Indian Journal of Agricultural Sciences **88** (8): 1270–4, August 2018/Article

Postharvest quality maintenance of W. Murcott mandarin using packaging films

B V C MAHAJAN[1], T S CHAHAL[2], W S DHILLON[3] and SWATI KAPOOR[4]

Punjab Horticulture Postharvest Technology Centre, Punjab Agricultural University, Ludhiana, Punjab 141 004

Received: 12 September 2017; Accepted: 04 May 2018

ABSTRACT

The fruits of W. Murcott mandarin were evaluated for shelf life and quality attributes for two weeks under passive MAP conditions. The fruits were harvested during second week of January at optimum maturity when they attained orange colour and packed in paper molded trays followed by wrapping with different packaging films, viz. heat shrinkable film (15 µ), cling (15 µ) and LDPE (25 µ) film. After packaging, the fruits were stored under ambient conditions (18-20°C; 90-95% RH). The fruits were 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, resulting in off flavour and decay of fruits in the package. The shrink film reduced the loss in weight, firmness, decay incidence and maintained various qualities attributes like total soluble solids, sugars, acidity and ascorbic acid content of the fruits during shelf-life better than unwrapped control fruits. The data revealed that packing of W. Murcott fruit in shrink film can prolong the shelf-life and maintain the quality for 10 days compared to only 5 days in case of unpacked control fruits.

Key words: Ambient conditions, Packaging films, Quality, Shelf life, W. Murcott

W. Murcott is a new cultivar of mandarin recently introduced in Punjab for commercial cultivation. The fruit of W. Murcott mandarin have smooth rind, easy to peel, less seeded with an attractive orange rind. The fruit matures during January-February and produces medium large fruit. This Mandarin has become popular among farmers, traders and consumers because of its juiciness and good blend of TSS: acid ratio. The major constraint of postharvest losses in fruits could be attributed to inappropriate packaging. Like other fruit, W. Murcott also needs specialized packaging for fetching good price in the retail/super market.

Packaging plays an important role in extending the shelf life of produce. 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 (Sandhya 2010, Soltani *et al.* 2016). 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, bruising during handling and transport and possibility from some fungal infections. Main advantages associated with packaging film are reduced weight loss, decay, minimum fruit deformation and chilling injury (Singh *et al*. 2012, Kumar *et al*. 2017). In this regard, the present investigation was conducted to study the effect of different packaging films on storage life and quality of W. Murcott fruit under ambient conditions.

MATERIALS AND METHODS

Fifteen plants of W. Murcott having uniform age and vigour were selected at Punjab Agricultural University, Fruit Research Station Jallowal. These plants were maintained under a recommended schedule of fertilizer, irrigation and phytosanitary treatments of insect pest control. The fruits of W. Murcott were harvested at optimum maturity when fruits attained orange colour. The bruised and diseased fruits were sorted out and only healthy and uniform sized fruits were selected for the study. The fruits were properly washed in chlorinated water of 100 ppm aqueous solution and thereafter dried under shade to remove the surface water.

Three types of packaging films commercially available in the market, viz heat shrinkable film (15 µ), cling film (15 µ) and low density polyethylene film (LDPE, 25 µ) films were used for packaging of fruits. The fruits were packed in paper molded 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 at 165ºC for 10 sec. Thereafter, the packed fruits as well as control (non-packed) fruits were stored under ambient conditions (18-20°C and 90-95% RH). The various physiological and biochemical attributes of the fruits were

[1]Director (e mail: mahajanbvc@gmail.com), PHPTC, PAU, Ludhiana. [2]e mail: tanjeetchahal@pau.edu, Fruit Research Station, PAU, Jallowal. [3]ICAR, New Delhi. [4]Department of Food Science and Technology, PAU, Ludhiana.

recorded at 5 days interval till 15 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**.** A sample of 0.5 ml was automatically withdrawn from the headspace atmosphere with a pin-needle connected to the injection system. Gases were analyzed with inbuilt sensors for CO_2 and O_2. The instrument was calibrated towards air.

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 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 (Lawless and Heymann 2010).

