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Shelf Life of Mandarin (*Citrus reticulata* Blanco.) cv Kinnow

GOUSIA HUSSAIN, I. A. BISATI, H. A. BHAT AND ASMA HASSAN

Department of Horticulture, Allahabad Agriculture Institute-Deemed University
Allahabad 211007, India

Abstract

An experiment was carried out to study the effect of different chemicals and packaging materials on the shelf life of Kinnow mandarin under ambient conditions during 2002-03. The experiment was laid in completely randomized design with ten treatments and three replications. Fruits were treated with three chemicals viz. $CaCl_2$ (4%), captaf (0.1%) and mancozeb (0.2%) in combination with three packaging materials viz. perforated polythene, perforated paper bags and bamboo baskets. Regular observations were made at an interval of 7 days upto 42 days of storage to study the chemical changes in the fruits. Significant effect of all treatments was observed for chemicals parameters TSS, pH, acidity, and ascorbic acid contents of the fruits. Among the treatments $CaCl_2$ + perforated polythene bags showed a significant increase in TSS and pH with a decrease in acidity and ascorbic acid contents at slow rates compared to control and other treatments and hence effective for prolonging the shelf life of Kinnow mandarin fruits without effecting its marketable quality.

Key words : Shelf life, Mandarin, *Citrus reticulata*, Kinnow.

Citrus fruits are among the most important fruit crops in the sub-tropical region. Among the new citrus introductions in India, mandarin is undoubtedly the most prized one. Kinnow was developed by crossing King and Willow leaf mandarin at citrus Research Station, Riverside, California (USA) and released in 1935. It was introduced to India and established at Regional Fruit Research Station, Abohar (Punjab) in 1959. The production of fresh citrus fruits and their storage are two important aspects, which require attention. Every year nearly 15—20% of the production is lost in the producing areas owing to lack of adequate transportation and storage facilities and other allied bottlenecks (Singh 1971). The loss is mainly due to short shelf life caused by rapid ripening of fruits and attack by micro-organisms. Therefore, proper treatment and packaging are essential to check the post-harvest losses during transportation and post-transport storage period. The storage life of fresh citrus fruits can be increased by retarding the onset of senescence and by checking the growth of contaminating micro-organisms. Recent development of antibiotics, fungicides, growth regulators and packaging films have provided new potential for prolonging shelf life of many fruits. Therefore the present investigation was undertaken to study the role of different chemicals and packaging materials on the shelf life of kinnow mandarin.

Methods

The present investigation was carried out at Department of Horticulture, Allahabad Agriculture Institute—Deemed University, Allahabad during 2002-2003. The fruits were harvested on 10 November 2002 from the horticultural farm of the Institute. The fruits were immediately brought to the laboratory in plastic crates to avoid mechanical injury. Three hundred sixty healthy and uniform sized fruits were used for the studies which were divided into ten lots and each lot comprised thirty six fruits. Fruits were first washed with tap water and allowed to dry under electric fan and then treated with $CaCl_2$ at 4%, captaf at 0.1% and mancozeb at 0.2% separately for 10 minutes and then dried again. One set was treated with distilled water, which served as control. The treated fruits were then packed in perforated paper bags, perforated polythene bags (with 0.2% ventilation) and bamboo baskets. Both treated and untreated fruits were stored at ambient conditions on wooden table. The observations were recorded at an interval of 7 days. The treatments were T_0—Control, T_1—$CaCl_2$ 4% + perfo-

Table 1. Soluble solids as influenced by various treatments at different periods of storage. *Not in maketable condition.

