Indian J. Hort. 69(4), December 2012: 484-488

Effect of hot water treatment and oxalic acid on colour retention and storage quality of litchi fruit cv. Rose Scented

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ABSTRACT

Post-harvest browning, highly perishable nature and poor shelf-life of litchi cv. Rose Scented fruits are the major constraints that significantly reduce its commercial potential in the fresh market. To overcome these maladies, an investigation using Hot Water Treatment (HWT) at 55°C for 12 min., alone or in combination with 10% oxalic acid (OA) for 15 min. along with control (pre-cooling and without pre-cooling), was conducted under cold storage conditions (5°C and 85 ± 5% RH). Treated fruits were placed inside the polythene bags kept at 2% ventilation level. Commercial sulphur dioxide (SO_2) fumigation was also included for comparison. Litchi fruits that were treated with a combined treatment of HWT at 55°C for 12 min. and 10% OA for 15 min. stored well upto 18 days under cold storage conditions, with maximum retention of red pericarp colour and very good sensory and quality attributes, registering maximum marketability percentage, TSS content and titratable acidity.

Key words: Litchi, hot water treatment, oxalic acid, sulphur dioxide fumigatigon, browning, cold storage.

INTRODUCTION

It is well known that the reddish skin of litchi (*Litchi chinensis* Sonn.) fruit is one of the most important aspects of fruit quality. Unfortunately, litchi fruit rapidly deteriorates once harvested, which results in skin browning, being the first visual symptom of deterioration (Jaiswal *et al.*, 4). For maintaining postharvest litchi fruit quality, SO_2 fumigation and hydrochloric acid dipping (Underhill *et al.*, 19) was in vogue. However, the rising health concerns among consumers against the negative impact of sulphur fumigation and HCl (Son *et al.*, 17) has necessitates the search for alternative postharvest treatments that can overcome the above problems without compromising on fruit quality.

Oxalic acid (OA) is a metabolic product that is distributed among different organs of plants. Kayashima and Katayama (5) considered that OA was available as a natural antioxidant and might play an important role in the natural and artificial preservation of oxidized materials. This fact suggests that treatment with controlled OA is a safe and promising method for controlling litchi pericarp browning during postharvest storage. Oxalic acid is the most effective anti-browning agent on apple slices (Son *et al.*, 17), while HWT alone or HWT followed by an HCl dip are also effective in reducing browning and maintaining a distinct red color which seem to be more attractive than the SO_2- treatment of litchi fruit (Litcher *et al.*, 7).

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MATERIALS AND METHODS

The experiment was carried out at the Department of Horticulture, GBPUA&T, Pantnagar, Uttarakhand. Litchi fruits of cv. Rose Scented of uniform maturity, harvested from an orchard of Horticulture Research Centre, Patharchatta (Uttarakhand), were used for this study. The harvested fruits were destalked (up to 0.5 cm long pedicels), graded and pre-cooled for 1 h using ice-cooled water at 5°C. The different treatments consists of pre-cooling (T_1), without pre-cooling (T_2), HWT at 55°C for 12 min. (T_3), sulphur treatment @ 0.5 g kg^{-1} fruit (T_4), and HWT (55°C, 12 min.) + 10% OA for 15 min. (T_5). After pre-cooling, fruits were air dried. For applying HWT and OA, the air-dried pre-cooled fruits were dipped in hot water kept at 55°C for 12 min., air dried and finally dipped in 10% OA for 15 min. The air dried fruits were then placed inside the polythene bags maintained at 2% level of ventilation and kept for observations under cold storage conditions (5 ± 1°C and 85 ± 5% RH). Sulphur fumigation for fruits was carried out by burning sulphur inside a closed chamber for 45 min. Fruits subjected to pre-cooling, without pre-cooling, HWT and sulphur fumigation were included for comparisons. Each treatment was replicated four times and each replication consists of fifty fruits. Observations on physico-chemical properties were carried out periodically at every three days interval for physiological loss in weight, browning index, decay loss, marketability, TSS, titratable acidity, fruit colour and taste.

