

Influence of Coatings on Postharvest Physiology and Shelf life of Kinnow Fruits under Super Market Conditions

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Abstract

The Kinnow mandarin (*Citrus nobilis x Citrus deliciosa*) fruits after harvesting were coated with different coating emulsions viz. cellulose, citrashine, terpenoidal oligomer and sta-fresh. The control fruits were kept uncoated. The fruits were stored under supermarket conditions (18-20°C and 80-85% RH). The observations on various physico-chemical attributes of fruits were recorded at different storage intervals. The data revealed that fruits coated with citrashine or terpenoidal oligomer coatings can be stored for 15 days under supermarket conditions (18-20°C and 80-85% RH) with highly acceptable quality as compared to control which maintained storage life of one week only.

INTRODUCTION

The Kinnow mandarin (*Citrus nobilis x Citrus deliciosa*) is an important fruit of India and commercially grown in the arid irrigated and sub-montaneous zone of Punjab state. The area under Kinnow is increasing at faster rate due to wide range of adaptability and very high economic returns to growers. However, Kinnow is a perishable fruit and liable to be spoiled under ambient conditions. Application of coating is simple and effective techniques which can help in reducing the postharvest losses and enhancing the shelf-life of fruits by reducing rate of respiration, transpiration and other metabolic processes of fruits (Zagory and Kader, 1988). Edible coatings provide a barrier against external elements and therefore increase shelf-life by reducing gas exchange, loss of water, flavours, aroma and soluble migration towards the cuticle (Guilbert et al., 1996). The uses of food grade wax coatings on fresh fruits and vegetables have been approved by Food Safety and Standard Authority of India under regulation 7.3.1 (FSSAI, 2006) and with the enforcement of this act, the food grade coating materials are now-a-days

being supplied by various leading companies in the markets. Therefore, the application of these products needs to be tested during postharvest operations of various commodities. Hence the present study was planned to study the effect of different edible coatings on shelf-life and quality of Kinnow fruits under super market conditions.

MATERIALS AND METHODS

Sample preparation

The Kinnow fruits of uniform size, disease and bruise free were picked randomly from all the four directions of the plants with the help of secateur at physiological mature stage. The fruits were collected in plastic crates and shifted to postharvest laboratory. In the laboratory, the fruits were sorted graded and washed with chlorine solution (100 ppm). Thereafter fruits were divided into requisite lot for further handling.

Experimental treatments and design

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The experiment was conducted using randomized complete block design with three replications involving four treatments. The treatments consisted of edible coatings *viz.* Cellulose coating, Terpenoidal oligomer coating, Citrashine and Sta-fresh. The fruits were coated with different coatings with the help of a piece of foam pad drenched with particular coating material and coating was applied gently on the surface of fruits. Thereafter fruits were air dried. The coated and control fruits were stored under super-market conditions (18-20°C and 80-85% RH). The various physico-chemical parameters of fruits were recorded at five days interval till 20 days.

Physiological loss in weight (PLW)

The PLW of fruits was calculated on initial weight basis. The per cent loss in weight after each storage interval was calculated by subtracting final weight from the initial weight of the fruits and then converted into percentage value. The cumulative loss in weight was calculated on fresh weight basis.

Fruit firmness

Firmness of randomly selected fruits (three from each replication) was measured with the help of a (Texture analyser) using 8 mm stainless steel probe. The results recorded and expressed in terms of pressure g force.

Organoleptic quality

The fruits were rated for this character by a panel of ten judges on the basis of external appearance of fruits, texture, taste, and flavour. A nine point 'Hedonic Scale'

described by Amerine et al. (196) used for its inference.

Total soluble solids, titratable acidity and ascorbic acid

Total soluble solids (TSS) were determined from the juice at room temperature with the help of hand refractometer (Model Erma, Japan) and expressed in percent. These readings were corrected with the help of temperature correction chart at 20°C temperature (AOAC, 1990). For recording the acid content, 2 ml of juice was diluted to 10 ml with distilled water and titrated against 0.1 N sodium hydroxide solution using phenolphthalein as an indicator. The acid content was expressed as % of citric acid. Ascorbic acid content of the juice was estimated using the detective dye 2,6-dichlorophenol indophenols (DCPIP) visual titration method (Ranganna, 1998). To 10 ml of each sample, 90 ml of the acid was added. Out of this prepared sample, 10 ml was taken and titrated against the 2,6-dichlorophenol indophenol dye solution till the pink end point obtained which persisted for at least 15 sec. The percentage ascorbic acid amount was then estimated.