The total soluble solids (TSS) of the fruit juice were determined using a hand refractometer and expressed as per cent TSS after making the temperature correction at 20ºC. The total sugars, titratable acidity and vitamin-C were estimated as per standard procedures (Ranganna 2000). The total sugars were estimated by Lane and Eynon method by titrating the clarified fruit juice against Fehling solution after inversion and results were expressed in per cent. The titratable acidity was estimated by titrating the known quantity of fruit juice against N/10 standard alkali and results were reported in per cent citric acid. Similarly, vitamin-C was estimated by titrating the known quantity of fruit juice against 2,6-dichlorophenolindophenol dye and results were expressed in mg /100g on fresh weight basis.

The experiments consisted of 4 treatments and 3 storage intervals and laid out in completely randomized design with three replications for each treatment. The experiments were conducted for two years during 2014-15 and 2015-16. The data were pooled and analyzed for variance by using the SAS (V 9.3, SAS Institute Inc., and Cary, NC, USA) package.

RESULTS AND DISCUSSION

Respiration rate (*% O_2 and CO_2*): During storage of fruits under ambient conditions, a decline in O_2 and swelling in CO_2 levels occurred in all the three films (Fig 1). However, gaseous environment inside the package was significantly different depending on the type of film used. The heat shrinkable packaging film registered a steady increase in CO_2 and decrease in O_2 concentration within the package where as LDPE film recorded a swift increase in CO_2 and decrease in O_2 concentration inside the package. The film that minimizes the variations to O_2 and CO_2 gases inside the sealed pack proved better in enhancing the shelf life of the fruits. These findings were in accordance with Mahajan *et al.* (2015) who observed reduced respiration rate in shrink packed peach fruits due to impressive gas barrier properties of heat shrinkable film.

Physiological loss in weight (%): The shrink film packed fruits registered the lowest average PLW (0.50%) and ranged between 0 to 1.05% from 5 to 15 days of storage as compared to control where PLW was found to be the highest (6.90%) and ranged between 3.50 to 9.55% (Table 1). The cling and LDPE films recorded invariably higher PLW (0.62 and 0.71%) as compared to shrink film. The higher weight loss in unpacked fruit is generated by high metabolic activity i.e. respiration and transpiration rates. 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 (Faasema *et al*. 2011, Giuggioli *et al.* 2015).

Firmness (lb force): The fruit firmness followed a declining trend commensurate with advancement in storage period (Table 1). The fruits packed in shrink packaging film maintained the highest average firmness (6.42 lb force) and control fruits registered the lowest mean firmness (4.94 lb force). The firmness of fruits

