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Effect of packaging films on shelf life and quality of kinnow fruits packed in consumer packages

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ABSTRACT

Kinnow mandarin fruits were harvested at firm mature stage, sorted and graded. For preparing consumer packs six fruits were packed in paper moulded trays and tightly sealed in packaging films viz cryovac heat shrinkable Opti 200 (15 µ) and cling film (15 µ). After packaging the consumer packs were stored at super-market conditions (18-20°C, 80-85% RH). The fruits were evaluated for various physico-chemical quality attributes periodically. The shrink film packaging proved quite effective in reducing the weight and firmness loss and maintained the various quality attributes like total soluble solids, acidity, ascorbic acid and carotene content of the fruit during shelf life period. It was noticed that shrink film improved the shelf life and maintained the quality of kinnow fruits for 20 days under supermarket conditions as against 10 days only in case of unpacked control fruits.

Keywords: Kinnow mandarin; packaging films; shelf-life; quality

INTRODUCTION

Kinnow mandarin a hybrid of King and Willow leaf (*Citrus nobilis* x *Citrus deliciosa*) occupies the prime position amongst the citrus fruits grown in India. It is a predominant citrus fruit commercially grown in the arid irrigated and sub-montanous zone of Punjab. It is famous for its attractive colour, high juice content and pleasant taste. Due to these quality traits kinnow is in high demand not only in Indian markets but also in Sri Lanka, Thailand and some middle east countries like Bahrain, Kuwait and Saudi Arabia (Dhatt and Mahajan 2011). The area under kinnow is increasing at faster rate due to wide range of adaptability and very high economic returns to growers. It ranks first with respect to area and production in Punjab (Anon 2012). The kinnow fruit matures during December to February for commercial harvesting and during these months a glut like situation is seen at various whole sale markets of Punjab.

Generally in India fruits and vegetables are sold at the prevailing ambient condition which leads to huge qualitative and quantitative losses. However with the

increasing purchasing power parity and the consumer driven market scenario the concept of super markets is fast gearing up and many companies like Walmart, Reliance, Mother Dairy, Namdhari Fresh etc have opened up there retail outlets in big cities and demand good quality of fruits for sale in their outlets. The role of packaging is very important in post harvest operations of horticultural crops but its role is still underestimated in the country. Use of polymeric films is very pronounced in packaging of fruits with a purpose to extend their storage life. 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 (Lange 2000) thereby allowing lower physiological weight loss, reducing decay incidence and maintaining retention of colour and texture of fruits during extended shelf life (Sharma et al 2010). Hence the present investigation was planned to study the effect of packaging films such as shrink and cling packaging films on storage life and quality of kinnow fruits under super-market conditions.

MATERIAL AND METHODS

The kinnow fruits were harvested with the help of scateur in the month of February at firm mature stage. The bruised and diseased fruits were sorted out and only healthy and uniform sized fruits were selected for the study. A six cell paper moulded tray (220 mm x 140 mm and 3.15 mm thick) was used to hold the fruits in the orientation to make a consumer pack. In each tray six fruits of 70-72 mm diameter size were packed. The consumer packs were wrapped in shrink film tube and sealed using hot wire sealer. This pack was then passed through shrink packing machine preheated to 165°C at a set speed for 10 sec residence time. Similar packs were prepared using cling film but they were not passed through the shrink packing machine. One set of non-packed (control) fruits was also kept for comparison. Thereafter the packed fruits as well as control (non-packed) fruits were stored at 18-20°C and 90-95% RH (super-market conditions).The weight loss after each interval of storage was calculated on initial weight of the fruits and expressed in per cent. The firmness of the fruits was measured with the help of Texture Analyzer (Model TA-HDi Make, Stable Microsystems, UK) using compression platen (75 mm diameter) with test speed of 1mm/second and the total compression of the fruits was kept at 5 mm. 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 flavor, making use of a 9-point Hedonic scale (Amerine1965). 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 titratable acidity,

ascorbic acid and carotene content of fruit juice were estimated as per standard procedure (Anon 2005). Data were analyzed for variance by using the SAS (V 9.3, SAS Institute Inc and Cary, NC, USA) package.