Limonin

The limonin was estimated from the chloroform extract of sample by calorimetric method (Vaks and Liftshitz, 1981). Five ml of centrifuged juice, made to 25 ml with distilled water was extracted with petroleum ether (b.p. 60-80°C) in a separating funnel (250 ml) to extract the coloring matter. The petroleum ether extract was discarded and the aqueous solution was extracted with chloroform (3×25 ml). The chloroform extract was washed with distilled water (4×50 ml). The volume was

made to 50 ml with chloroform. A known quantity of these solutions was used for determination of limonin by developing color with Burhnam's reagent for standard solution preparation.

Carotene

Total carotene was extracted and estimated following the method described Ranganna (1994). A sample of 5 ml juice was weighed and ground in a pestle and mortar with 2:3 acetone in petroleum ether using sodium sulphate to facilitate grinding. Extractions were made till the residual mass in the pestle and mortar became colorless. The volume was made to 100 ml with 2:3 acetone in petroleum ether. The extract was measured for total carotenoids at 452 nm on spectrophotometer. The concentration of carotene was calculated from standard curve prepared with β -carotene.

Statistical design

The experiment consists of five treatments and five storage intervals and each treatment was replicated thrice. The experiment was arranged in completely randomized design. SAS 9.3 was used for analysis of variance and p-values were worked out from the data. The parameters which differed significantly at $p < 0.05$ level were further subjected to mean comparison using LSD at 5% level of significance.

RESULTS AND DISCUSSION

Physiological loss in weight (PLW)

In general, the PLW of fruits increased during storage (Table 1). The citrashine coated fruits recorded minimum PLW (5.40%) closely followed by terpenoidal oligomer coating (6.23%). The control fruits

recorded the highest weight loss (12.20%). In case of Kinnow fruit the acceptable level of weight loss is $< 5.5\%$ (Mahajan, 2002) above which the fruits show symptoms of shriveling and liable to fetch lower prices in the market. Therefore, it can be visualized from the data that citrashine and terpenoidal oligomer coated fruits can be marketed for about 15 days as compared to control which maintained marketable quality up to ten days only. The citrashine and terpenoidal oligomer coating has been reported to play an important role in lowering the weight loss of pear (Mahajan et al., 2005), sweet lime and apple (Bishnoi et al., 2008, 2009).

Firmness

The firmness of fruits followed a declining trend commensurate with the advancement in storage period (Table 1). The highest mean fruit firmness (1085.50 g force) was recorded in citrashine coated fruits, followed by terpenoidal oligomer coating (1033.31g force), while the lowest mean fruit firmness (834.85 g force) was noticed in case of control fruits. Fruit firmness is one of the most crucial factors in determining the postharvest quality of fruits (Shear, 1975). Softening of fruits is caused either by breakdown of insoluble protopectins into soluble pectin or by hydrolysis of starch (Mattoo et al., 1975). The loss of pectic substances in the middle lamella of the cell wall is perhaps the key steps in the ripening process that leads to the loss of cell wall integrity thus cause loss of firmness and softening (Solomos and Laties, 1973). The coating of fruits with citrashine and terpenoidal oligomer resulted in higher fruit firmness, during storage, which might be due to reduction in moisture loss and respiratory activity

and thus maintained the turgidity of the cells (Sidhu et al., 2009, Bishnoi et al., 2008, 2009).

Organoleptic quality

The maximum mean organoleptic rating (7.72) was recorded in citrashine coated fruits, followed by terpenoidal oligomer coated Kinnow fruits (7.53), while the lowest mean organoleptic score was recorded in the control fruits (6.13). There was a gradual increase in organoleptic rating of coated Kinnow fruits up to 15 days of storage, whereas in case of control the increase in the organoleptic quality score was observed up to 5 days, after which a sharp decline in organoleptic rating was recorded (Table 2). Mahajan et al. (2005) noticed that citrashine coating was most effective in improving the overall quality and organoleptic quality of pear fruits without development of off-flavour.

