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Effect of hot water treatment and oxalic acid at different regimes on storage quality of litchi fruit cv. Rose Scented under ambient conditions

E.S. Marboh*, R.L. Lal and D.S. Mishra
Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture & Technology, Pantnagar 263 415

ABSTRACT

A study was conducted in order to examine the efficacy of hot water treatment (HWT) at 98^{0}C for 30 seconds and 55^{0}C for 12 min. and its combination with oxalic acid (OA) at 0.25 and 10% for 15 min. at room temperature. The control fruits were kept untreated under the same conditions. The fruits were analyzed for physico-chemical characteristics at every one day interval. Combined treatments of HWT (55^{0}C, 12 min) and OA (10%, 15 min.) followed by HWT (98^{0}C, 30 sec) and OA (10%, 15 min.) recorded significantly the lowest level of browning and spoilage loss, and have registered highest marketability percentage, TSS, ascorbic acid content and titratable acidity. However, results suggest that treatment with HWT (55^{0}C, 12 min.) + OA (10%, 15 min.) was most effective in preserving the physiological changes and enhancing quality of litchi fruit.

Key words: Litchi, browning index, hot water treatment, oxalic acid, ambient storage.

INTRODUCTION

Physiological browning and pathological diseases are the two major constraints that limit the marketing scope of litchi in any litchi industry (Zauberman *et al*., 18). Litchi fruit is very delicate in nature and highly perishable, which accounts for its low shelf life. Wherever it is grown, its shelf life under ambient conditions is never more than 24 to 72 h (Kumar and Kumar, 4). The attractive bright red colour may be lost within 48 hrs (Underhill and Critchley, 16). Studies carried out by workers around the world, have pointed out that pericarp browning in litchi is due to the involvement of several factors *viz.,* enzymatic activities, desiccation, pH (Underhill and Critchley, 17), temperature (chilling injury), mechanical injury, pathogen and pests attack and senescence (Fitzell and Coates, 3).

Sulphur-dioxide fumigation has been used commercially to control pericarp browning (Zauberman *et al*., 18) but this practice leaves undesirable residues, alters the fruit taste and result in health hazards for consumers and pack house workers (Sivakumar *et al*., 14). Therefore, maintenance of litchi fruit quality during storage has necessitated the development of an alternative postharvest technology. In this regard, an investigation was conducted to study the effect of post-harvest treatments, using oxalic acid and hot water treatment at different regimes. Heat treatments have been used to extend storability of several fruits including pomegranate (Mirdehghan *et al*., 8) and litchi (Lichter *et al*., 6). Zheng *et al*. (19) reported that use of oxalic acid could give good control of postharvest deterioration mango fruit. The objective of this study was to investigate the effect of various treatments in inhibiting browning and deterioration of litchi fruit during ambient storage.

*Corresponding author's present address: Division of Fruits and Horticultural Technology, IARI, New Delhi 110 0012;
E-mail: evening_stone@yahoo.com

MATERIALS AND METHODS

Mature fruit of litchi (*Litchi chinensis* Sonn.) cv. Rose Scented were obtained from an orchard of Horticulture Research Centre, Patharchatta, Uttarakhand. Fruits were selected for uniformity of shape, colour and size and any diseased or blemished fruit discarded. Fruits were destalked (up to 0.5 cm. long pedicels), pre-cooled and subjected to various treatments within 3 hour of harvest. Fruits were subjected to the following different treatments *viz*., T_1 = Precooling; T_2 = Without Precooling; T_3 = HWT (55^{0}C, 12 min); T_4 = HWT (98^{0}C, 30 sec); T_5 = HWT (55^{0}C, 12 min.) + 0.25% OA (15min.); T_6 = HWT (55^{0}C, 12 min) + 10.0% OA (15min); T_7 = HWT (98^{0}C, 30 sec) + 0.25% OA (15 min.); T_8 = HWT (98^{0}C, 30 sec) + 10.0% OA (15min.).

Control fruits (precooling, without precooling and HWT) was included for comparison. Precooling was done

Table 1. Physiological loss in weight (%), browning index and spoilage percentage of litchi fruits during room temperature storage as affected by various treatments.

