Indian J. Hort. 69(3), September 2012: 404-408

Effect of heat shrinkable films on storability of kiwifruits under ambient conditions

R.R. Sharma*, R.K. Pal and Vishal Rana**
Division of Post Harvest Technology, Indian Agricultural Research Institute, New Delhi 110 012

ABSTRACT

A study was conducted to observe the effect of different types of heat shrinkable films on shelf-life and quality of kiwifruits stored under ambient conditions. Fully mature kiwifruits of cv. Allison were shrink-wrapped in three heat shrinkable films like Cryovac (9 µ), polyolefin (13 µ) and LDPE (25 µ) and unwrapped fruits served as control. The fruits stored under ambient conditions (22-28°C & 62-68% RH) up to 18 days. Observations on PLW, decay loss, firmness, TSS, titratable acidity, ascorbic acid content, respiration rate and ethylene evolution rate were recorded at 3 days regular interval. Results revealed that all heat shrinkable films influenced PLW, decay loss, fruit firmness, and quality parameters of 'Allison' kiwifruit during storage. However, best results were obtained with Cryovac film (9 µ), which exhibited least mean PLW (2.3%) and mean decay loss (2.8%), and fruit with moderately good TSS and higher ascorbic acid content. The respiration and ethylene evolution rates were also influenced by heat shrinkable films with minimum respiration as well ethylene evolution rate recorded in fruits wrapped in Cryovac film. All the heat shrinkable films delayed ripening of kiwifruit, but the effect rendered by Cryovac film was much more significant. The study indicated that kiwifruits could be stored up to 18 days when packed in Cryovac heat shrinkable films with least PLW and decay loss while maintaining the fruit quality.

Key words: Heat shrinkable film, decay loss, quality attributes, shelf-life, respiration rate, ethylene evolution.

INTRODUCTION

Kiwifruit (*Actinidia deliciosa* Chev.) is commercially cultivated in different countries of the world like New Zealand, United States of America, Italy, Chile and South Africa. However, its importance in India has been realized only in the last decade or so (Chattopadhyay, 6; Chauhan and Chandel, 7; Rathore and Pandey, 16). Now, there has been sizeable increase in its area and production in the states like Himachal Pradesh, J & K, Uttarakhand and NE region. Kiwifruit usually matures between last week of October to first week of November, depending upon the elevation, temperature and other climatic conditions. It is a typical climacteric fruit as it does not show any change for about a week at room temperature after harvesting (Chattopadhayay, 6). However, afterwards, there is a sharp increase in its respiration rate, which triggers ripening, thereby it deteriorates at a faster rate, thereby limiting its shelf life for about 3-4 days after ripening. Thus, there is an urgent need to develop protocol for extending its shelf life so as to make it available in the market for a longer period.

For extending shelf-life of horticultural produce, shrink-wrapping has been used in some fruits to reduce post harvest losses and to extend the availability (Anzueto and Rizvi, 2; Ben-Yehoshua 3, 4; Ladaniya and Singh, 11). An extension of shelf-life of an individual and tray-wrapped citrus fruits with heat shrinkable films has been reported (Ladaniya 9; Ladaniya and Singh, 11; Ladaniya *et al.*, 12). Sharma *et al.* (14) have reported enhancement in fruit quality of apple when shrink-wrapped individually and stored in Zero Energy Cool Chamber. However, no work has been reported on shrink-wrapping of kiwifruit. Hence, a study was conducted to evaluate the quality and shelf-life of kiwifruit wrapped in heat shrinkable films.

MATERIALS AND METHODS

Fully mature kiwifruits cv. Allison were harvested from the orchard of Department of Pomology and Orchard Management, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh), packed in CFB boxes and transported to IARI, New Delhi. After sorting and grading, 100 fruits each were individually shrink-wrapped in heat shrinkable films such as Cryovac (9 µ), polyolefin (13 µ) and LDPE (25 µ). Un-wrapped fruits served as control. The wrapped and un-wrapped kiwifruits were stored under ambient conditions (22-28°C & 62-68% RH) for 18 days. The experiment was laid out in completely randomized design (CRD) with four treatments having five replications per treatment. Observations on PLW (%), decay loss (%), firmness (N), and quality parameters like TSS, titratable acidity, ascorbic acid, respiration rate and ethylene evolution

*Corresponding author's E-mail: rrs_fht@rediffmail.com
**Deptt. of Pomology and Orchard Management, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan 173 230

rate were recorded at a regular interval of 3 days as per prescribed methods (AOAC, 1).