	Treatment	Average total soluble solids at different periods of storage on DAS					
		7	14	21	28	35	42
T_0	Control	10.02	10.98*	11.88*	–	–	–
T_1	$CaCl_2$ + Perforated paper bags	9.68	9.71	9.76	9.83	9.89	9.97
T_2	Captaf + Perforated paper bags	9.72	9.76	9.81	9.87	9.94	10.03
T_3	Mancozeb + Perforated paper bags	9.69	9.73	9.79	9.86	9.92	10.00
T_4	$CaCl_2$ + Perforated polyethylene bags	9.52	9.54	9.60	9.70	9.78	9.87
T_5	Captaf + Perforated polyethylene bags	9.57	9.60	9.65	9.73	9.80	9.88
T_6	Mancozeb + Perforated polyethylene bags	9.60	9.64	9.69	9.76	9.85	9.90
T_7	$CaCl_2$ + Bamboo basket	9.77	9.81	9.87	9.93	10.02	–
T_8	Captaf + Bamboo basket	9.79	9.85	9.91	9.98	10.06	–
T_9	Mancozeb + Bamboo basket	9.80	9.87	9.93	9.99	10.08	–
	SE (±)	0.586	NS	NS	NS	2.002	3.043
	CD at 5%	1.223	NS	NS	NS	4.177	6.347

rated paper bags, T_2—captaf 0.1% + perforated paper bags, T_3—Mancozeb 0.2% + perforated paper bags, T_4—$CaCl_2$ 4% + perforated polythene bags, T_5–Captaf 0.1% + perforated polythene bags, T_6–Mancozeb 0.2% + perforated polythene bags, T_7–$CaCl_2$ 4% + bamboo basket, T_8–Captaf 0.1% + bamboo basket and T_9–Mancozeb 0.2% + bamboo basket. The treatments were replicated thrice and the experiment was laid in completely randomized design. TSS in the fruits was determined with the help of portable hand refractometer. The pH of the juice was determined with the help of an electronic pH meter (Elico model L110, electronics and Industrial Co. Pvt. Ltd, Hyderabad). The total acidity (citric acid) was determined by titrating the juice against standard alkali solution using phenolphthalein as indicator. Ascorbic acid was determined by 2, 6-dichlorophenol-Indophenol visual titration method (Rangana 1986).

Results and Discussion

The maximum TSS content (11.88%) was recorded in the control fruits after 21 days of storage and minimum (9.87%) in $CaCl_2$ + perforated polythene (T_4) whereas TSS of 9.88% was recorded in fruits treated with captaf 0.1% and wrapped in perforated polythene (T_3) after 42 days of storage (Table 1).

The increase in TSS is due to hydrolysis of polysaccharides (starch) to monosaccharides (sucrose, fructose and glucose) and concentration of the juice as a result of dehydration. Another possible reason for the increase of the TSS might be due to the higher transpiration and oxidation rate with higher gaseous diffusion of fruits under control, which re-

Table 2. The pH as influenced by various treatments at different periods of storage. *Not in marketable condition.

	Treatment	Average pH different periods of storage on DAS					
		7	14	21	28	35	42
T_0	Control	2.98	3.12*	3.25	–	–	–
T_1	$CaCl_2$ + Perforated paper bags	2.89	2.91	2.91	2.98	3.07	3.18
T_2	Captaf + Perforated paper bags	2.89	2.93	2.95	2.99	3.09	3.20
T_3	Mancozeb + Perforated paper bags	2.91	2.92	2.96	3.05	3.10	3.21
T_4	$CaCl_2$ + Perforated polyethylene bags	2.86	2.87	2.89	2.93	3.00	3.09
T_5	Captaf + Perforated polyethylene bags	2.86	2.88	2.91	2.94	3.03	3.12
T_6	Mancozeb + Perforated polyethylene bags	2.87	2.89	2.90	2.96	3.05	3.15
T_7	$CaCl_2$ + Bamboo basket	2.91	2.94	2.98	3.05	3.15	–
T_8	Captaf + Bamboo basket	2.92	2.93	2.99	3.08	3.18	–
T_9	Mancozeb + Bamboo basket	2.92	2.94	3.01	3.07	3.19	–
	SE (±)	NS	NS	NS	0.646	0.840	1.038
	CD at 5%	NS	NS	NS	1.347	1.752	2.164

Table 3. Titrable acidity (%) as influenced by various treatments at different periods of storage. *Not in marketable condition.