Treatment	PLW (%) Storage days					Browning index Storage days					Spoilage (%) Storage days				
	1	2	3	4	Mean	1	2	3	4	Mean	1	2	3	4	Mean
T_1	1.59	2.25	3.27	4.90	3.00	36.67	46.67	113.33	210.00	101.67	0.00	11.67	35.00	48.33	23.75
T_2	1.73	2.51	3.31	5.67	3.31	43.33	53.33	133.33	223.33	113.33	0.00	8.33	30.00	43.33	20.42
T_3	0.87	1.89	3.00	4.53	2.57	276.67	296.67	436.67	500.00	377.50	0.00	6.67	26.67	40.00	18.33
T_4	2.21	2.63	3.83	7.56	4.06	366.67	443.33	473.33	500.00	445.83	0.00	8.33	28.33	45.00	20.42
T_5	1.79	2.56	3.67	5.84	3.47	106.67	196.67	266.67	313.33	220.83	0.00	6.67	25.00	35.00	16.67
T_6	1.89	2.58	3.76	6.56	3.70	0.00	0.00	31.67	53.33	21.25	0.00	0.00	11.67	23.33	8.75
T_7	1.92	3.10	4.69	6.92	4.16	56.67	256.67	453.33	500.00	316.67	0.00	6.67	26.67	38.33	17.92
T_8	2.29	3.17	5.65	9.23	5.08	0.00	0.00	32.67	56.67	22.33	0.00	3.33	13.33	26.67	10.83
Means	1.79	2.59	3.90	6.40	3.67	110.83	161.67	242.63	294.58	202.43	0.00	6.46	24.58	37.50	17.14
			CD at 5%					CD at 5%					CD at 5%		
Treatment (A)			0.24					10.29					4.12		
Storage days (B)			0.17					7.28					2.91		
A × B			0.49					20.59					8.24		

Table 2. TSS, titratable acidity and ascorbic acid content of litchi fruits during room temperature storage as affected by various treatments.

Treatment	TSS (%) Storage days						Acidity (%) Storage days						Ascorbic acid (mg/ 100 g pulp) Storage days					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean	0	1	2	3	4	Mean
T_1	15.93	16.23	16.77	17.37	17.77	16.81	0.46	0.42	0.39	0.36	0.33	0.39	28.91	23.97	19.14	13.35	9.74	19.02
T_2	16.03	16.37	16.85	17.53	17.90	16.94	0.45	0.40	0.39	0.35	0.33	0.38	28.86	24.58	17.47	13.81	9.52	18.85
T_3	16.15	16.53	16.97	17.53	17.87	17.01	0.41	0.37	0.33	0.32	0.30	0.35	29.02	25.41	18.20	13.81	10.21	19.33
T_4	16.09	16.33	16.77	17.63	18.03	16.97	0.47	0.41	0.39	0.34	0.32	0.39	29.30	24.80	17.81	13.81	9.60	19.06
T_5	16.23	16.62	17.10	17.43	17.93	17.06	0.43	0.39	0.35	0.32	0.30	0.36	28.58	24.58	19.27	14.24	10.32	19.40
T_6	16.23	16.72	17.27	17.83	18.33	17.28	0.45	0.41	0.38	0.36	0.33	0.39	29.13	25.36	19.45	14.35	10.38	19.73
T_7	16.13	16.50	17.06	17.47	17.88	17.01	0.50	0.41	0.38	0.36	0.33	0.40	29.24	25.14	18.90	13.09	8.88	19.05
T_8	16.13	16.47	17.07	17.60	18.05	17.06	0.48	0.44	0.40	0.37	0.34	0.40	29.58	24.02	18.23	14.29	10.16	19.26
Means	15.93	16.23	16.77	17.37	17.77	16.81	0.46	0.41	0.38	0.35	0.32	0.38	29.08	24.73	18.56	13.84	9.85	19.21
			CD at 5%						CD at 5%						CD at 5%			
Treatment (A)			0.12						0.01						0.22			
Storage days (B)			0.09						0.010						0.17			
A × B			NS						NS						0.49			

for one hour using iced water at 5^{0}C followed by air drying at room temperature. Each treatment was replicated thrice in Complete Randomized Block Design. After soaking, fruits were placed inside the polythene bags maintained at 2% level of ventilation and kept for observations under ambient conditions. Each treatment had fifty fruits per replication and sampled periodically at every one day interval. The fruits were assessed for physiological loss in weight, browning index, spoilage loss, TSS, titratable acidity and ascorbic acid content. For browning, the following scale was used (Ramma, 11): 0 = no browning (excellent quality); 1 = slight browning; 2 = 25% browning; 3 = 25–50% browning; 4 = 50-75% browning and 5 > 75% (very poor quality). Browning index was calculated as Ó (browning scale x percentage of corresponding fruit within each class). Total soluble solids (TSS) was measured with help of hand refractometer. Titratable acidity and ascorbic acid content were evaluated according to the method described by Ranganna (12).

