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Effect of different packaging films on shelf-life and quality of Daisy mandarin under ambient conditions

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ABSTRACT

The fruits of Daisy mandarin were harvested at dark orange colour satge and packed in paper moulded trays followed by wrapping with different packaging films, *viz*., heat shrinkable film (15 µ), cling (15 µ) and low density polyethylene (25 µ LDPE) film. After packaging, the fruits were stored under ambient conditions (18-20°C; 90-95% RH). The fruits were then evaluated for various quality attributes periodically. The in-package gaseous composition (O_2 and CO_2) in shrink film packed fruits was found to be at desired level, which resulted in maintenance of pleasant flavour of the fruits. On the other hand, LDPE film accumulated very high level of CO_2, which led to formation of fermenting odour and decay of fruits in the package. After 15 days of storage, shrink film helped in reducing the loss in weight (1.12%), firmness (7 lb force), decay incidence (0%) and maintained various qualities attributes like total soluble solids (11.8%), sugars (7.75%), acidity (0.46%) and ascorbic acid content (12.3 mg/100 g) of the fruits during shelf-life better than unwrapped control fruits where PLW (10.71%), firmness (4 lb force) and decay (5%) was recorded. The data revealed that shrink film proved quite effective in prolonging the shelf-life and maintaining the quality of Daisy mandarin fruits for 15 days compared to only 5 days in case of unpacked control.

Key words: Daisy mandarin, packaging films, quality, storage conditions.

INTRODUCTION

The Daisy mandarin (*Citrus reticulata* Blanco) is a cross of 'Fremont' and 'Fortune' mandarins. It was introduced in Punjab from USA to diversify "Kinnow", a leading mandarin grown in Punjab, which occupies more than 50 per cent of the total area under fruits. Another objective of introducing this fruit was to expand the market period of mandarin in Punjab from November to February. The harvesting time of Kinnow mandarin is limited to January and February months (Anon, 2). The fruits of Daisy mandarin ripen from 15 to 20th November and produce medium large fruit with an attractive dark orange peel. This mandarin has a potential to be a leading variety in the North-West Indian plains, because of its early ripening behavior having very attractive deep orange colour and good blend of TSS: acid ratio. Modified atmospheric packaging (MAP) is a new technology for postharvest handling of fruits that delays physiological processes in produce and thereby maintains the quality during storage. Packing of fruits in polymeric films creates modified atmospheric conditions around the produce inside the package allowing lower degree of control of gases and can interplay with physiological processes of commodity resulting in reduced rate of respiration, transpiration and other metabolic processes of fruits (Zagory and Kader, 15; Erkan and Wang, 4). Besides, reducing moisture losses and changing the O_2 and CO_2 levels, the polymeric films can also protect fruits from some damage, *e.g.* scuffing and bruising during handling and transport and possibility from some fungal infections. Hence, the present investigation was conducted to study the effect of different packaging films on storage life and quality of Daisy mandarin under ambient conditions (18-20°C & 65-70% RH).

MATERIALS AND METHODS

The present study was carried-out at Punjab Horticultural Postharvest Technology Centre, PAU, Ludhiana during 2012-13 and 2013-14. The fruits of Daisy mandarin were harvested when they attained dark orange colour. The bruised and diseased fruits were sorted-out and only healthy and uniform sized fruits were selected for the study. Before packing the fruits, they were properly washed in chlorinated water and dried under shade. Three types of commercially available packaging films, *viz.* heat shrinkable (15 µ), cling (15 µ) and low density polyethylene (LDPE, 25 µ) were used for packaging of fruits in paper moulded trays (22 cm × 13 cm) and tightly sealed with different packaging films. However, the shrink film wrapped packs were passed through a shrink wrapping machine (Model BS-450, Samrath Engineers, India) at 165ºC for 10 sec. Thereafter, the packed fruits as well as control (non-packed) fruits were stored under ambient conditions (18-20°C & 90-95% RH). The

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various physiological and biochemical attributes of the fruits were recorded at 5-day interval till 25 days.

