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Effect of postharvest treatments on shelf-life and quality of litchi

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Abstract

Effect of postharvest treatments on shelf-life and quality of litchi cvs. 'Bombai' and 'Madraji' were studied. Fruits of both the cultivars were stored in polyethylene bags, bamboo baskets with litchi leaf lining and open conditions at 5 °C and under ambient temperature for 9 days. In all the cases, fruits stored in open conditions lost weight rapidly and became unmarketable within 3 days due to rapid pericarp browning. In contrast, fruits kept in polyethylene bag had reduced weight loss and retained pericarp colour greatly during storage. Decay symptom was observed when the fruits were stored in ambient temperature either in polyethylene bags or in bamboo baskets with litchi leaf lining. However, no decay symptom was found in fruits kept at 5 °C irrespective of storage treatments. The changes in TSS, ascorbic acid and total phenolics in the aril were minimum in the treatment of polyethylene bags than that of bamboo baskets with litchi leaf lining and open conditions. Overall, fruits of both cultivars showed similar storage behavior and maintained better quality at 5 °C than ambient temperature.

Key words: Postharvest, storage temperature, polyethylene bag, shelf-life, quality, *Litchi chinensis*

Introduction

Litchi (*Litchi chinensis* Sonn.) is a highly priced and popular fruit of Bangladesh due to its unique taste, flavour and colour. It grows almost all over Bangladesh but its commercial production is centered largely in the northern and eastern regions of the country. The pericarp browning is considered the most important postharvest problem of litchi which is usually caused by dehydration of the pericarp and browning can become apparent when as little as 2% of the pericarp moisture is lost after harvest (Underhill and Critchley, 1994). Although sensory quality of the flesh is not affected, this alteration clearly reduces the commercial value of the fruit. Molla *et al.* (2010) estimated about 20% of postharvest losses of litchi in Bangladesh, even as high as 50% prior to consumption (Amiruzzaman, 1990).

The retention of fresh red pericarp color from harvest to consumption is a major focus of postharvest issue of litchi. During the last decade intense interest is aroused on the postharvest handling of this fruit. Sulphur-based treatment (Tongdee, 1994) is an established method to reduce postharvest loss of litchi in many countries. But due to increasing concerns of health and environmental issues, these methods have been limited in USA, Europe and Japan (Wu *et al.,* 2011). Use of coating treatments: chitosan (Zhang and Quantick, 1997), polysaccharide coatings (York, 1995) and wax (Underhill and Simons, 1993) are also well documented. Coatings are used commercially on other fruits but in litchi it is not viable. Several researchers showed that controlled atmosphere (Duan *et al.,* 2004) and modified atmosphere packaging (Pesis *et al.,* 2002) technologies significantly reduced pericarp browning. But due to high cost, the benefits have not been promising enough for their commercial adoption in developing countries like Bangladesh.

The use of low temperature treatment combined with packaging is the most common method of minimizing postharvest moisture loss of horticultural commodities (Ryall and Lipton, 1979) which is usually simpler and more economical compared to other methods. Olesen and Wiltshire (2000) found that storage at 5 ºC for 3 weeks resulted in better colour retention and less weight loss. To the best of our knowledge, there is no accessible published information regarding cost-effective storage technique of litchi. Therefore, the present investigation was undertaken to investigate the effects of storage temperature and packaging on the shelf-life and quality of litchi.

Materials and methods

Experimental site: The experiment was carried out both at the laboratories of Horticulture, and Food Science and Preservation, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The experiment was conducted during May to June, 2015.

Plant materials: Two commercial cultivars of litchi: 'Bombai' and 'Madraji' were chosen. Fruits of uniform size, shape, weight as well as diseases and injury-free were harvested from the well managed orchard and immediately transferred to the laboratory. Fruits along with approximately 15 cm of branches were used.