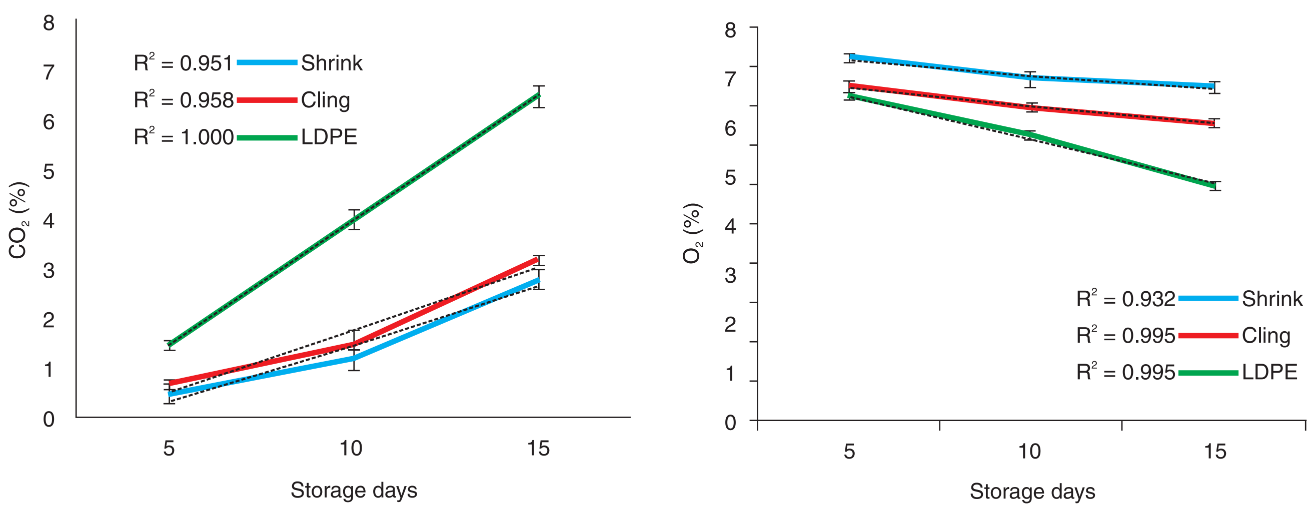

Fig 1 Effect of different packaging films on CO_2 and O_2 rate (%) of W. Murcott fruit during storage

Table 1 Effect of different packaging films on physical and sensory quality of W. Murcott fruit under ambient conditions

Treatment	Storage market conditions			
	5 Day	10 Day	15 Day	Mean
PLW (%)				
Shrink film	0.00	0.46	1.05	0.50
Cling film	0.00	0.62	1.23	0.62
LDPE film	0.00	0.75	1.39	0.71
Control	3.50	7.65	9.55	6.90
Mean	0.88	2.37	3.31	
LSD (P=0.05)	Treatment (T) = 0.06; Storage (S) = 0.09; T × S = 0.13			
Firmness (lb force)				
Shrink film	7.40	6.20	5.65	6.42
Cling film	7.10	5.91	4.10	5.70
LDPE film	7.13	5.48	4.39	5.67
Control	6.68	4.40	3.74	4.94
Mean	7.08	5.50	4.47	
LSD (P=0.05)	Treatment (T) = 0.6; Storage (S) = 0.12; T × S = 0.19			
Sensory quality				
Shrink film	7.6	7.2	6.7	7.2
Cling film	7.4	7.0	6.3	6.9
LDPE film	7.1	6.2	5.7	6.3
Control	7.0	6.3	5.0	6.1
Mean	7.3	6.7	5.9	
LSD (P=0.05)	Treatment (T) = 0.5; Storage (S) = 0.10; T × S = 0.17			
Spoilage (%)				
Shrink film	0	0	0	0
Cling film	0	0	0	0
LDPE film	0	4	10	5
Control	0	1	8	3
Mean	0	1	5	
LSD (P=0.05)	Treatment (T) = 0.6; Storage (S) = 0.9; T × S = 0.16			

Table 2 Effect of different packaging films on biochemical components of W. Murcott fruit under ambient conditions

Treatment	Storage market conditions			
	5 Day	10 Day	15 Day	Mean
TSS (%)				
Shrink film	10.20	10.90	11.00	10.70
Cling film	10.10	10.70	10.30	10.37
LDPE film	10.15	10.50	10.00	10.22
Control	10.45	10.45	9.30	10.07
Mean	10.23	10.64	10.15	
LSD (P=0.05)	Treatment (T) = 0.06; Storage (S) = 0.08; T × S = 0.14			
Total sugars (%)				
Shrink film	6.50	6.78	6.70	6.66
Cling film	6.42	6.65	6.50	6.52
LDPE film	6.60	6.72	6.00	6.44
Control	6.70	6.85	5.80	6.45
Mean	6.56	6.75	6.25	
LSD (P=0.05)	Treatment (T) = 0.05; Storage (S) = 0.07; T × S = 0.10			
Acidity (%)				
Shrink film	0.62	0.57	0.49	0.56
Cling film	0.61	0.54	0.46	0.54
LDPE film	0.61	0.52	0.45	0.53
Control	0.59	0.47	0.40	0.49
Mean	0.61	0.53	0.45	
LSD (P=0.05)	Treatment (T) = 0.03; Storage (S) = 0.08; T × S = NS			
Vitamin C (mg /100g)				
Shrink film	24.22	21.04	19.59	21.62
Cling film	24.11	21.00	17.94	21.02
LDPE film	23.14	19.06	15.56	19.25
Control	22.55	17.62	13.94	18.04
Mean	23.51	19.68	16.76	
LSD (P=0.05)	Treatment (T) = 0.6; Storage (S) = 0.15; T × S = 0.20			