RESULTS AND DISCUSSION

Weight loss: Shrink film packed fruits registered the lowest mean PLW (1.06) whereas the control fruits on the other hand recorded the highest PLW (12.20%) (Table 1). The weight loss during different storage interval for different films ranged between 0.63-2.12 per cent (shrink film), 1.74-5.63 per cent (cling film) and control (4-22.33%). The acceptable level of weight loss for kinnow fruit is <5.5 per cent above which the fruits show symptoms of shriveling and wilting and are liable to fetch lower prices in the market (Mahajan et al 2002). The data revealed that kinnow fruits without wrapping can have less than 10 days shelf life whereas fruits wrapped in heat shrink film recorded significant reduction in weight loss even after 25 days of storage life. The highest weight loss in unpacked control fruits might be due to exposure of fruit surface to the open atmosphere resulting in higher rate of transpiration and respiration thereby leading to higher weight loss. Heat shrinkable films are known to have better gas transmission and water vapour transmission rate than other films and therefore have greater effect on reducing weight loss. Nanda et al (2001) and Singh and Rao (2005) reported lower weight loss in shrink wrapped pomegranate and papaya fruits during storage.

Fruit firmness: A gradual decline in firmness in film packed fruits was noticed with advancement of storage period whereas in control package the decline in fruit firmness was found to be abrupt and fast (Table 1). The maximum average fruit firmness (1,542.54 g force) was observed with shrink film packaging. The control fruits recorded the minimum average fruit firmness (999.36 g force). Fruit firmness is one of the most important attributes in determining the post harvest quality (Lachapella et al 2013). Softening of fruits is caused by loss of pectic substances in the middle lamella of the cell wall that leads to the loss of cell wall integrity thus causes loss of firmness leading to shriveling and softening (Solomos and Laties 1973). The maintenance of higher firmness in heat shrink film packed fruits during storage could be due to reduction in moisture loss, respiratory activity and thus maintained the turgidity of the cells. Pongener et al (2011) observed higher firmness in shrink film packed peach fruits.

Organoleptic quality: The shrink film packed kinnow fruits showed gradual and steady increase in the organoleptic quality attributes up to 20 days after which a gradual decline was observed whereas in control fruits the sensory score increased up to 5 days of storage and thereafter declined at faster pace (Table 1). The highest mean organoleptic rating (7.76) was recorded in shrink film wrapped fruits. The

Table 1. Effect of different packaging films on weight loss, firmness and organoleptic quality of kinnow fruit during storage

Treatment	Days of storage						
	0	5	10	15	20	25	Mean
PLW (%)							
Shrink film	0.00	0.63	0.65	1.30	1.67	2.12	1.06
Cling film	0.00	1.74	2.79	3.78	4.62	5.63	3.09
Control	0.00	4.00	6.90	12.10	15.67	22.33	10.17
Mean	0.00	2.12	3.45	5.73	7.32	10.03	
$LSD_{0.05}$	Treatment (T) = 0.6, Storage days (S) = 0.4, T x S = 1.8						
Firmness (g force)							
Shrink film	1821.90	1686.27	1610.83	1455.10	1394.47	1286.67	1542.54
Cling film	1821.90	1591.90	1251.63	1189.80	959.17	813.67	1271.35
Control	1821.90	1130.23	1016.20	814.67	623.27	589.90	999.36
Mean	1821.90	1469.47	1292.89	1153.19	992.30	896.75	
$LSD_{0.05}$	Treatment (T) = 62.0, Storage days (S) = 46.2 T x S = 160.0						
Organoleptic quality							
Shrink film	7.00	7.60	7.83	7.93	8.63	7.57	7.76
Cling film	7.00	7.43	7.58	7.63	6.68	5.75	7.01
Control	7.00	7.08	6.90	6.42	5.37	4.87	6.27
Mean	7.00	7.37	7.44	7.33	6.89	6.06	
$LSD_{0.05}$	Treatment (T) = 1.5, Storage days (S) = 1.8, T x S = 2.2						

non-packed control fruits registered the lowest mean value in sensory rating (6.27). Wrapping of banana and kiwi fruits in heat shrinkable film have been reported to maintain acceptable appearance, flavor and overall eating quality (Kudachikar et al 2007, Sharma et al 2012).