Design of the experiment: The experiment was arranged in the completely randomized design. Ten fruits of each cultivar were selected randomly and stored in the following six storage conditions: (i) T_1: Open condition at ambient temperature; (ii) T_2: Open condition at 5 ºC; (iii) T_3: Bamboo baskets lined with litchi leaves and kept at ambient temperature; (iv) T_4: Bamboo baskets lined with litchi leaves at 5 ºC; (v) T_5: LDPE (low density polyethylene) bags (with 4 small perforations) and kept at ambient temperature and (vi) T_6: LDPE bags (with 4 small perforations) and kept at 5 ºC. Note that in Bangladesh, litchi fruits are generally packed in bamboo baskets lined with litchi leaves. For storage at 5 ºC, fruits were kept in a refrigerator (Hitachi, Japan) maintaining 5 ºC and 80 ± 5% relative humidity (RH) throughout the experimental period. For ambient condition, fruits were stored at the laboratory and the daily data on temperature and relative humidity during the experimental period were obtained using a combined thermometer and hygrometer. The average daily air temperature of 32 ºC was recorded and 69% relative humidity was observed during the period. In all storage conditions, fruits were stored for 3, 6 and 9 days.

Pericarp colour: Litchi fruit colour was recorded using a Chromameter (Konica Minolta CM 250d, Japan) calibrated against a standard white plate. Chromatic analysis was carried out following the CIE (Commission International de l'Eclairage) system of 1976. Values of L*, a* and b* were measured to describe the three dimensional colour space and interpreted as follows: L* indicating lightness, a* value indicating redness and a positive b* value yellowness (Hutchings, 1994). The pericarp colour was expressed in terms of L, Chroma (C*) and Hue angle (H^o) as the changes of pericarp colour during storage of the fruit was better described using C* and H^o than a* and b*. The hue angle (H^o), hue = arctangent (b*/a*), represented red-purple (0^o), yellow (90^o), bluish-green (180^o) and blue (270^o) (McGuire, 1992). The chroma (C*), obtained from $(a^{*2} + b^{*2})^{1/2}$, corresponded to the intensity or colour saturation, in which low values represented dull colour while high values represent vivid colour. The pericarp colour was measured in the central region of individual fruit from the beginning till the end of the storage period. The data of each measurement are the average of duplicated measurements at two opposite points on the equator of each fruit.

Percentage weight loss: Fruits were individually weighed before the storage treatment and also weighed after the said storage period. Fruit weight loss was calculated as the percent reduction in weight. However, individual fruit weight was measured using an electronic balance (G & G, T100, Germany) and recorded in grams.

Postharvest decay analysis: The incidence of postharvest disease was recorded by scoring in percentage of incidence on a visual scale of 1 to 5, which described the severity of postharvest fungal decay as 1 = no disease, 2 = 25%, 3 = 50% and 4 = 75% of fruit surface affected by fungal diseases and 5 = entire fruit surface was brown (Sivakumar and Korsten, 2006).

Total soluble solids: Fruits were peeled, and the pericarp, aril tissues (flesh) and stone (seed) were separated. Aril tissue was then gently squeezed and a few drops of juice were used to determine total soluble solids (TSS) using a digital refractometer (Hanna Instruments, Romania).

Ascorbic acid content: Ascorbic acid content (mg 100 g^{-1} fresh weight) was determined using the spectrophotometric procedure (Bajaj and Kaur,1981). Five grams of fresh tissue were homogenized in a 100 mL oxalic acid-EDTA cold solution. The absorbance at 760 nm was measured with a UV/VIS spectrophotometer (PG Instrument Ltd. Model T60, UK). Ascorbic acid concentration was quantified using a standard curve of L-ascorbic acid and expressed as mg 100 g^{-1} of the fresh weight.

Total phenol content: The total phenolic compounds were quantified using Folin–Ciocalteu reagent (FC) and the colorimetric method of Singleton and Rossi (1965). Extraction was done according to Velioglu *et al.* (1998) using 1 g fresh flesh. The tissues were disrupted into the extraction medium using a homogenizer (VELP Scientifica, Italy). The absorbance was measured at 765 nm using a UV/VIS spectrophotometer (PG Instrument Ltd. Model T60, UK). Then the phenol content was estimated from a standard curve of gallic acid and results were expressed as mg of gallic acid equivalents (GAE) 100 g^{-1} of the fresh fruit.

Statistical analyses: One factor analysis of variance (ANOVA) was conducted for all variables using the Statgraphics Plus Version 2.1 statistical program (STSC, Inc., 1987). The means were compared using Fisher's Least Significant Difference (LSD) while the Student t-test was used to compare pairs of means. All treatment means were regarded as significant with $P \leq 0.05$.

Results and discussion

Severe pericarp browning and decay symptoms were observed in the fruits of both cultivars after 6 and 9 days of storage, respectively in T_1 (open condition at ambient temperature), T_2 (open condition at 5 °C) and T_3 (bamboo basket at ambient temperature) treatments. So, the results for these treatments are not presented here.