Fruit firmness was recorded by measuring firmness force with the help of Instron texture analyser and represented as N (Newton). Respiration rate of the fruits was determined by PBI Dansensor CO_2/O_2 gas analyzer (Model ChakMate 9900) and represented as mg CO_2/kg/h. Ethylene evolution rate was determined by Hewlett Packard gas chromatograph model 5890 series II (Pal, 13). Six fruits were kept in air-tight chambers fitted with a specially designed adopter on the lid having a silicon rubber septum for withdrawal of gas samples. These chambers were incubated at room temperature for 2 h. One millilitre of gas sample was drawn with the help of Hamilton gas tight syringe and analyzed in gas chromatograph having 2 × 2m Porapak-N-column and Flame Ionization Detector. The temperature of the column, detector and injector were maintained at 60, 275 and 110°C, respectively. The flow of carrier gas (N_2) was 30 ml/min. Quantitative estimation of ethylene was done by using the external standard calibration gas of 105 ppm ethylene. After calculations, ethylene evolution rate was expressed as μlC_2H_4/kg/h. TSS (%) was recorded using hand refractometer. Acidity (%) was determined by titrating known amount of fruit juice with 0.1N NaOH solution. Ascorbic acid content (mg/100 g pulp) were also determined by following standard procedures (AOAC, 1). For recording all these parameters, five fruits were randomly selected from a single lot and replicated five times.

Data obtained for different parameters from both the years of study were pooled and subjected to analysis and differences among the treatments were compared by calculating critical difference (Gomez and Gomez, 8).

RESULTS AND DISCUSSION

The results revealed that all heat shrinkable films have significantly influenced the PLW and decay loss of kiwifruits under ambient conditions over unwrapped (control) fruits. Among films, Cryovac (9 μ) was the most effective in reducing the mean PLW (2.3%) and decay loss (2.8%) over unwrapped kiwifruits (10.7 and 8.7 per cent, respectively) (Table 1). Further, an increase in PLW and decay loss was observed with the increase in storage period from 3rd to 18th day (Table 1). Interestingly, PLW was as high as 12.5 per cent even on 12th day of storage in unwrapped kiwifruit, which increased to 18.2 per cent on 18th day. Similarly, decay loss was quite high in unwrapped kiwifruit (10.5%) on 15th day of storage, which increased to 12.2 per cent on 18th day of storage (Table 1). These observations suggest that heat shrinkable films were quite effective in reducing the PLW and decay loss in kiwifruit under ambient conditions. Reduction in PLW or decay loss may primarily be due to creation of modified atmosphere around the fruits by the shrinkable films and Cryovac films were most effective, primarily because these films are known to bring out effective reduction in PLW or decay in many fruits due to modified atmosphere created by gas permeability properties (Ben-Yehoshua, 4; Ben-Yehoshua *et al.*, 5). Moreover, lesser decay of kiwifruits in these films may be due to reduction in condensation by Cryovac films (Ben-Yehoshua *et al.*, 5). Ladaniya and Singh (11) and Ladaniya *et al.* (12) have also reported such trends in PLW and decay in citrus fruits following shrink-wrapping.