Total Soluble Solids: The shrink film wrapped kinnow fruits maintained 9.45 per cent TSS after 5 days of storage which reached to peak value of 12.30 per cent after 20 days of storage and then declined (Table 1). The control fruits registered 10 per cent TSS after 5 days of storage which

reached to peak value at 10 days of storage (11.17%) and then declined faster afterward. The increase in TSS of fruits during storage may possibly be due to breakdown of complex organic metabolites into simple molecules (Wills et al 1980). The delayed increase in TSS over a longer period of time in film wrapped kinnow fruits might be attributed to delayed ripening and senescence processes. The positive influence of heat shrinkable films on TSS of pear fruits have been reported by Mahajan et al (2013).

Acidity: The acidity of kinnow fruits showed a linear declining trend with advancement of storage period (Table 2). The highest average acidity (0.54%) was recorded in the fruits wrapped in shrink films and the lowest average acidity (0.48%) was observed in control fruits. A decrease in acidity during ripening and storage could be attributed to the use of organic acids as respiratory substrate (Echeverria and Valich 1989). In shrink wrapped fruits the lowering of acidity was delayed which might be due to the effect of shrink packaging film in delaying the respiratory and ripening process (Mahajan et al 2013).

Ascorbic acid: A continuous decline in vitamin C content in kinnow fruits was noticed with advancement of storage period irrespective of different packaging films (Table 2). The maximum average vitamin C content (19.18 mg) was observed with shrink film packaging. The control fruits recorded the minimum average vitamin C content (17.22 mg). This fall in ascorbic acid during storage might be due to its oxidation (Lin et al 1988). The influence of heat shrinkable films on maintaining higher ascorbic acid content in sweet orange has also been reported (Ladaniya and Singh 2001).

Carotene: The film packed kinnow fruits showed a gradual and steady increase in carotene content up to 15 days of storage (0.63%) after which a decline was observed whereas in control fruits the carotene content increased up to 10 days of storage (0.54%) and thereafter declined at faster pace (Table 2). The highest mean carotene content was observed in fruits packed in shrink film (0.53 mg %) closely followed by Cling film (0.51 mg %). The fruits in control displayed the lowest mean value in carotene content (0.48 mg %). Initially the increase in carotene content of kinnow juice may be due to synthesis of carotenoides as a result of carotenogenesis reaction. Further after a certain period the decline in carotene content may be due to oxidative changes leading to degradation in carotenoides (Meyer 1987).

The present study envisaged that packaging of kinnow fruits in paper moulded tray followed by wrapping with heat shrinkable packaging film can prolong the shelf life of fruits up to 20 days with acceptable quality.

Table 2. Effect of different packaging films on TSS, acidity and Vitamin C content of kinnow fruit during storage

Treatment	Days of storage						
	0	5	10	15	20	25	Mean
TSS (%)							
Shrink film	9.10	9.45	10.55	10.93	12.30	11.52	10.64
Cling film	9.10	9.21	10.29	10.61	11.86	11.19	10.38
Control	9.10	10.00	11.17	10.83	10.80	9.57	10.25
Mean	9.10	9.55	10.67	10.79	11.65	10.76	
$LSD_{0.05}$	Treatment (T) = 0.20, Storage days (S) = 0.09, T x S = 0.42						
Acidity (%)							
Shrink film	0.63	0.58	0.55	0.53	0.51	0.46	0.54
Cling film	0.63	0.59	0.55	0.52	0.50	0.48	0.55
Control	0.63	0.52	0.50	0.47	0.38	0.35	0.48
Mean	0.63	0.56	0.53	0.51	0.46	0.43	
$LSD_{0.05}$	Treatment (T) = NS, Storage days (S) = 0.03, T x S = NS						
Vitamin-C (mg/100 g F.W.)							
Shrink film	24.31	22.66	21.15	18.89	15.24	12.85	19.18
Cling film	24.31	22.41	20.04	18.40	14.76	12.14	18.68
Control	24.31	21.19	17.72	15.81	13.23	11.03	17.22
Mean	24.31	22.09	19.64	17.70	14.41	12.01	
$LSD_{0.05}$	Treatment (T) = 0.11, Storage days (S) = 0.07, T x S = 0.20						
Carotene (%)							
Shrink film	0.48	0.51	0.55	0.63	0.54	0.47	0.53
Cling film	0.48	0.50	0.54	0.60	0.51	0.46	0.52
Control	0.48	0.51	0.54	0.52	0.44	0.41	0.48
Mean	0.48	0.51	0.54	0.58	0.50	0.45	
$LSD_{0.05}$	Treatment (T) = 0.03, Storage days (S) = 0.03, T x S = NS						