Pericarp colour: The results indicated that the pericarp colour was cultivar dependent. At harvest, 'Bombai' showed comparatively higher L and C* value than 'Madraji', whilst H° was higher in 'Madraji' (Table 1). In both the cultivars, a significant decrease in L and C* were detected in all the fruits kept in ambient temperature except the polyethylene bag treatment at 3 and 6 days of storage, indicating fruits became darker in these storage conditions. On the other hand, no significant changes in L and C* were observed when stored at 5 °C except in open condition at 6 days and bamboo basket at 9 days, respectively (Table 1). Regarding hue angle, H° decreased in the fruits stored at 5 °C regardless of storage treatments in both the cultivars except the open condition at 6 days storage and bamboo baskets at 9 days, respectively. An increase in H° was recorded in the fruits of both the cultivars stored at ambient temperature combined with all storage treatments over time except in the polyethylene bag treatment up to 6 days, indicating fruits turned to deeper brown.

The pericarp colour is an important quality parameter that affects the consumers' decision to purchase or not. The pericap colour of fruits stored in open condition and bamboo baskets had lower L and C* with higher H° than the fruits kept in polyethylene bags at 5 °C indicating that polyethylene bags successfully maintained brighter red colour. The water loss from fruits stored in polyethylene bags could have reduced desiccation and browning ratio. It is also observed that fruits stored at 5 °C maintained brighter and more red pericarp colour than those kept at ambient temperature which is in agreement with the findings of Somboonkaew (2010) where fruits of litchi cvs. 'Kom' and 'Maruritius' stored at 5 °C maintained better pericarp colour than 13 °C. The increase in H° recorded in fruits kept in ambient condition indicated that fruits became darker and turned deeper brown which is in agreement with those of Kaewchana *et al.* (2006) who observed a very slight increase of H° in litchi cv. 'HongHuay' stored at 20 °C for 9 days.

Table 1. Changes in pericarp colour of litchi cvs. Bombai and Madraji in relation to storage treatments and duration

Treatments	Changes in pericarp colour of fruit at different days after storage (DAS)								
	Lightness (L*)			Chroma (C*)			Hue angle (H*)		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
‘Bombai’									
At harvest	40.58 a	40.58 a	40.58 a	34.21 a	34.21 a	34.21 a	31.54 bc	31.54 cd	31.54 b
T1	33.46 c	-	-	23.13 d	-	-	37.03 a	-	-
T2	36.84 b	33.05 c	-	31.42 b	29.29 cd	-	28.68 bc	36.64 a	-
T3	36.92 b	32.64 c	-	28.72 c	26.81 d	-	33.16 ab	34.97 ab	-
T4	38.99 ab	36.41 b	32.35 b	32.37 ab	32.70 ab	30.39 b	30.17 bc	33.87 bc	37.65 a
T5	37.24 b	37.21 b	22.76 c	30.52 bc	30.44 bc	15.62 c	28.41 c	28.57 e	33.11 ab
T6	39.76 a	38.53 ab	36.16 ab	33.85 a	33.43 a	32.20 ab	31.23 bc	30.59 de	29.67 b
LSD (P=0.05)	2.41	2.61	4.59	2.27	2.98	2.59	4.53	2.61	5.32
‘Madraji’									
At harvest	46.06 a	46.06 a	46.06 a	34.05 a	34.05 a	34.05 a	38.76 b	38.76 b	38.76 ab
T1	38.14 c	-	-	25.66 e	-	-	42.69 a	-	-
T2	42.46 b	39.36 c	-	31.07 bc	27.15 c	-	34.74 cd	45.55 a	-
T3	36.80 c	29.98 d	-	28.04 d	25.11 c	-	35.03 cd	43.68 a	-
T4	43.91 ab	42.77 b	38.95 b	33.13 ab	29.67 b	27.12 b	37.16 bc	37.97 b	42.03 a
T5	42.01 b	31.29 d	27.68 c	30.20 c	27.11 c	23.81 c	33.81 d	29.33 c	35.51 b
T6	45.65 a	44.53 ab	42.69 ab	33.76 a	33.15 a	31.72 a	38.01 b	37.36 b	36.50 b
LSD (P=0.05)	2.58	2.82	5.91	2.08	2.37	3.12	2.94	4.23	3.92