	Treatment	Average Titrable acidity (%) at different periods of storage on DAS 7	14	21	28	35	42
T_0	Control	0.800	0.790*	0.780*	–	–	–
T_1	$CaCl_2$ + Perforated paper bags	0.818	0.817	0.809	0.802	0.800	0.794
T_2	Captaf + Perforated paper bags	0.816	0.810	0.807	0.801	0.796	0.788
T_3	Mancozeb + Perforated paper bags	0.816	0.812	0.809	0.800	0.797	0.790
T_4	$CaCl_2$ + Perforated polyethylene bags	0.825	0.821	0.815	0.811	0.807	0.803
T_5	Captaf + Perforated polyethylene bags	0.822	0.819	0.813	0.808	0.804	0.800
T_6	Mancozeb + Perforated polyethylene bags	0.822	0.818	0.810	0.805	0.802	0.799
T_7	$CaCl_2$ + Bamboo basket	0.813	0.810	0.805	0.800	0.793	–
T_8	Captaf + Bamboo basket	0.811	0.808	0.803	0.797	0.790	–
T_9	Mancozeb + Bamboo basket	0.811	0.807	0.801	0.795	0.790	–
	SE (±)	NS	NS	NS	0.190	0.189	0.293
	CD at 5%	NS	NS	NS	0.397	0.393	0.610

sulted in the increase of TSS significantly at a rapid rate.

Attia (1995) also revealed that treating the fruits with either wax emulsion, or lining them in perforated polyethylene significantly increased TSS content. Observations are also in conformity with the findings of Bhadu (1983) in guava and Falak et al. (1997) in orange cv Blood Red.

Table 2 reveals that as the storage period increased, pH of the fruits also showed an increase, but the increase in the pH was fast in (T_0) untreated fruits than treated fruits. The change in the pH of (T_0) untreated fruits being 2.98, 3.12, 3.25 after 7, 14 and 21 days of storage, respectively. The minimum change in pH was observed in (T_4) $CaCl_2$ + perforated polyethylene, being of the order 2.86, 2.87, 2.89, 2.93, 3.00 and 3.09 after 7, 14, 21, 28, 35 and 42 days of storage, respectively. The change in pH was inverse with titrable acidity. If the acidity tends to increase or decrease, the pH may be expected to rise or fall. The results are in conformity with the work of Dutt et al. (1969) on Darjeeling mandarin.

Investigations related to total titrable acidity indicated that the acidity measured in terms of citric acid showed a gradual decline with the advancement of storage period (Table 3). Retention of titrable acidity after 42 days of storage was maximum (0.803%) with $CaCl_2$ + perforated polythene (T_4) whereas titrable acidity of 0.800% was recorded with captaf + perforated polythene (T_5). However, control fruits (T_0) retained 0.800% titrable acidity just after 7 days of storage. The reduction in titrable acidity was partly due to utilization of acids in respiration and partly due to conversion of acids into sugars. The results are in line with those of Dris and Niskanen (1999) in apple and Angadi (1938) in Coorg mandarin. Falak et al. (1997) also found that orange (cv Blood Red) fruits wrapped in polyethylene bags and stored at 4—6 C showed high level of acidity than those kept in news paper at ambient temperature.

Ascorbic acid (vitamin C) content of the fruits reduces with the prolongation of storage period. The ascorbic acid retention was found to be maximum (9.15 mg/100 ml) in $CaCl_2$ + perforated polythene (T_4) followed by (9.10 mg/100 ml) in Captaf + perforated polythene (T_5) after 42 days of storage whereas minimum (9.01) was found in (T_0) control after 21 days of storage (Table 4).

Ascorbic acid is quite sensitive to oxidation, the cause of retaining minimum of ascorbic acid in (T_0) control fruits might be due to rapid loss through oxidation because of greater availability of oxygen. Higher ascorbic acid content in (T_4) $CaCl_2$ + perforated polyethylene might be due to less gaseous exchange from the fruits surface under the protective cover of $CaCl_2$ and perforated polythene.