RESULTS AND DISCUSSION

The fruit weight loss during the storage period of 4 days significantly increased with increasing period of storage. Lowest weight loss (2.57%) was noted in HWT (55^{0}C, 12 min) i.e. T3 which might be due to the recrystallisation or melting of the epicuticular wax, thereby reducing respiration and transpiration rate (Lichter *et al*., 6). Whereas, treatment that involves a combination of HWT (98^{0}C, 30 s) and OA (10%, 15 min) dipping in T_8 treatment was found to record the highest weight loss (5.08%) which might be due to a reduction in fruit firmness, indicating structural damage to the cross-linkages in the cell wall (Olesen *et al.,* 9) (Table 1).

Atinut *et al.* (1) reported that, higher the concentration of acid used greater is the degree of browning inhibition which supports the finding of higher browning index in fruit treated with HWT and OA at low concentration (0.25%). Maximum reduction (21.25) in browning was noted in T_6, which was statistically *at par* with T_8. This might be due to inhibition of PPO and POD activities. Highest browning index (377.50 and 445.83) in fruit treated with HWT (T_3 and T_4) may possibly be due to extensive browning caused by increased anthocyanase activity as reported by Underhill and Critchley (16)

Percentage of spoilt fruits was found significantly highest in control *i.e.* T_1 (23.75%), which was statistically *at par* with T_4 and T_2; while lowest spoilage (8.75%) in T_6 which was also statistically *at par* with T_8 (10.83) might be due to the fungistatic effects of the applied treatments - HWT by killing the organisms on and below the fruit surface as reported by Fallik *et al*. (2) in apples, and OA by providing an acidic conditions on the peel surface that makes most fungi difficult to develop as confirmed by Lichter *et al.* (5) in litchi (Table 2).

Treatments showed a progressive increase in fruit TSS from the day just after treatment (16.12%) upto the end of the 4 days (17.97%) storage period. Significantly, maximum TSS (17.28%) was recorded in fruits treated with T_6, while lowest TSS (16.81%) was recorded in T_1. Increase in TSS of fruit during storage at ambient storage conditions might be due to large loss of water from fruits (Ray *et al.,* 13) in which the concentration of sugars might have increased.

Titratable acidity of fruits was significantly affected by treatments and recorded lowest titratable acidity (0.35%) in T_3, while highest titratable acidity (0.40%) was reported in T_8 and T_7 which was statistically *at par* with T_6, T_4 and T_1, whereas minimum acidity (0.35%) was recorded in T_3 which was also *at par* with T_5. There occurred a gradual declining trend in acidity of fruit in all treatments with advancement of storage period, which might be due to utilization of organic acids in respiratory process and other biodegradable reactions (Mahajan, 7).

Throughout the entire storage period, massive reduction in ascorbic acid was observed regardless of treatments in which more than 50% loss was observed on the 3rd day of storage. Maintenance of higher ascorbic acid content ((19.73 mg/100g pulp) by T_6 treatment might be due to the inhibitory effect on ascorbic acid oxidation (Tannerbaum *et al.*, 15). Ascorbic acid being sensitive to light, oxygen and heat, its enormous reduction might be due to the fact that it was easily oxidize in the presence of oxygen by both enzymatic and non-enzymatic catalyst, and therefore, is liable to be lost during storage (Rai *et al.,* 10). Minimum ascorbic acid content (18.85%) was recorded in T_2 which was statistically *at par* with T_1, T_7 and T_4 respectively

From the present study, it can be concluded that treatment with hot water (HWT) at 55^{0}C for 12 min followed by dipping in oxalic acid (OA) at 10% for 15 min was the most effective treatment for maximum retention of physico-chemical parameters of litchi fruit at ambient temperature.

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