T_1: Open at ambient temperature; T_2: Open at 5 ºC; T_3: Bamboo basket at ambient temperature; T_4: Bamboo basket at 5 ºC; T_5: LDPE bag at ambient temperature; T_6: LDPE bag at 5 ºC. In each column, means followed by the same letters are not significantly different according to Fisher’s least difference test ($P\leq 0.05$)

Percent weight loss: Weight loss of all fruits increased with storage time and tended to be higher at ambient temperature than at 5 °C (Table 2). In both the cultivars, storage treatments significantly influenced weight loss whereas the weight loss of fruits stored in open condition was greater than those kept in bamboo baskets lined with litchi leaves and polyethylene bags in both the storage temperatures (5 °C and ambient temperature) (Table 2). No significant differences were detected between open condition and bamboo basket treatments irrespective of storage duration and temperature in both the cultivars (Table 2). The reduced weight loss of fruits in polyethylene bags may be due to the creation of humid atmosphere around individual fruits which reduced the water vapour transmission. It was also observed that higher storage temperature (ambient temperature) induced higher moisture loss as reported by Underhill and Critchley (1994). Higher temperature caused more free energy of water molecules which increased water movement and potential for exchange to atmosphere around fruits (Kays and Paull, 2004) resulting faster evaporation.

Postharvest decay analysis: Postharvest decay was not noted up to 3 days of storage regardless of storage treatments and temperature in both the cultivars (Table 3). However, decay were detected after 6 days of storage in both the cultivars kept in bamboo baskets and polyethylene bags at ambient temperature and afterward the incidence increased with extended storage period. On the other hand, no decay was observed in the fruits kept at 5 °C irrespective of storage treatments. In general, low temperature affected the growth and spread of pathogen and decay in fruits. In the present study, the ambient temperature promoted decay whereas storage at 5 °C inhibited the infection in both the cultivars. It is evident from the result that the storage treatment of polyethylene bags with 5 °C gave the best results in

Table 3. Decay symptoms of litchi cvs. Bombai and Madraji in relation to storage treatments

Treatments	Days after storage (DAS)					
	‘Bombai’			‘Madraji’		
	3	6	9	3	6	9
T1	1	-	-	1	-	-
T2	1	1	-	1	1	-
T3	1	1	-	1	2	-
T4	1	1	1	1	1	1
T5	1	2	3	1	3	4
T6	1	1	1	1	1	1

T_1: Open condition at ambient temperature; T_2: Unwrapped at 5 ºC; T_3: Bamboo basket at ambient temperature; T_4: Bamboo basket at 5 ºC; T_5: LDPE bag at ambient temperature; T_6: LDPE bag at 5 ºC. 1 = no incidence; 2 = one spot to 5% of disease on each fruit; 3 = 10% on fruit surface; 4 = 15% on fruit surface

Table 2. Weight loss (%) of fruits of litchi cvs. Bombai and Madraji in relation to storage treatments and duration

Treatments	Days after storage (DAS)					
	‘Bombai’			‘Madraji’		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
T1	11.01 a	-	-	12.08 a	-	-
T2	6.08 b	8.11 b	-	6.65 c	7.92 b	-
T3	10.28 a	11.50 a	-	9.83 b	11.94 a	-
T4	5.31 b	7.52 b	9.38 a	5.70 c	7.21 b	8.58 a
T5	3.52 c	4.49 c	6.13 b	2.98 d	4.08 c	5.60 b
T6	1.75 d	2.93 d	3.24 c	1.94 e	2.67 d	3.89 c
LSD (P=0.05)	0.77	0.62	0.51	1.01	0.76	0.39

T_1: Open at ambient temperature; T_2: Open at 5 ºC; T_3: Bamboo basket at ambient temperature; T_4: Bamboo basket at 5 ºC; T_5: LDPE bag at ambient temperature; T_6: LDPE bag at 5 ºC. In each column, means followed by the same letters are not significantly different according to Fisher’s least difference test ($P\leq 0.05$).

controlling decay in both the cultivars. Similar result was reported by Campbell (1959) where polyethylene bags reduced decay of litchi fruits of cvs. 'Brewster' and 'Bengal' up to 5 weeks when stored at both 2 and 7.5 °C.

