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Effect of Washing and Seal Packaging on Scuffing Damaged Citrus Fruit Quality

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ABSTRACT

These studies were carried out to evaluate the effect of washing on the shelf life of damaged citrus fruit quality. The unwashed fruits had higher weight loss than washed fruits, and all the sealed fruits had lower weight loss than unwrapped fruit. Sealed and washed fruits maintained the initial deformation and firmness and had good appearance while the unwashed and unwrapped fruits became softer. The total soluble solids (TSS) were not affected by washing and sealing but the unwrapped fruits had lower acidity and higher TSS/acid ratio than in sealed fruits. Higher O_2 and lower CO_2 contents were recorded in washed and sealed fruit bags than in unwashed and sealed fruit bags.

Key Words: Citrus fruit; Curing; Damage; Washing; Packing; Shelf life

INTRODUCTION

The usual practice of washing of citrus fruits after harvest is an effective method for removing spores from the surface of the fruit. Barkai-Golan (1966) reported that peel was almost free from spores (especially Penicillium) after the fruits were washed in a bath of Sodium O-phenylphenate (SSOP). A special case was the washing of Robin tangerine prior to degreening, which reduced anthracnose decay due to mechanical removal of *Colletotrichum appressoria* from the surface of the fruit (Brown, 1975).

This paper describes the effects of washing and seal packaging on scuffing damaged citrus fruit quality.

MATERIALS AND METHODS

These studies were conducted on mandarin fruit in Silsoe College, Silsoe Cranfield University Bedford MK 45 4DT U.K. during 1997-98. Ortanique mandarins produced in Spain and obtained from a U.K commercial source were used. Scraping the surface with abrasive paper damaged the fruits and then some were washed with distilled water and others were not washed. Some fruits were seal-packed with polyethylene film (120 gauge) and others were not seal-packed. After this the fruits were cured at 35°C with 95-98% RH for 48 h, then stored at 5°C with 95% RH for 30 days.

The fruits were analysed after 30 days of storage. The following parameters i.e. weight loss percentage, deformation, firmness TSS, acidity and TSS/acid ratio were measured. The O_2 and CO_2 content of the sealed-packed polyethylene envelopes were measured using gas chromatography before curing, after curing at 35°C with 95-98% RH for 48 h and subsequent storage at 5°C with 95% RH for 30 days at the end of the experiment. The experiment was a completely randomized factorial design (2 washing x 2 sealing) replicated four times.

RESULTS AND DISCUSSION

Weight loss percentage. The effect of seal packaging on weight loss percentage was that all the sealed fruits had lower weight loss than unwrapped fruits (Table I). Transpiration is the major process leading to weight loss. Therefore the unwrapped fruits were more affected than sealed fruits. The unwrapped fruits produced higher rate of transpiration and evaporation, which resulted in decreased weight due to loss of moisture. The unwashed fruits had higher weight loss than washed fruits. The damaged part of the unwashed fruits bruised and became softer in the presence of peel oil/oleocellosis. Due to this, the unwashed damaged part of the fruits exhibited higher weight loss probably because the damaged skin increased transpiration/evaporation and respiration and thus increased the weight loss of the fruit. Lower weight loss was noted in washed fruits because the fruits did not show bruising/softening and due to this fruits did not allow such a high level of transpiration, evaporation and respiration. Kawada and Kitagawa (1994) reported that the pre-storage curing and storage temperature are important for minimizing fruit injury and decay. Weight loss after 15 days storage at 20°C with 70% RH was lower in sealed fruits than those stored unwrapped (Martinez-Javega *et al.*, 1991). High temperature (20°C) pretreatment decreased weight loss during storage for up to three months in Satsuma mandarins (Nam & Kweon, 1989).