Results reveal that heat shrinkable films significantly influence fruit firmness (N), respiration and ethylene evolution rates of kiwifruits under ambient conditions. Shrink-wrapped fruits in either film had higher firmness than unwrapped fruits (Fig. 1a). Among different heat shrinkable films, kiwifruits wrapped in Cryovac films had higher firmness (21.4 N) than other films. Further, the firmness decreased with the increase in storage period. Similarly, decrease in firmness with the increase in storage is due to the fact that fruit started ripening as a result of which, cell wall

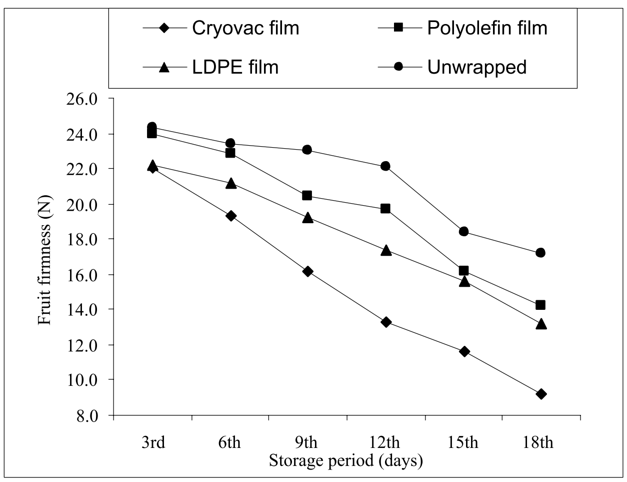
Table 1. Effect of heat shrinkable films on physiological loss in weight (%) and fruit decay (%) in kiwifruit cv. Allison under ambient conditions.

Heat shrinkable film	Days of storage											
	PLW (%)						Decay loss (%)					
	3	6	9	12	15	18	3	6	9	12	15	18
Cryovac (9 μ)	0.9	1.2	1.8	2.4	3.2	4.4	1.0	1.7	2.1	3.2	3.6	4.9
Polyolefin (13 μ)	1.2	2.5	3.4	3.8	4.3	5.9	1.4	2.1	3.6	4.7	5.1	6.2
LDPE (25 μ)	1.6	2.9	4.3	5.5	6.6	7.6	1.6	2.4	4.3	5.2	6.6	7.6
Unwrapped	3.3	5.2	9.6	12.5	15.3	18.2	4.3	5.2	9.3	9.9	10.5	12.2
$CD_{(0.05)}$	Film (F) = 0.3, days of storage (D) = 0.3, F × D = 1.2						Film (F) = 0.2, days of storage (D) = 0.4, F × D = 1.0					

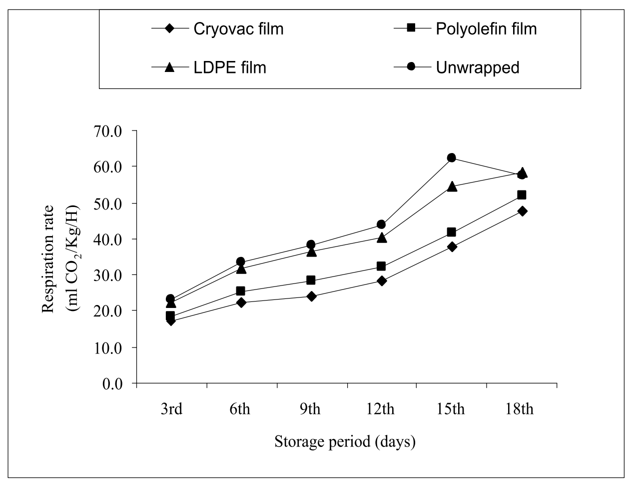
integration is disturbed, which lowered down the fruit texture during storage (Sharma *et al*., 14).

The respiration rate increased with increase in the storage period, although shrink-wrapped fruits showed lesser rates of respiration than unwrapped fruits with least respiration (29.5 mg CO_2/kg/h) rates in Cryovac film shrink-wrapped fruits (Fig. 1b). Interestingly, no ethylene was liberated by the fruits up to 3 days of storage, however, later its rate increased with the increase in storage period (Fig. 1c). Further, fruits wrapped in Cryovac films showed no ethylene liberation up to 9 days indicating that Cryovac film had significantly reduced both respiration and ethylene evolution rates in kiwifruit. Thus, lower rate of respiration and ethylene evolution in fruits wrapped in Cryovac films might have delayed the ripening and thereby maintained better texture during storage than other films and control (Fig. 1c). Unwrapped kiwifruits showed increase in ethylene evolution up to 15 days (43.2 µLC_2H_2/kg/h) and then declined to 37.5 µlC_2H_2/kg/h on 18 days, whereas fruits wrapped in other films showed increasing trend in ethylene evolution rate up to 18 days, although different films behaved differently in doing so primarily because they have different gas and water permeability (Ben-Yehoshua *et al*., 5).