Total soluble solids: At harvest, TSS (total soluble solids) content of aril was comparatively higher in cv. 'Madraji' (17.40) than of cv. 'Bombai' (15.17). In both the cultivars, a decreasing trend of TSS was detected in the fruits kept at 5 °C regardless of storage treatments whereas at ambient temperature TSS became slightly higher (Table 4). However, the changes in TSS were not significant for 3 and 9 days of storage in both the cultivars. Similarly, no significant difference in TSS was observed in fruits stored in different storage conditions except stored in bamboo basket at ambient temperature in both the cultivars. At the end of storage, the TSS of fruits from bamboo baskets with 5 °C temperature was higher than that of polyethylene bags at both the temperatures (Table 4). The results show that the changes of TSS were minimum in polyethylene bag treatment than of the open condition treatment and bamboo baskets irrespective of temperature and storage time. On the other hand, 5 °C temperature was better than ambient temperature in respect of minimizing the changes of TSS.

The minimum change of TSS recorded in the fruits stored in polyethylene bags was possibly due to low water loss which could inhibit the change of concentration of soluble solids in the aril of stored fruits which was also observed by Somboonkaew (2010). In contrast, the increases in the TSS in the fruits of open condition could be due to the higher water loss as well as respiration that accelerated fruit senescence compared to the fruits stored in polyethylene bags and bamboo baskets. The result is in agreement with those of Sivakumar and Korsten (2006) where they reported that the changes of TSS in fruits of litchi cv. 'Mauritius' could be minimized by modified atmosphere packaging. The minimum changes of TSS in fruits stored at 5 °C could be partly due to keeping the TSS unchanged by reducing the respiration in both the cultivars. Although no significant differences were detected in TSS among the storage treatments in both the cultivars at 3 and 6 days of storage but the quality of fruits mainly in open condition and ambient temperature conditions decreased.

Ascorbic acid content: At harvest, ascorbic acid content in the aril of 'Bombai' (67.19 mg 100 g^{-1} FW) was relatively higher than 'Madraji' (63.35 mg 100 g^{-1} FW). During storage, the concentration of ascorbic acid in both the cultivars followed a decreasing trend irrespective of storage treatments and temperatures (Table 5). Similar losses of ascorbic acid during storage were also observed in cv. 'Bombai' (Mahajan and Goswami, 2004), 'Calcuttia' (Nagar, 1994) and 'Huaizhi' (Zhang and Quantick, 2000), and is believed to result from enzyme-mediated oxidation of ascorbic acid (Lee and Kader, 2000). Storage temperature affected ascorbic acid in aril of both the cultivars, where fruits stored at 5 °C had comparatively higher levels of ascorbic acid than those stored at ambient temperature. Regarding storage treatment, fruits stored in open condition had the highest reduction in ascorbic acid than those in bamboo baskets and polyethylene bags, respectively in both the cultivars (Table 5). Fruits stored in polyethylene bag at 5 °C maintained better ascorbic acid contents in both the cultivars upto 4 days after storage and afterward a significant decrease was recorded. Polyethylene bag treatment delayed ascorbic acid loss possibly by reducing the rate of ascorbate oxidation.

Total phenolic content: At harvest, total phenolic contents of

Table 4. Total soluble solids (TSS) of litchi cvs. Bombai and Madraji in relation to storage treatments and duration

Treatments	Days after storage (DAS)					
	'Bombai'			'Madraji'		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
At harvest	15.17 a	15.17 ab	15.17 b	17.40 a	17.40 ab	17.40 b
T1	16.10 a	-	-	17.57 a	-	-
T2	14.30 a	16.83 ab	-	15.90 a	18.23 a	-
T3	14.77 a	17.13 a	-	16.06 a	18.47 a	-
T4	15.07 a	14.33 b	18.82 a	16.47 a	15.10 c	19.82 a
T5	14.37 a	15.37 ab	15.48 b	16.43 a	16.90 ab	17.33 b
T6	15.07 a	14.76 ab	14.75 b	17.13 a	16.53 bc	16.97 b
LSD (*P*=0.05)	2.06	2.71	1.91	2.38	1.64	2.30

T_1: Open at ambient temperature; T_2: Open at 5 ºC; T_3: Bamboo basket at ambient temperature; T_4: Bamboo basket at 5 ºC; T_5: LDPE bag at ambient temperature; T_6: LDPE bag at 5 ºC. In each column, means followed by the same letters are not significantly different according to Fisher's least difference test ($P \leq 0.05$).