Deformation and firmness. The sealed fruits had lower deformation and higher firmness than unwrapped fruit (Table I). The sealed fruits decreased the evaporation/transpiration and respiration. The moisture of

Table I. Effects of washing and seal packaging (120 gauge polyethylene film) on the quality of scuffing damaged Ortanique mandarin fruit after curing for 48 hours at 35°C with 95-98% RH and subsequent storage at 5°C with 95% RH for 30 days

Characters	Sealed in Polyethylene Film		Without polyethylene Film		LSD (P=0.05)
	Washed	Unwashed	Washed	Unwashed	
Weight loss percentage	0.77	1.41	6.72	7.45	0.48
Deformation at 5N (undamaged part)	0.80	0.83	1.45	1.55	0.09
Deformation at 5N (damaged part)	0.82	0.98	1.47	1.72	0.06
Deformation at 5N (undamaged +damaged part)	0.81	0.92	1.44	1.64	0.08
Deformation at skin failure (undamaged part)	3.69	3.75	5.30	5.45	0.20
Deformation at skin failure (damaged part)	3.78	4.08	5.38	5.67	0.12
Deformation at skin failure (undamaged damaged part)	3.77	3.98	5.34	5.56	0.07
Firmness at skin failure (undamaged part)	5.19	5.11	4.21	4.10	0.12
Firmness at skin failure (damaged part)	5.16	5.01	4.19	4.02	0.08
Firmness at skin failure (undamaged +damaged part)	5.30	5.11	4.15	4.12	0.08
TSS	14.85	14.83	14.80	14.78	NS
Acidity	1.22	1.21	1.17	1.15	0.03
TSS/acid ratio	12.17	12.27	12.65	12.85	0.49

the fruits was preserved which is a prerequisite for fruit firmness. In unwrapped fruits, the deformation was higher and firmness was lower due to higher loss of moisture and respiration.

The washed fruits produced less deformation and more firmness and the fruits remained completely firm due to higher moisture content within the fruit, and due to no bruising/decay symptoms. The unwashed fruits showed higher deformation and lower firmness due to greater loss of moisture. The damaged part of the fruit was completely bruised in the presence of peel oil/oleocellosiss and it is possible that due to this the damaged part increased the loss of moisture and respiration.

Sealed and washed fruits maintained the initial deformation and firmness and had good appearance while the unwashed fruit became softer. The control fruits (oranges) were the softest, while seal packaged fruit exhibited the best firmness (Martinez-Javega *et al*., 1991).

Total soluble solids (TSS), acidity and TSS/acid ratio. The sealed fruits showed slightly higher TSS values than unwrapped fruits (Table I). This was may be because the sealed fruits reduced the loss of moisture and respiration. The unwrapped fruit increased the moisture loss and respiration and due to this the values of TSS slightly decreased.

Higher acidity and lower TSS/acid ratio were recorded in sealed fruits than unwrapped fruits. The seal packaging did not reduce the water content of the fruit by less evaporation and respiration, so the fruits showed the more acidity and less TSS/acid ratio. The unwrapped fruit had less acidity and more TSS/acid ratio because the unwrapped fruits lost more acidity due to higher loss of moisture. The increase in TSS/acid ratio was because the fruits presented less acidity, which increased this ratio. The reduction in acidity of unwrapped fruits may be due to the decrease in citric acid and because the organic acids may be utilized as respiratory substrates at the higher rate of respiration. Juice and ascorbic acid content decreased with storage life (Rana *et al*., 1992). In stored oranges, acids decreased faster than sugars so that the fruit was predicted to be slightly sweeter (Samson, 1986). Titratable acidity and ascorbic acid content of sweet oranges have been shown to decrease during storage (Chattopadhyay *et al*., 1992). Fruits conditioned at 15°C or above prior to cold storage improved the quality of some citrus species and cultivars (Murata & Yamawaki, 1992).

Gases. The effect of washing and intervals of scuffing damaged Ortanique mandarin fruits sealed in 120 gauge polyethylene film bags on CO_2 and O_2 contents are given in Figs. 1, 2 and 3. The effects of washing and intervals and interaction between washing and intervals were significant (p=0.05).

