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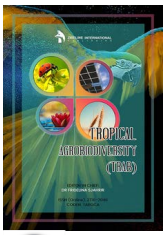

REVIEW ARTICLE

QUALITY RETENTION OF LITCHI (*LITCHI CHINENSIS* SONN.) BY USING POLYPROPYLENE BAG AND LOW TEMPERATURE

Fakhar Uddin Talukder[a], Md. Kamrul Hassan[b], Md. Sohanur Rahman[a*], Md. Saidee Rahman[c], Md. Al Emran Hossain[d]

[a] Scientific Officer, Pest Management Division, Bangladesh Jute Research Institute, Bangladesh.
[b] Professor, Department of Horticulture, Bangladesh Agricultural University, Bangladesh.
[c] Scientific Officer, Rice Farming System Division, Bangladesh Rice Research Institute, Regional Station, Gopalgonj, Bangladesh.
[d] Scientific Officer, Agronomy and Farming Systems Division, Bangladesh Sugar crop Research Institute, Bangladesh.
[*]Corresponding author e-mail: sohanbau2010@gmail.com

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ABSTRACT

This experiment was conducted to observe the postharvest behaviors of litchi for using low temperature (4 °C) and polypropylene (PP) bags of different thickness. The two-factor experiment was conducted in a completely randomized design with three replications. Total 8 treatments are implemented in this study. The experiment consisted of two factors: Factor A: Temperature (T_1: Ambient temperature, T_2: 4ºC temperature) and Factor B: Polypropylene bag (P_1: unwrapped, P_2: 50µ PP bag, P_3: 75µ PP bag, P_4: 100µ PP bag. In case of low temperature (4 °C), litchi retained its 50% color at 10th days of storage, highest shelf life (21.33 days), highest moister content (83.3%) & highest amount of vitamin C (35.61 mg/100g) were found at 3rd day of storage. In case of different thickness of polypropylene bags, litchi kept in 75µ PP bags retained its 100% color up to 4th day of storage, shelf life (16.34 days), maximum moister content (83.14%) & maximum amount of vitamin C (35.78 mg/100g) were found at 3rd day of storage. It can be possible to save a large amount of litchi fruits every year from postharvest decay by using low temperature (4 °C) and 75µ PP bag.

KEYWORDS

Low temperature, Polypropylene bags, Litchi, Postharvest

1. INTRODUCTION

Litchi *(Litchi chinensis* Sonn.) is a subtropical to tropical fruit that originated nearby northern Vietnam and southern China (Menzel, 2001). It is renowned for its prime quality, for example - juiciness, slight sweet-sour taste, qualitative sweet flavor and for fascinating color. Its family is Sapindaceae and subfamily is Nepheleae. The eatable part of litchi is a cream to white colored diaphanous pulp adjacent to a glazing brown seed. The eating of a litchi could meet 2-4% of the dietary reference intakes (DRI) for K, P, Fe, Mg, Mn and Zn and give DRI (22%) for Cu (Wall, 2006). According to a study, the pulp is individualized by acid and sweet taste; it is ambrosial, very succulent and texture is grape like (Cavaletto, 1980). According to another study, Litchi is non-climacteric and degrade very swiftly after harvest (Wills et al., 2004). Pericarp browning is the most momentous optical sign of fruit quality deterioration. The pericarp browning is deliberated as the most serious postharvest problem of litchi. Dehydration of the pericarp usually causes pericarp browning at the first few days after harvest. Pericarp losses a few percent of fresh weight when litchi start to brown (Jiang and Fu, 1999). The pericarp becomes completely brown when once the primary fresh weight goes less than 50 percent. The present study actually focuses on pericarp browning reduction of litchi; the biochemistry of pericarp browning should be plainly learnt. The evident colors of mature litchis are hugely for a range of anthocyanins residing in the middle to upper mesocarp (Underhill and Critchley, 1993). A studied that fruits wrapped in polyethylene at 5 °C exerted a little bit changes in weight loss and the peal were brighter (Chaiprasart, 2005). Roy noticed that litchi (cv. Bombai) kept in unperforated polyethylene bag without litchi leaf at low temperature (7-8 °C) showed the longest shelf life (21.50 days) (Roy, 2002). Kamleshwar investigated that litchi fruits covered with perforated plastic bags were justly to maintain good quality until the 7th days of storage (Kamleshwar, 2001).