Ahlawat et al. (1984) also reported an increase in ascorbic acid content upto a certain period of storage of Kinnow fruits. Gupta et al. (1987) also suggested that application of calcium compounds retained high TSS and ascorbic acid content for longer periods than control. Keeping all the above factors into consideration it can be concluded that perforated polythene as packaging material in combination with $CaCl_2$ is the best among all the treatments for the increase in shelf life of mandarin cv Kinnow at room temperature

Table 4. Ascorbic acid (mg/100 ml of juice) as influenced by various treatments at different periods of storage. *Not in marketable condition.

	Treatment	Average ascorbic acid (mg/100 ml of juice) at different periods of storage on DAS					
		7	14	21	28	35	42
T_0	Control	13.55	11.94*	9.01*	–	–	–
T_1	$CaCl_2$ + Perforated paper bags	13.91	13.01	11.91	10.80	9.90	8.87
T_2	Captaf + Perforated paper bags	13.76	12.09	11.00	10.05	9.15	8.72
T_3	Mancozeb + Perforated paper bags	13.78	12.40	11.09	10.25	9.85	8.80
T_4	$CaCl_2$ + Perforated polyethylene bags	14.84	14.00	12.94	10.54	10.28	9.15
T_5	Captaf + Perforated polyethylene bags	14.02	13.89	12.09	11.11	10.11	9.10
T_6	Mancozeb + Perforated polyethylene bags	14.01	13.80	12.01	11.67	10.01	9.02
T_7	$CaCl_2$ + Bamboo basket	13.70	12.01	10.91	10.00	9.05	–
T_8	Captaf + Bamboo basket	13.67	11.95	10.82	9.84	9.01	–
T_9	Mancozeb + Bamboo basket	13.65	11.82	10.75	9.72	8.87	–
	SE (±)	NS	NS	NS	2.422	2.240	3.252
	CD at 5%	NS	NS	NS	5.053	4.672	6.783

and the fruits can be stored upto 42 days without affecting its marketable quality.

References

Ahlawat V. P., B. S. Daulta and J. P. Singh. 1984. Effect of pre-harvest application of GA_3 and captaf on storage behavior of Kinnow mandarin hybrid. *Haryana J. Hort. Sci.* 13 : 4—8.

Angadi S. G. 1938. *Effect of temperature on storage of coorg Mandarin* (*Citrus reticulate*). M.Sc. thesis, Univ. Agric. Sci., Bangalore, India.

Attia M. M. 1995. Effect of post harvest treatments on fruit losses an keeping quality of Balady oranges through cold storage. *Alexandria J. Agric. Res.* 40 : 349—363.

Bhadu R. 1983. *Studies on post-harvest physiology of guava.* M.Sc. thesis. HAU, Hisar, India.

Dris R. and R. Niskanen. 1999. Calcium chloride sprays decrease physiological disorders following long term cold storage of apples. *Pl. Foods for Human Nutr.* 54 : 159—171.

Dutt S. C., K. P. Sarkar and A. N. Bose. 1969. Storage of mandarin oranges. *Indian. J. Hort.* 17 : 60—68.

Falak N., Mohammad Jan, Manzoor, Nazki; F. K. Kan and T. H. Shah. 1997. Effect of storage temperature and packaging material on the extension storage life of orange (cv Blood Red.) *Sarhad J. Agric.* 13 : 299—302.

Gupta O. P., S. Sidiqui and K. S. Chauhan. 1987. Evaluation of various calcium compounds for increasing the shelf life of ber fruits. *Indian J. Agric. Res.* 21 : 65—70.

Rangana S. 1986. *Handbook of analysis and quality control for fruit and vegetable products,* 2nd edition. Tata McGraw Hill Publ. Co. Ltd., New Delhi, India.

Singh K. K. 1971. *Storage behavior of sweet oranges and mandarins.* ICAR Publ., New Delhi, India.