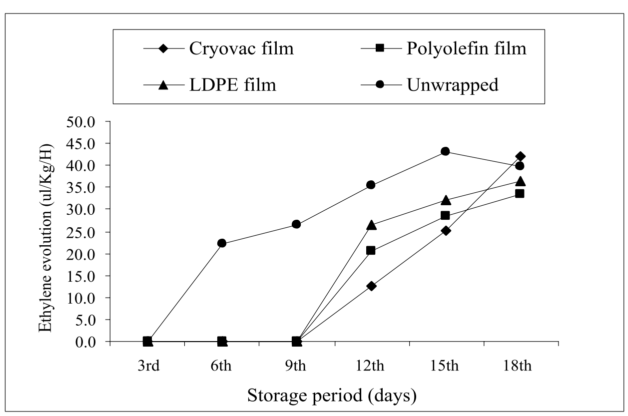
Heat shrinkable films significantly influenced the quality parameters like TSS and ascorbic acid under ambient conditions. Kiwifuits wrapped in Cryovac films showed steady increase in TSS from 3 days (6.2%) to 18 days (15.6%) of storage (Fig. 2a), whereas unwrapped fruits showed sharp increase in TSS from 6[th] day up to 15 days of storage, and then declined (14.6%) (Fig. 2a). Fruits wrapped in other films also showed the similar but less effective trend. Such effects of heat shrinkable films on TSS might be due to delay in the fruit ripening (Sharma *et al*., 14). Further, TSS