The in-package gaseous composition (CO_2 and O_2 concentration) of sealed fruit package was monitored at periodic intervals with the help of portable Head Space Gas Analyzer (Model: GS 3/P, Make: Systech Instruments, U.K.). The physiological loss in weight (PLW) of stored fruit was calculated by subtracting final weight from the initial weight of the fruits and expressed in per cent. The fruit firmness was measured with the help of a penetrometer (Model FT- 327, USA) using 8 mm stainless steel probe and expressed in terms of pound force pressure (lb force). The overall organoleptic rating of the fruits was done by a panel of ten judges on the basis of external appearance of fruits, texture, taste, and flavour and overall quality rating was calculated making use of a 9-point hedonic scale (Amerine *et al.*, 1). The total soluble solids (TSS) of the fruit juice were determined using a hand refractometer. The total sugars, titratable acidity and vitamin-C were estimated as per standard procedures (AOAC, 3).

The experiment consisted of four treatments and five storage intervals that laid out in completely randomized design with three replications for each treatment and each storage interval. There were 60 trays and each tray contained six fruits. The data were pooled and analyzed for variance by using the SAS (V 9.3, SAS Institute Inc., Cary, NC, USA) package.

RESULTS AND DISCUSSION

During storage, a decrease in O_2 and an increase in CO_2 levels occurred for passive modified atmospheric packaging (MAP) in all the three films during storage under ambient conditions (Fig. 1a & b). However, gaseous composition in-side the package was significantly different depending on the type of film used. The heat shrinkable packaging film registered a gradual increase in CO_2 and decrease in O_2 concentration within the package closely followed by cling film, whereas, LDPE film recorded a sharp increase in CO_2 and decrease in O_2 concentration inside the package. The fluctuation to O_2 and CO_2 gases inside the packaging affected the quality parameters of Daisy fruit significantly. The film that minimizes those fluctuations proved better in enhancing the shelf-life of the fruits. These findings are in accordance with the results of Nanda *et al.* (9) who observed reduced respiration rate in shrink packed pomegranate fruits due to impressive gas barrier properties of heat shrinkable film. The shrink film is known to have better gas exchange properties due to its structure, which promote desirable permeability for better gaseous environment within the package in controlled respiration of fruit resulting. Zagory and Kader (15) confirmed about modification of the atmosphere around the fresh produce in the package made of flexible plastic films.

The PLW, in general, increased with the advancement of storage period rather slowly in the beginning but at a faster rate as the storage period advanced (Fig. 1c). It was noticed that shrink film packed fruits registered the lowest average PLW (1.19%) and ranged between 0 to 2.20% and it was at par with cling film (0-2.93%) from 5 to 25 days of storage as compared to control having highest (10.03%), though it ranged between 2.89 to 16.52%. The reduction in weight loss in film-packed fruits is attributed to lower moisture loss due to restricted respiratory process of fruits inside the packaging films (Rai *et al.*, 10). The positive role of shrink film in reducing the PLW has also been reported in papaya (Singh and Rao, 14).

The fruit firmness followed a declining trend commensurate with advancement in storage period (Fig. 1d). The fruits packed in shrink packaging film maintained the highest average firmness (6.8 lb force) and control registered the lowest mean firmness (4.7 lb force). The firmness of fruits in shrink film and cling film declined slower and steadily from 5 to 25 days of storage interval. Whereas, in case of control fruits, the decline in firmness was abrupt and sharp that declined from 8.0 to 2.0 lb force, thereby leading to excessive softening and shriveling of fruits. The desired value of firmness was observed to be 7 lb force and this value was noticed in case of shrink wrapped fruits on 15 days of storage, whereas, in case of unpacked control fruits, this value fell somewhere between 5 and 10 days of storage. Below 7 lb force, the fruits showed the symptoms of softening and wilting. The lower rate of softening in packaging film packed fruits might be due to the effect of the films in lowering the rate of respiration, delaying the ripening process and reduction in moisture loss (Zagory and Kader, 15). The polymeric film packaging has been reported to maintain higher firmness in pear fruits (Mahajan *et al.*, 7).