in shrink film declined slower and steadily and ranged between 7.40 to 5.65 lb force from 5 to 15 days of storage interval, whereas in case of control fruits, the decline in firmness was abrupt and varied from 6.68 to 3.74 lb force, thereby leading to excessive softening and shriveling of fruits. The firmness of cling and LDPE film wrapped fruit was 5.70 and 5.67 lb force. The desired value of firmness was observed to be 6 lb force and this value was noticed in case of shrink wrapped fruits on 10th day of storage, whereas in case of unpacked control fruits, this value was achieved on 5th day of storage. Below 6 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 1998). The polymeric film packaging has been reported to maintain higher firmness in papaya and apricot fruits (Singh and Rao 2005, Peano *et al.* 2014).

Sensory quality: 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 (7.2), closely followed by cling film. On the other hand, the control fruits registered the minimum sensory score (6.1). The sensory score (7.0) is considered as moderately desirable and below this value the quality became unacceptable. Keeping this value as cut of limit, the shrink wrapped fruits maintained the quality upto 10 days of storage as against 5 days in case of unpacked fruits. The flavour of fruit depends on a delicate balance of sugars, acids, phenols and aromatic compounds with a number of additional factors such as pulp texture and visual appearance also influence the perceived quality and consumer acceptance and appreciation (Predieri *et al.* 2006). The recording of higher sensory score in shrink wrapped fruit might be due to the ability of heat shrinkable film to retain the desirable gaseous atmosphere inside the package which is responsible for maintaining the texture and flavour of the fruit (Sharma *et al.* 2012).

Spoilage (%): The spoilage of W. Murcott fruits was found to be negligible in shrink and cling film packages (Table 1). The LDPE film packed fruits recorded the highest spoilage (5%) even higher than unpacked control fruits (3%). 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.* (2012) reported that packaging of pear fruits in LDPE polythene bags resulted in development of off- flavour and decay during storage, whereas shrink film wrapped pear fruits exhibited lower decay incidence and better retention of firmness and other physico-chemical attributes during storage.

Total soluble solids and total sugars (%): The fruits packed in shrink film registered maximum average TSS and total sugars content (10.70% and 6.66%, respectively) (Table 2). On the other hand, the control fruits recorded the lowest average TSS and total sugars content (10.07% and 6.45%, respectively). The cling and LDPE film wrapped fruit recorded moderately higher TSS and total sugar as compared to unpacked fruits. A continuous increase in TSS and total sugars upto 10 days was observed in film packed fruits and thereafter declined slowly and steadily, whereas control fruits recorded highest TSS and total sugars after 5 days of storage as compared to film packed fruits and thereafter declined at a faster rate resulted in development of flat taste. The gradual increase and decrease in TSS and sugars in film wrapped fruits during storage may be possibly due to retarded ripening and senescence processes which simultaneously delayed the conversion of starch into sugars. The present results confirmed the findings of Sharma *et al.* (2012) who have reported a delayed and sustained increase in the total soluble solids and sugars in shrink film packed kiwi fruits.

Titratable acidity (%): The acidity of fruits experienced a linear decline as the storage period advanced (Table 2). 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 0.56 and 0.54 per cent, respectively. The control fruits showed the lowest mean acidity (0.49 %). The decrease in titratable acids during storage may be attributed to utilization of organic acid in hydrolysis of polysaccharides during respiratory process (Bhardwaj and Pandey 2011). The wrapped fruits, maintained higher acidity, which might be due to the effect of packaging films in delaying the ripening processes (Phong and Nhung, 2016).

Ascorbic acid (mg/100g FW): The ascorbic acid content of the fruits showed linear decline during storage irrespective of different treatments (Table 2). However, the shrink film packed fruits retained the highest ascorbic acid content (21.62 mg %) as compared to control fruits (18.04 mg %). The decrease in ascorbic acid during storage may be due to the oxidation of L-ascorbic acid into dehydroascorbic acid (Lin *et al.* 1988). The influence of heat shrinkable films on maintaining higher ascorbic acid content in citrus fruits has also been reported (Dhillon *et al*. 2016).