REFERENCES

Amerine MA, Pangborn RM and Roessler EB 1965. Principles of sensory evaluation of food. Academic Press, London, p 5.

Anonymous 2005. Official and tentative methods of analytical chemists. AOAC, 17th edition, Washington, DC, USA.

Anonymous 2012. In: Package of practices for cultivation of fruits, Directorate of Communication, Punjab Agricultural University, Ludhiana, pp 1-2.

Dhatt AS and Mahajan BVC 2011. Postharvest management of citrus fruits. In: Prospects and problems of citrus in Punjab, PS Aulakh PS and others (eds), Punjab Agricultural University, Ludhiana, Punjab, pp 98-105.

Echeverria E and Valich J 1989. Enzymes of sugar and acid metabolism in stored Valencia oranges. Journal of the American Society for Horticultural Science **114**: 445-449

Kudachikar VB, Kulkarni SG, Vasantha MS, Arvinda PB and Aradhya SM 2007. Effect of modified atmosphere packaging on shelf life and fruit quality of banana stored at low temperature. Journal of Food Science and Technology **44**: 74-78.

Lachapella M, Bourgeois and DeEII JR 2013. Effect of preharvest weather conditions on firmness of McIntosh apples at harvest time. HortScience **48**:474-480.

Ladaniya MS and Singh S 2001. Tray over-wrapping of Mosambi sweet orange. Journal of Food Science and Technology **38**: 362-365.

Lange DL 2000. New film technologies for horticultural products. Horticultural Technology **10**: 487-490.

Lin ZF, Li SS, Zhang DL, Lui SX, Li YB, Li ZG and Chen MD 1988. The changes in oxidation and peroxidation in post harvest litchi fruits. Acta Botanica Sinica **30**: 383-387.

Mahajan BVC, Dhatt AS and Rattan GS 2002. Evaluation of various wax formulations on the post harvest characteristics of kinnow. Indian Journal of Citriculture **1(2)**: 185-88.

Mahajan BVC, Kumar D and Dhillon WS 2013. Effect of different polymeric films on the shelf life and quality of pear fruits under supermarket conditions. Indian Journal of Horticulture **70**: 309-312.

Meyer LH 1987. Food Chemistry. CBS publisher and distributer, New Delhi, pp 228-235.

Nanda S, Rao DVS and Krishnamurthy S 2001. Effect of shrink film wrapping and storage temperature on the shelf life and quality of pomegranate fruits cv Ganesh. Postharvest Biology and Technology **22**: 61-69.

Pongener A, Mahajan BVC and Singh H 2011. Effect of different packaging films on storage life and quality of peach fruits under cold storage conditions. Indian Journal Horticulture **68(2)**: 240-245.

Sharma RR, Pal RK and Rana V 2012. Effect of heat shrinkable films on storability of kiwifruits under ambient conditions. Indian Journal of Horticulture **66**: 404-408.

Sharma RR, Pal RK, Singh D, Samuel DVK, Kar A and Asrey R 2010. Storage life and fruit quality of individually shrink-wrapped apples (*Malus domestica*) in zero energy cool chamber. Indian Journal of Agriculture Science **80(4)**: 338-341.

Singh SP and Rao DVS 2005. Quality assurance of papaya by shrink film wrapping during storage and ripening. Journal of Food Science and Technology **42**: 523-525.

Solomos T and Laties GG 1973. Cellular organization and fruit ripening. Nature **245**: 390-391.

Wills RBH, Cambridge PA and Scott KJ 1980. Use of flesh firmness and other objective tests to determine consumer acceptability of delicious apples. Australian Journal of Experimental Agriculture and Animal Husbandry **20**: 252-56.

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