The effect of washing was to alter the CO_2 and O_2 content of the atmospheres of Ortanique mandarin fruit bags. Higher O_2 and lower CO_2 contents were recorded in washed and sealed fruit bags than in unwashed and sealed fruit bags where O_2 levels decreased and CO_2 levels

Fig. 1. Effects of washing and seal packaging of scuffing damaged on Ortanique mandarin fruits in 120 gauge polyethylene film bags on their O_2 and CO_2 concentrations before curing for 48 h at 35°C with 95-98% RH and after subsequent storage at 5°C with 95% RH for 30 days

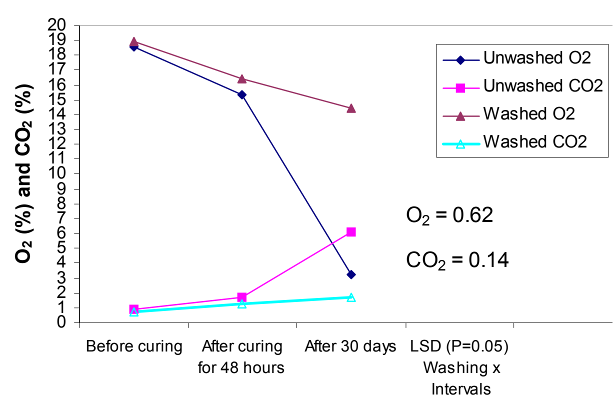


Fig. 2. Effect of intervals on O_2 and CO_2; Values are the means of two washed and unwashed treatments

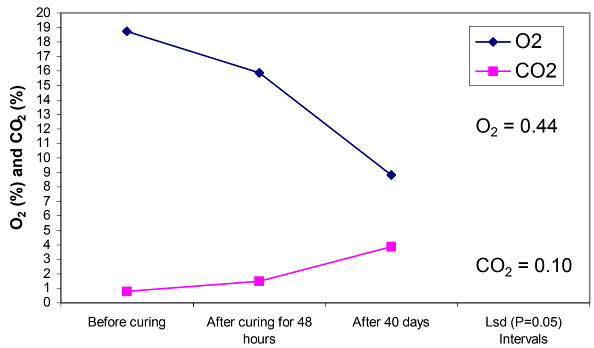
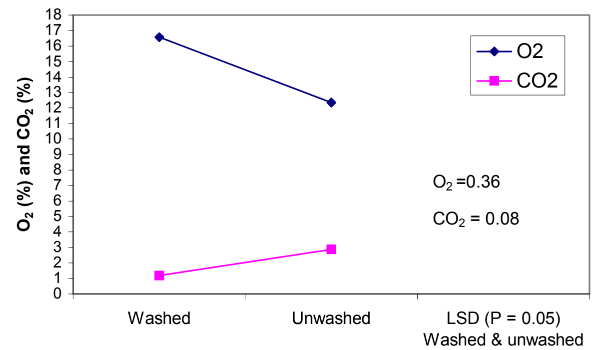


Fig. 3. Effect of washing on O_2 and CO_2 ; Values are the means of two washed and unwashed treatments



increased after 30 days. The damaged part of the unwashed and sealed fruit bruised and became softer in the presence of peel oil/oleocellosis. It is possible that the damaged part of the unwashed fruit increased respiration because CO_2 increased and O_2 decreased.

The effect of intervals on O_2 and CO_2 content was to significantly decrease O_2 and increase CO_2 content at curing temperature 35°C. The respiratory activity increased at high temperature: CO_2 levels increased and O_2 levels decreased but after curing the respiratory activity decreased due to low temperature and curing effect.

The effect of interaction between washing and intervals significantly increased CO_2 and decreased O_2 content in unwashed and sealed fruit bags compared to other treatment combinations where O_2 levels were higher and CO_2 levels were lower. It is possible that tissues were damaged in the presence of peel oil/oleocellosis and due to this respiration increased, which increased CO_2 and decreased O_2 levels. The CO_2 production increased as symptoms of the disorders occurred on the peel of the unwashed fruit. The CA conditions for maintaining quality in citrus fruits appear to be about 0 to 1% CO_2 and 10 –15% O_2 (Ookagaki & Manago, 1977).

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