Fruit TSS and titratable acidity were evaluated as per the method suggested by Ranganna (13). Post harvest decay was assessed on a 1-5 hedonic scale, based on the severity of post harvest fungal decay : 1 = no decay; 2 = 25%; 3 = 50%; 4 = 75% of the fruit surface affected and 5 = 100% fruit decay and oozing (De Jagger and Korsten, 1). Browning index was evaluated using the following scale (Ramma, 12): 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) and was calculated using the following formula: Browning Index = Σ (browning scale × percentage of corresponding fruit within each class). Fruit marketability was assessed visually using hedonic based on the method adopted by Sivakumar *et al.* (15). Fruit colour and taste was evaluated at every 6 days intervals, using a semi-trained panel consisting of five judges, based on the following scale: 5 = Excellent; 4 = Good; 3 = Fair (acceptable); 2 = Poor (unacceptable for export); 1 = Very poor (totally unacceptable).

The experiment was laid out in two factor Complete Randomized Block Design The data were analyzed according to the procedure suggested by Snedecor and Cochran (16) applying the least significant differences (LSD) at 5% for comparison among the treatment means. Experimental data were the mean ± SEM of four replicates of the determinations for each sample.

RESULTS AND DISCUSSION

Data presented in Table 1 revealed that the fruit weight loss during the storage was significant regardless of various treatments. Lowest weight loss (5.20%) was significantly noted in singly hot water treatments, which might be due to the recrystallisation or melting of the epicuticular wax which covered and sealed barely visible cracks and stomata on the fruit surface, thereby reducing respiration and transpiration rate as opined by Lichter *et al*. (7). However, treatment that involves a combination of HWT (55°C, 12 min.) and 10% OA dipping for 15 min. record the highest weight loss (5.94%), which might be due to a reduction in fruit firmness, indicating structural damage to the cross-linkages in the cell wall (Saengnil *et al.*, 14; Neog and Saikia, 10).

Pericarp browning increased with storage time and used of OA significantly reduced pericarp browning. Minimum browning index was recorded in HWT (55°C, 12 min.) + 10% OA for 15 min. (Fig. 1A), which might be due to the effect of HWT prior to an OA dip, in facilitating the penetration of acid (Lichter *et al*., 7) thereby inhibiting polyphenol oxidase (PPO) and peroxidase (POD) activities and results in stabilization of anthocyanins (Lichter *et al*., 7; Saegnil *et al*., 14; Zheng and Tian, 20). However, use of HWT alone has been found to accelerate the extent of browning in fruits which is primarily attributed to enhanced anthocyanase activity due to loss of compartmentation of enzymes and substrates as reported by Hu *et al*. (3).

During the investigation, it was found that highest significant decay index was noted in fruits without precooling. However, under the combined HWT (55°C, 12 min.) + 10% OA for 15 min, fruit spoilage was not observed (Fig. 1 B). This might be due to the combined fungistatic effects of the applied treatments, *i.e.*, HWT by killing the organisms on and below the fruit surface as in apples (Fallik *et al*., 2) and OA by providing an acidic conditions on the peel surface, that provides an unfavourable conditions for the development of most fungi, as confirmed by Lichter *et al.* (6) in litchi.

Data presented in Table 1 revealed the effect of various treatments in influencing the marketable value of litchi fruits. Highest significant effect (100.00%) due to treatments on marketability percentage of fruits was recorded in HWT (55°C, 12 min.) + 10% OA for 15 min. Interpretation of the data clearly indicates the role of the combined effects of HWT and OA in reducing browning. This may be attributed to the fact that use of HWT and OA was effective in preventing the activity of PPO and POD, as reported previously by Saegnil *et al*. (14), and Zheng and Tian (20). However, poor marketable per cent (33.50) was recorded in HWT at 55°C for 15 min. due to extensive browning.

Data presented in Table 2, clearly indicates that the highest mean TSS (17.50%) for an 18 days storage was recorded in HWT (55°C, 12 min.) + 10% OA for 15 min., whereas minimum mean TSS (17.03%) was recorded in fruits without pre-cooling which was statistically at par with pre-cooling. Interpretation of the interaction effect between treatments and storage days reveals that there was a gradual increase in TSS of fruits initially upto 9 days, which then gradually declined later on till the last day of storage. This initial increase might be due to the breakdown of starch and polysaccharides into simple sugars and organic acids and water loss during the subsequent storage, but after 9 days the decline in TSS might be due to their utilization in evapo-transpiration and other biochemical activities. However, it can be argued that the large declined in TSS due to treatments other than the combined HWT and OA treatment might be due to increased senescence of the tissues (Mahajan *et al.*, 9), which can be attributed to a decrease in aril sucrose (Paul and Chen, 11).