From the studies it can be concluded that packaging of W. Murcott 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 10 days respectively as against 5 days only in case of unpacked control. This technology can be helpful in minimizing the postharvest losses of W. Murcott mandarin during retail marketing.

REFERENCES

Bhardwaj R J and Pandey S. 2011. Juice blends-a way of utilization of under-utilized fruits, vegetables, and spices: a review. *Critical Review Food Science and Nutrition* **51**: 563–70.

Dhillon W S, Mahajan B V C, Chahil T S, Kumar M and Singh S P. 2016. Effect of different packaging films on shelf-life and quality of Daisy mandarin under ambient conditions. *Indian Journal of Horticulture* **73**: 262-6.

Faasema J, Abu J O and Alakali J S. 2011. Effect of packaging and storage condition on the quality of sweet orange. *Journal of Agriculture Technology* **7**: 797-804.

Giuggiolia N R, Brianoa R, Baudinob C and Peanoa C. 2015. Effects of packaging and storage conditions on quality and volatile compounds of raspberry fruits. *CyTA – Journal of Food* **13**: 512-21.

Kumar K K, Bhagwan A, Kumar A K, Venkatlakxmi K and Madhavi K J. 2017. Effect of modified atmosphere packaging (MAP) on chilling injury and storage life of guava cv. Allahabada safeda stored at 6±1ºC. *International Journal of Chemical Studies* **5**: 771-6.

Lawless H T and Heymann H. 2010. *Sensory Evaluation of Food – Principles and Practices*. Second Edition. Springer New York Dordrecht Heidelberg, London.

Mahajan B V C, Dhillon W S, Kumar Mahesh and Singh B. 2015. Effect of different packaging films on shelf life and quality of peach under super and ordinary market conditions. *Journal of Food Science and Technology* **52**: 3756- 62.

Lin Z F, Li S S, Zhang D L, Lui S X, Li Y B, Li Z G and Chen M D. 1988. The changes in oxidation and peroxidation in post harvest litchi fruits. *Acta Botanica Sinica* **30:** 383-7.

Peano C, Giuggiolia N R and Girgenti V. 2014. Effects of innovative packaging materials on apricot fruits (cv Tom Cot®). *Fruits* **69**: 247-58.

Phong N V and Nhung D T C. 2016. Effect of microperforated polypropylene film packaging on mangosteen fruit quality at low temperature storage. *Journal of Experimental Biology and Agricultural Sciences* **4**: 706-13.

Predieri S, Ragazzini P and Rondelli R. 2006. Sensory evaluation and peach fruit quality. *Acta Horticulturae* **713**: 429-34.

Ranganna S. 2000. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Edition. Tata Mc Graw Hill Pub Co. Ltd, New Delhi, India.

Sandhya. 2010. Modified atmosphere packaging of fresh produce: Current status and future needs. *LWT-Food Science and Technol*ogy **43**: 381-92.

Sharma R R, Pal R K and Rana V. 2012. Effect of heat shrinkable films on storability of kiwifruits under ambient conditions. *Indian Journal of Horticulture* **66**: 404-8.

Singh J, Mahajan B V C and Dhillon W S. 2012. Effect of different packaging films on shelf life of individually wrapped pear fruits. *Journal of Research Punjab Agricultural University* **49**: 35-9.

Singh S P and Rao D V S. 2005. Quality assurance of papaya by shrink film wrapping during storage and ripening. *Journal of Food Science and Technology* **42**: 523-5.

Soltani M, Alimardani R, Mobli H, Mohtasebi H and Modi S S. 2015. Modified atmosphere packaging: A progressive technology for shelf-life extension of fruits and vegetables. *Journal of Applied Packaging Res*earch **3**: 33–59.

Zagory D and Kader A A. 1998. Modified atmosphere packaging of fresh produce*. Food Technology* **42**: 70–7.