Total soluble solids (TSS)

The coated fruits recorded a gradual and steady increase in the TSS of Kinnow fruits up to 15 days in storage, while, the control (uncoated) fruits recorded increase in TSS up to 10 days of storage (Table 2). The highest TSS (12.23%) was recorded in citrashine coated Kinnow fruit after 15 days in storage, followed by terpenoidal oligomer coating (11.94%). On the other hand, control fruits recorded highest TSS (11.17%) after 10 days of storage, thereafter the control fruits showed sharp decline in the TSS with advancement of storage period and recorded 9.57% TSS after 25 days. The increase in TSS during storage may possibly be due to breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch

into sugars (Wills et al., 1980). The delayed increase in TSS over a longer period of 040 in coated Kinnow fruits might be attributed that coating retard ripening and senescence processes and simultaneously delayed the conversion of starch into sugars. An increase in total soluble content with prolongation of storage period in citrashine coated soft pear fruits and terpenoidal oligomer coated apple fruits were also reviewed by Sidhu et al. (2009) and Bishnoi et al. (2008).

Acidity

The highest mean acidity (0.53%) was recorded in citrashine coated Kinnow fruits, followed by terpenoidal oligomer coating (0.50%). On the other hand, the lowest mean acidity (0.44%) was recorded in control fruits (Table 3). The decrease in titratable acids during storage may be attributed to utilization of organic acid in pyruvate decarboxylation reaction occurring during the ripening process of fruits (Pool et al., 1972). When the fruits were coated, the lowering of acidity was delayed, which might be due to the effect of coatings in delaying the respiratory and ripening process.

Vitamin C

The highest mean vitamin C content (17.97 %) was recorded in citrashine coated fruits, followed by terpenoidal oligomer coating (17.38%), while the lowest mean vitamin C content (15.79%) was recorded in case of control fruits (Table 3). The wax coatings have the potential benefit of better retention of the ascorbic acid. Mahajan et al. (2005) have reported higher ascorbic acid content in the Kinnow fruits that were treated with shellac based wax as compared to uncoated fruits.

Limonin

The highest mean limonin content (13.50 ppm) was recorded in citrashine coated Kinnow fruit followed by terpenoidal oligomer coating (13.31 ppm). On the other hand, the lowest mean limonin content (11.75 ppm) was recorded in control fruits (Table 4). Limonin is a complex compound (Ting and Rouseff, 1986). It is found to be bitter principle of Navel orange juice (Emerson, 1949) and grapefruit juice (Maier and Dreyer, 1965). The limonin content has been reported to decrease with the ripening of fruits. This indicate that a monolectone is a precursor which slowly disappears from the tissue as fruit matures, so juice of mature fruits develop less bitterness (Mayer and Dreyer, 1965). However the influence of

edible coatings on the limonin content of Kinnow fruit is yet to be ascertained and require further investigation.

Carotene

The maximum mean carotene content (0.56 mg %) was recorded in citrashine coated fruits, followed by terpenoidal oligomer (0.54 mg %), while the lowest mean carotene content (0.48 mg %) was recorded in control fruits (Table 4). The increase or decrease in carotene content of Kinnow juice may be due to catrotenogenesis reaction takes place in the cell. However the further investigation is required to confirm these findings.

Table 1: Effect of different coatings on physiological loss in weight (PLW) and firmness of Kinnow fruits under supermarket conditions (18-20°C and 80-85% RH)

Treatments	PLW (%)						Firmness (g force)						
	Storage period (day)						Storage period (day)						
	5	10	15	20	25	Mean	5	10	15	20	25	Mean	
Cellulose coating	1.39	5.27	8.27	9.77	15.34	8.01	1197.67	1116.73	883.73	839.57	730.43	953.63	
Terpenoidal oligomer coating	1.30	3.50	4.90	7.60	13.85	6.23	1229.87	1177.17	1020.63	912.27	826.60	1033.31	
Citrashine coating	1.15	3.03	4.73	7.07	11.01	5.40	1291.53	1213.77	1039.83	990.57	891.80	1085.50	
Stafresh coating	1.53	6.07	8.67	10.62	15.94	8.57	1154.13	1114.33	880.70	820.83	727.60	939.52	
Control	4.00	6.90	12.10	15.67	22.33	12.20	1130.23	1016.20	814.67	623.27	589.90	834.85	
Mean	1.87	4.95	7.73	10.14	15.70		1200.69	1127.64	927.91	873.30	753.27		
LSD at 5%													
Treatments (T)						0.82						Treatments (T)	62.80
Storage (S)						0.90						Storage (S)	68.79
T x S						2.02						T x S	NS