Table 5. Ascorbic acid contents of litchi cvs. Bombai and Madraji in relation to storage treatments and duration

Treatments	Days after storage (DAS)					
	'Bombai'			'Madraji'		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
At harvest	67.19 a	67.19 a	67.19 a	63.35 a	63.35 a	63.35 a
T1	41.83 c	-	-	44.28 d	-	-
T2	56.09 b	49.88 d	-	55.01 bc	44.95 c	-
T3	51.30 b	41.71 c	-	50.26 c	40.94 c	-
T4	62.63 a	57.85 d	46.22 c	59.42 ab	54.88 b	45.41 d
T5	53.13 b	45.43 b	33.91 d	55.66 b	45.52 c	35.02 c
T6	66.02 a	63.65 a	59.70 b	60.99 a	58.77 ab	56.03 b
LSD (*P*=0.05)	5.81	4.21	4.96	4.92	4.83	5.65

T_1: Open at ambient temperature; T_2: Open at 5 ºC; T_3: Bamboo basket at ambient temperature; T_4: Bamboo basket at 5 ºC; T_5: LDPE bag at ambient temperature; T_6: LDPE bag at 5 ºC. In each column, means followed by the same letters are not significantly different according to Fisher's least difference test ($P \leq 0.05$).

Table 6. The total phenolics content of litchi cvs. Bombai and Madraji in relation to storage treatments and duration

Treatments	Days after storage (DAS)					
	'Bombai'			'Madraji'		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
At harvest	115.79 a	115.79 a	115.79 a	153.27 a	153.27 a	153.27 a
T1	83.58 d	-	-	124.88 e	-	-
T2	99.94 bc	89.43 c	-	143.46 cd	131.84 cd	-
T3	96.33 c	80.27 d	-	129.99 e	120.56e	-
T4	111.11 a	99.36 b	89.71 c	146.74 bc	139.91 bc	130.04 c
T5	102.80 b	92.47 c	76.67 d	139.10 d	126.83 de	99.17 d
T6	113.44 a	110.33 a	98.72 b	150.62 ab	146.63 ab	141.96 b
LSD (*P*=0.05)	5.68	6.49	7.20	6.13	8.09	9.73

T_1: Open at ambient temperature; T_2: Open at 5 ºC; T_3: Bamboo basket at ambient temperature; T_4: Bamboo basket at 5 ºC; T_5: LDPE bag at ambient temperature; T_6: LDPE bag at 5 ºC. In each column, means followed by the same letters are not significantly different according to Fisher's least difference test ($P \leq 0.05$).

'Bombai' and 'Madraji' were 115.79 and 153.27 mg GAE g^{-1} fw, respectively and declined during 6 days of storage (Table 6). In general, the total phenolics of both the cultivars decreased during storage at room temperature regardless of storage treatments. The fruits stored in polyethylene bags had the highest total phenolics over storage time followed by bamboo baskets and open conditions (Table 6). The highest loss of total phenolics in aril tissue was recorded in fruits kept in open conditions at ambient temperature in both the cultivars where the minimum loss was detected in the fruits kept in polyethylene bags at 5 °C. A significant decrease of phenolics with storage time was detected in all the treatments except in the fruits kept in polyethylene bags at 5 °C. The longer storage periods led to enhance cell decompartmentalisation, polyphenol oxidase (PPO) and peroxidase (POD) activities (Jiang, 2000; Zhang and Quantick, 2000; Jiang *et al.,* 2006) which may promote decrease in phenolics in aril of litchi during storage. The lower fruit weight loss in fruits kept in polyethylene bags at 5 °C could slow cell decompartmentalisation in aril tissue resulting in a reduction in the interactions between phenolic substrates with PPO and POD (Jiang, 2000). There are also a number of reports on the beneficial effects of low temperature in preventing the loss of total phenolics in different litchi cvs. 'Rose' (Shah and Nath, 2008) and 'Feizixiao' (Wu *et al.,* 2001).

The data presented in this paper indicated that the storage temperature and packaging significantly affect the shelf-life and quality of litchi. It was observed that polyethylene bag effectively prolonged shelf-life of litchi in comparison with other packaging materials, mainly due to a reduction in the rate of water loss. Results also indicate that 5 ºC maintained better quality of fruit than ambient temperature irrespective of packaging materials. Fruits stored in polyethylene bag at 5 ºC maintained better pericarp colour, total soluble solid, ascorbic acid, total phenols, and overall quality. Therefore, polyethylene bag (LDPE) appears to be a significant advantage on litchi storage.

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