A gradual declining trend in the acidity content of fruit in all the treatment was observed with the advancement of storage period regardless of post harvest treatments (Table 2). However, under acid treatment, Underhill and Critchley (18) opined that there

Table 1. Effect of various treatments on physiological loss in weight and marketability of litchi fruits during cold storage.

Treatment	Physiological loss in weight (%)							Marketability (%)						
	Storage period (day)						Mean	Storage period (day)						Mean
	3	6	9	12	15	18		3	6	9	12	15	18	
T_1	1.64	3.91	5.68	6.43	7.28	8.33	5.54	87.50	72.25	50.75	33.75	22.75	11.50	46.42
T_2	1.78	3.97	5.78	6.61	7.77	8.52	5.74	80.75	69.50	49.50	36.25	22.25	7.78	44.34
T_3	1.73	3.45	5.38	6.28	6.89	7.50	5.20	68.75	58.75	37.50	23.75	12.25	0.00	33.50
T_4	1.86	4.04	5.92	6.74	7.26	7.88	5.62	100.00	100.00	100.00	97.25	91.75	84.50	95.58
T_5	2.29	4.26	6.13	7.09	7.60	8.25	5.94	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mean	1.86	3.93	5.78	6.63	7.36	8.09	5.61	87.40	80.10	67.55	58.20	49.80	40.76	63.97
						CD at 5%							CD at 5%	
Treatment (A)						0.23							2.59	
Storage period (B)						0.25							2.84	
A × B						NS							6.35	

Table 2. Effect of various treatments on total soluble solids and titratable acidity of litchi fruits during cold storage.

Treatment	Total soluble solids (%)								Titratable acidity (%)							
	Storage period (day)							Mean	Storage period (day)							Mean
	0	3	6	9	12	15	18		0	3	6	9	12	15	18	
T_1	15.68	16.48	17.25	17.90	17.73	17.55	17.18	17.11	0.56	0.47	0.39	0.32	0.28	0.22	0.19	0.34
T_2	15.85	16.38	17.18	17.73	17.60	17.43	17.05	17.03	0.56	0.45	0.37	0.30	0.24	0.21	0.18	0.33
T_3	16.05	16.58	17.40	18.03	18.00	17.95	17.65	17.38	0.55	0.42	0.33	0.27	0.24	0.21	0.15	0.32
T_4	15.97	16.55	17.38	17.95	17.88	17.75	17.58	17.30	0.59	0.49	0.41	0.35	0.30	0.25	0.23	0.37
T_5	16.06	16.73	17.58	18.18	18.13	17.98	17.83	17.50	0.60	0.48	0.41	0.37	0.32	0.29	0.26	0.39
Mean	15.92	16.54	17.36	17.96	17.87	17.73	17.46	17.26	0.57	0.46	0.38	0.32	0.28	0.24	0.20	0.35
						CD at 5%								CD at 5%		
Treatment (A)						0.26								0.01		
Storage period (B)						0.31								0.01		
A × B						NS								0.03		

was a slight penetration of acid into the fruit aril which however, did not reduce the eating quality. This might be responsible for the higher titratable acidity (0.39%) in fruits treated with HWT (55°C, 12 min.) + 10% OA for 15 min. Lowest acidity (0.32%) was noted in HWT at 55°C for 12 min., which might possibly be due to the utilization of organic acids in respiratory process and other biodegradable reactions (Mahajan, 8).

As illustrated in Fig. 1 (C and D), pronounced effects of the applied treatments on the organoleptic parameters of fruit was observed. Among the treatments, HWT (55°C, 12 min.) + 10% OA exerts the most superior effect in improving fruit colour and taste of litchi fruit cv. Rose Scented over an 18 days storage period. This might be due to the role of the applied treatment in inhibiting pericarp browning and