A gradual decline in sensory score during storage was noticed in shrink film packed fruits as compared to control where decline was sharp (Table 1). The maximum average sensory score was shown by fruits packed in shrink film (7.1). On the other hand, the control fruits registered the minimum sensory score (6.2). The sensory score of 7.0 is considered as moderately desirable and below this value, the quality starts deteriorating (Mahajan *et al.*, 8). Keeping this value as cut of limit, the shrink wrapped fruits maintained the quality upto 15 days of storage as against 5 days in case of unpacked fruits. Higher sensory score by the shrink wrapped fruits might be due to the ability of heat shrinkable film to

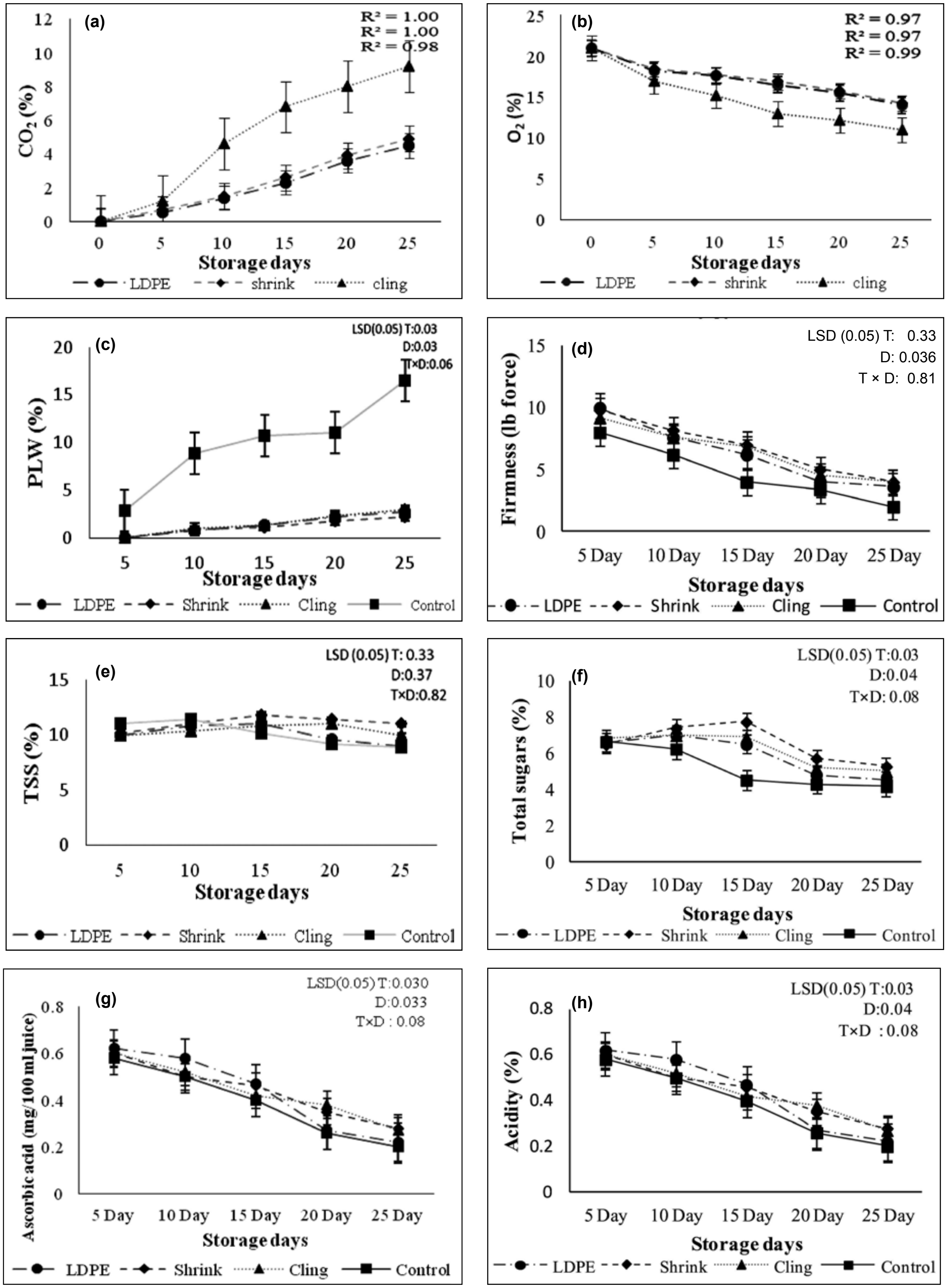

Fig. 1. Packaging films affect (a) CO_2 concentration; (b) O_2 concentration; (c) PLW; (d) firmness; (e) TSS; (f) total sugars; (g) ascorbic acid; and (h) acidity of Daisy mandarin fruits during storage. Vertical bars represents ± S.E.

retain the desirable gaseous atmosphere inside the package, which is responsible for maintaining the texture and flavour of the fruits (Nanda *et al.*, 9). The maintenance of freshness, crispness and aroma in shrink wrapped apples has been reported by Sharma *et al.* (10).