a. Fruit firmness



b. Respiration rate

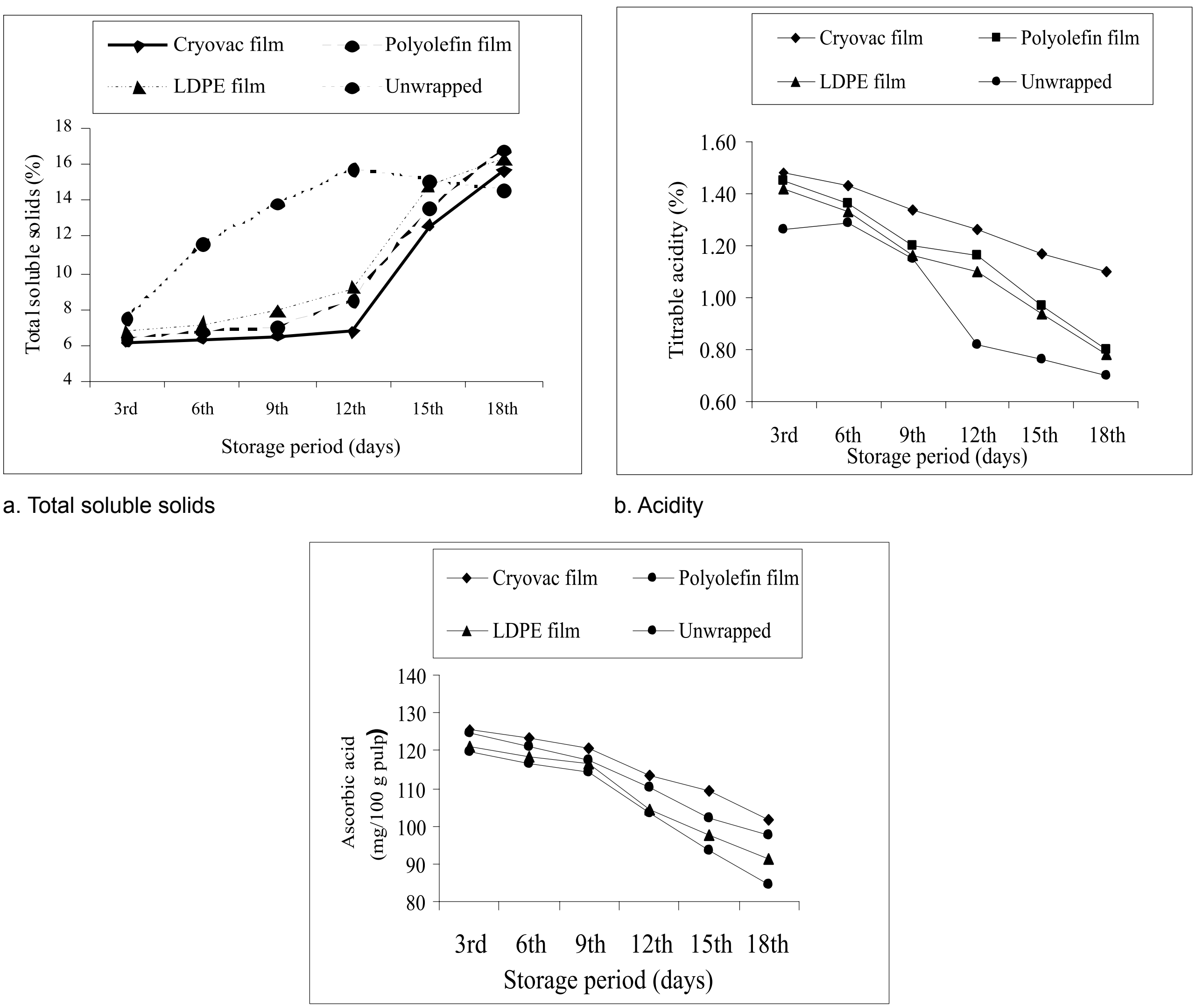


c. Ethylene evolution rate

Fig. 1. Effect of different heat shrinkable films on (a) fruit firmness (N), (b) respiration rate (mg CO_2 $kg^{-1}h^{-1}$) and ethylene evolution (µl C_2H_4 $kg^{-1}h^{-1}$) in kiwifruit cv. Allison under ambient conditions.

content increased with the increase in storage period from 3 days (6.7%) to 18 days (15.8%) of storage, which might be due to the fact that with the increase in storage period there is conversion of starch and other complex carbohydrates into simple sugars, thereby resulting in the increase in TSS with the storage period (Pandey *et al.*, 15). Ben-Yehoshua *et al.* (5) have also reported positive influence of heat shrinkable films on TSS in citrus fruits. Even LDPE films in Nagpur mandarin (Ladaniya, 10) and litchi (Semeerbabu *et al.*, 17) have also positive influence on TSS. Juice acidity showed declining trend over storage period but heat shrinkable films had no significant effect on it (Fig. 2b). Similarly, acidity declined over the period of storage but was not significantly influenced by the period, but fruits wrapped in Cryovac films retained significantly higher acidity at the end of 18th day of storage (1.3%) under ambient conditions (Fig. 2b). However, kiwifruits packed in Cryovac films have significantly higher content of ascorbic acid (115.6 mg/100 g pulp) than unwrapped fruits (105.2 mg/100 g pulp) (Fig. 2c). Such influence of heat shrinkable films on ascorbic acid content of citrus fruits have also been reported by Ladaniya (9), and Ladaniya and Singh (11).

On the basis of these studies, it can be concluded that Cryovac heat shrinkable film (9 μ) was the best for extending the shelf-life of kiwifruit for about a week, while maintaining fruit quality.



a. Total soluble solids

b. Acidity

c. Ascorbic acid

Fig. 2. Effect of different heat shrinkable films on (a) total soluble solids (%), (b) acidity (%) and ascorbic acid (mg/ 100 g pulp) in kiwifruit cv. Allison under ambient conditions.

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Received : February, 2011; Revised : March, 2012; Accepted : July, 2012