Table 2: Effect of different coatings on organoleptic quality and total soluble solids of Kinnow fruits under supermarket conditions (18-20°C and 80-85% RH)

Treatments	Organoleptic quality						Total soluble solids (%)					
	Storage period (day)						Storage period (day)					
	5	10	15	20	25	Mean	5	10	15	20	25	Mean
Cellulose coating	7.35	7.32	7.62	7.25	6.42	7.19	9.60	10.87	11.90	11.30	11.10	10.95
Terpenoidal oligomer coating	7.55	7.65	8.12	7.43	6.90	7.53	9.90	10.93	11.94	11.87	11.30	11.19
Citrashine coating	7.60	7.82	8.35	7.50	7.35	7.72	10.03	11.27	12.23	11.77	11.50	11.36
Stafresh coating	7.12	7.23	7.43	7.00	6.12	6.98	9.30	10.23	11.90	11.20	11.00	10.73
Control	7.08	6.90	6.42	5.37	4.87	6.13	10.00	11.17	10.83	10.80	9.57	10.47
Mean	7.34	7.38	7.59	6.91	6.33		9.77	10.89	11.76	11.39	10.89	
LSD at 5%												
Treatments (T)	0.07						Treatments (T) 0.30					
Storage (S)	0.08						Storage (S) 0.33					
T x S	0.18						T x S 0.73					

Table 3: Effect of different coatings on acidity and vitamin C of Kinnow fruits under supermarket conditions (18-20°C and 80-85% RH)

Treatments	Acidity (%)						Vitamin C (mg %)					
	Days of Storage						Days of Storage					
	5	10	15	20	25	Mean	5	10	15	20	25	Mean
Cellulose coating	0.53	0.51	0.50	0.45	0.42	0.48	21.93	18.68	17.32	14.25	11.14	16.66
Terpenoidal oligomer coating	0.57	0.52	0.51	0.48	0.44	0.50	22.21	19.66	18.11	14.84	12.07	17.38
Citrashine coating	0.57	0.56	0.54	0.50	0.47	0.53	22.34	20.72	18.36	15.57	12.86	17.97
Stafresh coating	0.53	0.52	0.47	0.46	0.43	0.48	21.41	18.04	15.96	13.71	11.39	16.10
Control	0.52	0.50	0.47	0.38	0.35	0.44	21.19	17.72	15.81	13.22	11.03	15.79
Mean	0.54	0.52	0.50	0.45	0.42		21.82	18.96	17.11	14.32	11.70	
LSD at 5%												
Treatments (T)	0.03						Treatments (T) 0.03					
Storage (S)	0.04						Storage (S) 0.06					
T x S	NS						T x S 0.07					

Table 4: Effect of different coatings on limonin (ppm) and carotene (IU) of Kinnow fruits under supermarket conditions (18-20⁰C and 80-85% RH)

Treatments	Limonin (ppm)						Carotene (IU)					
	Storage period (day)						Storage period (day)					
	5	10	15	20	25	Mean	5	10	15	20	25	Mean
Cellulose coating	14.88	13.93	14.09	10.73	9.81	12.69	0.52	0.60	0.55	0.50	0.43	0.52
Terpenoidal oligomer coating	15.11	14.03	14.91	11.63	10.87	13.31	0.55	0.62	0.57	0.50	0.45	0.54
Citrashine coating	15.17	14.12	15.03	11.97	11.21	13.50	0.55	0.64	0.62	0.51	0.46	0.56
Stafresh coating	14.63	13.71	13.87	9.81	8.92	12.19	0.52	0.60	0.54	0.50	0.42	0.52
Control	14.39	13.12	13.27	9.75	8.21	11.75	0.51	0.54	0.52	0.44	0.41	0.48
Mean	14.84	13.78	14.23	10.78	9.80		0.53	0.60	0.56	0.49	0.43	
LSD at 5%												
Treatments (T)	0.05						Treatments (T) 0.03					
Storage (S)	0.03						Storage (S) 0.02					
T x S	0.14						T x S NS					

CONCLUSION

Use of improved postharvest practices often leads to reduced postharvest losses. The present investigation envisaged that freshly harvested Kinnow fruits coated with citrashine or terpenoidal oligomer coatings can be successfully stored under supermarket conditions (18-20⁰C and 80-85% RH) with acceptable quality for 15 days as compared to control which maintained storage life of one week only.

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