough handling increased the respiration and moisture loss of citrus fruit peel (Eaks, 1961).

The diffusion rate of CO_2 was significantly higher in fruit peel before curing. After curing and subsequent storage for 30 days, where the diffusion rate of CO_2 decreased. The diffusion rate of CO_2 through fruit peel was similar after curing for 48 hours and after 30 days storage. The resistance of fruit peel to diffusion of CO_2 rose after curing. This increase in resistance was due to lignin formation in the tissues of the fruit peel. Due to this the tissues of the cured fruit peel remained firmer and the tissues of the fruit peel did not loss their integrity, which caused a rise in resistance to gas diffusion. This study showed that citrus fruit peel increased in resistance after curing, which was a result of the hardening of the tissues/drying of the peel. Such observation had been made earlier by Ben- Yehoshua diffusion. The flavedo portion of the fruit peel was the main site of resistance to gas diffusion. If it is damaged the gas diffusion will increase (Fig. 1-3).

These results suggest that part of the curing process is the reduction of the diffusion rate of CO_2. The diffusion rate of

Plate 1: Diffusion testing apparatus

CO_2 was injected into left side of the apparatus and the diffusion rate of CO_2 was measured from the right side of the apparatus or CO_2 was injected towards the inner side (white/albedo side) of the fruit peel and the diffusion rate of CO_2 was measured from the outer side (coloured/flavedo side)

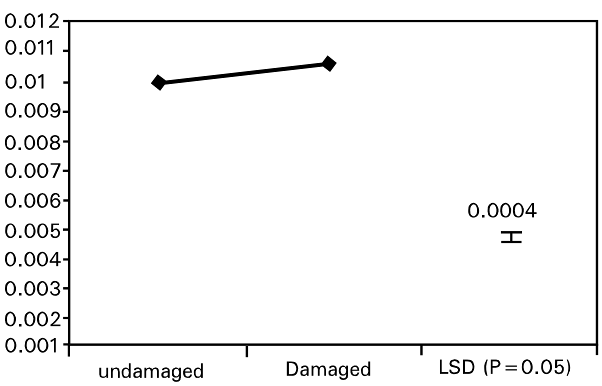

Fig. 1: Effect of damage on the diffusion rate of CO_2 and figures are the means of two damage levels i.e. damaged and undamaged

of the fruit peel indicated that as the fruit peel/cell wall dries the permeability to gas diffusion declines. Hardening of the tissues of fruit peel after curing caused a rise in resistance to

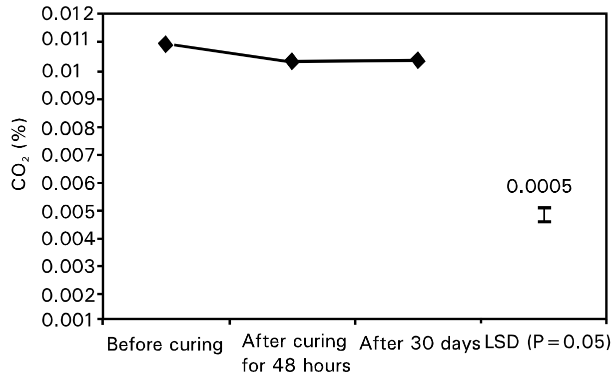

Fig. 2: Effect of curing on the diffusion rate of CO_2 and the figure are the means of three curing levels, i.e. before curing, after curing for 48 hours and after subsequent storage of 30 days

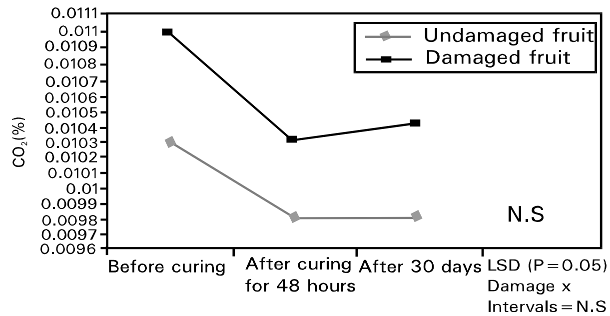

Fig. 3: Effect of scuffing damage and curing on the diffusion rate of CO_2 concentrations (CO_2 ml cm^{-2} $hour^{-1}$) in Clementine mandarin fruit peel before curing, after curing at 35°C with 95-98% RH for 48 hours and after subsequent storage at 5°C with 95% RH for 30 days

gas CO_2 for both the damaged and undamaged fruit peel was shown to be reduced after curing. Additionally there was no evidence that the curing of the peel altered the diffusion rate of CO_2 after the longer storage time of thirty days.

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