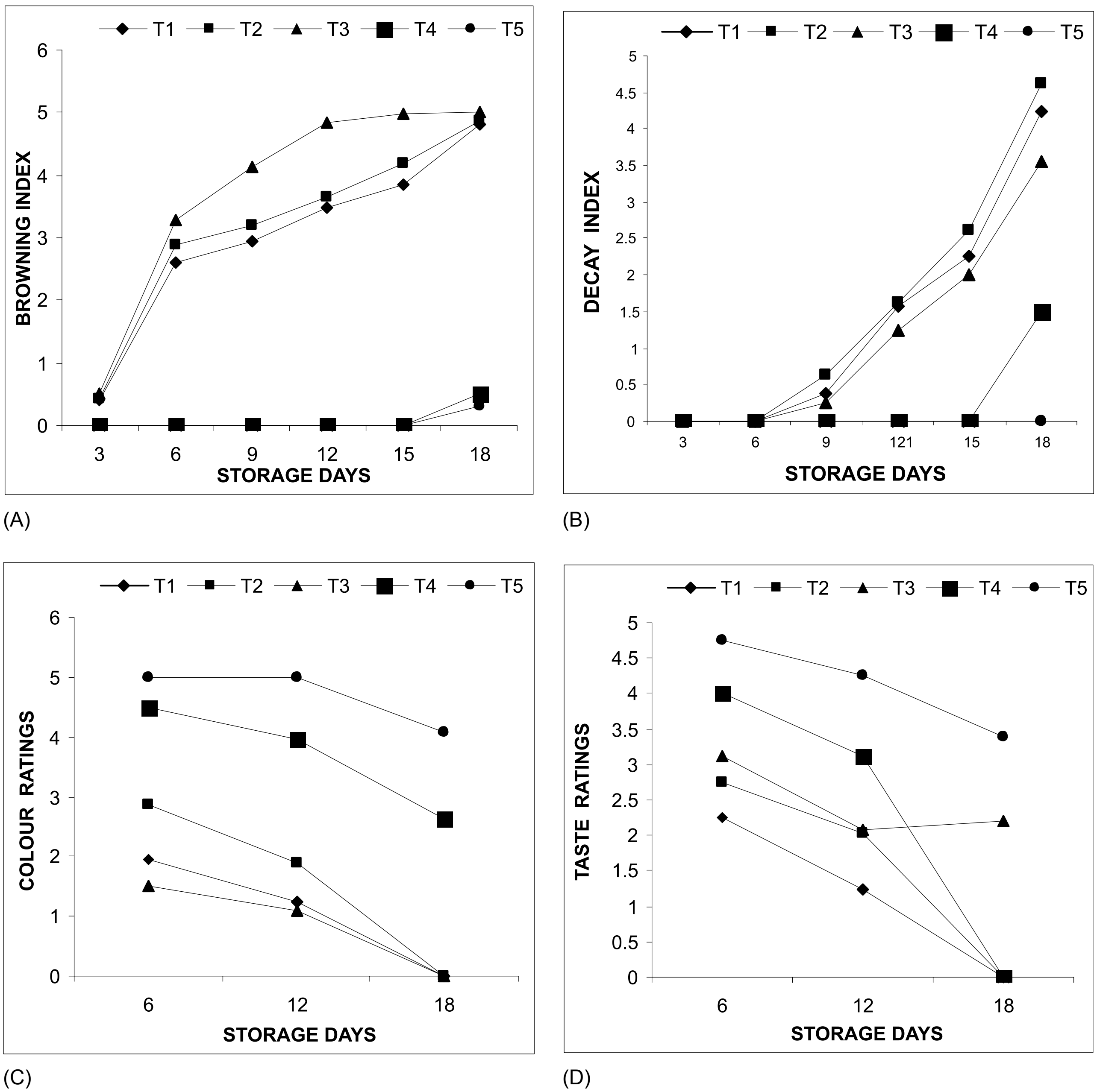

Fig. 1. Effect of different treatments on storage quality of litchi. T_1 = pre-cooling; T_2 = Without pre-cooling; T_3 = HWT (55°C, 12 min.); T_4 = sulphur treatment (0.5 g/ kg fruit); T_5 = HWT (55°C, 12 min.) + 10% OA (15 min.) on (A) Browning index (B) decay index, (C) colour, and (D) taste of litchi fruits.

disease development as well as maintenance of higher TSS and acidity content of fruits, as reported earlier by many workers (Underhill and Critchley, 18; Saegnil *et al*., 14; Zheng and Tian, 20).

In the light of these data, it can be concluded that treatment with hot water (HWT) at 55°C for 12 min. followed by dipping in oxalic acid (OA) at 10% for 15 min. and stored at low temperature (5°C and 85 ± 5% RH) was the most effective treatment for maximum retention of physico-chemical parameters of litchi fruit.

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Received : October, 2011; Revised : July, 2012;
Accepted : September, 2012