The spoilage of Daisy mandarin fruits was found to be lower in shrink and cling film packages (Table 1). The LDPE film packed fruits recorded the highest spoilage (9%) even higher than unpacked control fruits (5%). The occurrence of higher decay incidence in LDPE film might be due to accumulation of excessive water vapour inside the package, because of restricted movement of water through the film. Singh *et al.* (13) reported that packaging of pear fruits in LDPE polythene bags resulted in development of off-flavour and decay during storage. Mahajan *et al.* (8) mentioned that shrink film wrapped peach exhibited lower decay incidence and better retention of firmness and other physico-chemical attributes during storage as compared to unwrapped peach.

The fruits packed in shrink film registered maximum average TSS and total sugars content (11.1 and 6.53%) (Fig. 1e & f). On the other hand, the control fruits recorded the lowest average TSS and total sugars (10.4 and 5.11%) content. A continuous increase in TSS and total sugars upto 15 days was earlier observed in film packed fruits and thereafter declined slowly and steadily, whereas control fruits recorded highest TSS and total sugars after 10 days of storage as compared to film packed fruits and thereafter declined at a faster rate resulted in development of flat taste (Lau, 6). The present results confirmed the findings of Sharma *et al.* (9) who have reported a delayed and sustained increase in the total soluble solids and sugars in shrink film packed kiwi fruits.

The ascorbic acid content of the fruits showed linear decline during storage irrespective of different treatments (Fig. 1g). However, the shrink film packed fruits maintained the highest ascorbic acid content (11.89 mg %) as compared to control fruits (10.30 mg %). The influence of heat shrinkable films on maintaining higher ascorbic acid content has also been reported in citrus fruits (Ladaniya and Singh, 5).

The acidity of Daisy mandarin fruits experienced a linear decline as the storage period advanced (Fig. 1h). It was noticed that shrink and cling film packed fruits showed higher acidity over the other treatments throughout the storage period and recorded mean acidity of 0.44 per cent. The control fruits showed the lowest mean acidity (0.37%). In wrapped fruits, the lowering of acidity was delayed, which might be due to the effect of packaging films in delaying the respiratory and ripening processes. Nanda *et al.* (9) observed higher acidity content in shrink wrapped pomegranate fruits.

From the studies, it can be concluded that packaging of Daisy mandarin fruits in paper moulded trays followed by wrapping with heat shrinkable film seems to hold promise in improving the shelf-life and maintaining the quality upto 15 days respectively as against 5 days only in case of unpacked control. This technology can be helpful in minimizing the postharvest losses of Daisy mandarin fruits during retail marketing.

Table 1. Effect of packaging films on sensory quality and decay incidence of Daisy mandarin during storage.

Treatment	5 day	10 day	15 day	20 day	25 day	Mean
Sensory quality (Hedonic scale 1-9)						
LDPE	7.8	7.0	6.5	5.5	5.2	6.4
Shrink	8.2	7.5	7.0	6.8	6.2	7.1
Cling	8.0	7.3	6.9	6.5	6.0	6.9
Control	7.5	6.7	6.0	5.5	5.2	6.2
Mean	7.9	7.1	6.6	6.1	5.7	
$CD_{(0.05)}$ Treatment (T) = 0.03		Days (D) = 0.04 T × D = 0.09				
Decay (%)						
LDPE	0	2	8	15	18	9
Shrink	0	0	0	0	0	0
Cling	0	0	0	0	0	0
Control	0	0	5	8	10	5
Mean	0	1	3	6	7	
$CD_{(0.05)}$ Treatment (T) = 0.4		Days (D) = 0.6 T × D = 0.9				

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