A studied that the effect of low-density polyethylene, PVC and temperature (5 or 27 ºC) on litchi at storage; Low temperature provide long shelf life (Fontes et al., 1999). A group researchers noticed that litchi fruits treated by 50 ppm aqueous solution of $CuSO_4$, $CaCl_2$, $AgNO_3$ and Borax for 30 minutes and sealed in low density polyethylene greatly prolonged shelf life (Ghosh et al., 2003). A group researcher investigated that wrapping fruits in polyethylene bag provide the longest life and better quality at 4 ºC than at 0 °C (up to 18 and 16 days, respectively) (Mitra et al., 1996). After harvest, litchi fruits deteriorate fast. At ambient temperature e.g 20-30°C,

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litchi loses its bright red color and pericarp oncoming browning within 24 hour of harvest (Cambell, 1959; Chaudhury and Banerjee, 1959; Singh, 1976; Chakraborty et al., 1980; Kevin et al., 1982; Mukherjee, 1957; Garg and Ram, 1972). Drying induced pericarp browning starts on the protoberances of the pericarp and following spreads over the whole pericarp after 1-2 days (Tongdee et a1., 1982; Underhill and Critchley, 1995).

The early hydro-cooling by using iced-water for 2–3 hours at 0–2 °C can achieve satisfactory results of postharvest treatments for litchi (Lin and Chiang, 1988). Low temperature treatment with litchi (5 days at 5 ºC) prior to storage for 40 day at 1 ºC delayed browning of fruit pericarp after withdrawal from cold storage (Zhang et al., 2000). A group researcher obtained that modified atmosphere (MA) is compatible for the extension of shelf life of litchi (Hassn et al., 2009a). Hassan has noticed that the commonly practiced storage methods comprise low temperature storage, controlled atmosphere (CA) storage and modified atmosphere (MA) storage (Hassan, 2010). According to Jiang and Fu, the defeat of water loss was complementary correlated with membrane permeability- the rate of browning, polyphenol oxidase activity and pH of tissue negatively correlated with anthocyanin content (Jiang and Fu, 1999). Postharvest decay, browning of pericarp, micro-cracking and desiccation were considered as major obstacles that prohibit the extension of shelf life of litchi (Swarts and Anderson, 1980; Huang and Scott, 1985; Underhill, 1992; Li et al., 2001; Underhill and Simons, 1993). Research activities related to the lightening of pericarp browning problem of obtainable litchi varieties was unnoticeable in the face of its distinguished importance. So, the present study had been commenced to minimize the postharvest losses of litchi by using of PP bag & low temperature (4 °C).

2. Materials and Methods

The experiment was brought to pass at the laboratories of the Departments of Horticulture and Biochemistry of Bangladesh Agricultural University, Mymensingh during the period from 15 May to 15 September, 2016. The experimental litchi fruits were collected from the local growers of Ishurdi, Pabna. The maturity of the fruits was ascertained by the comparative smoothness of epicarp and flatness of tubercles.

2.1 Experimental materials

The commercially prominent litchi variety namely 'Bombai'. This, is a momentous commercial cultivar of Bangladesh. Fruits are almost heart shaped. Ripening begins from the last week of May. The color at maturity is pointed out as yellow-green background with red tubercles. Generally, the weight of fruit varies from 15-20g. Fruit pulp has pleasant flavor and is soft, greyish white, juicy, sour too sweet in taste. By weight the ratio of rind, pulp and seed is 12.11:70.08:16.8. A group researcher noticed that the mean weight of litchi fruit was 19 g which consisted of 19.9% seed, 62.2 % pulp, 17.9% skin, on the basis of weight (Ghosh et al., 1987). They also narrated that the fruit pulp contained 11.0% sugars, 17.7% total soluble solids and 0.42% acidity.

2.2 Experimental treatments

Total 8 treatments are accomplished in this experiment. The experiment was consisted of two factors.

Factor A: Temperature

T_1: Ambient temperature

T_2: Low temperature (4 ºC)

Factor B: PP bags (Polypropylene bag), size: 36cm X 24 cm

P_1: Control (unwrapped)

P_2: 50µ PP bag

P_3: 75µ PP bag

P_4: 100µ PP bag

2.3 Experimental design

The two-factor experiment was done in completely randomized design with three replications of 8 fruits at each. A total of 192 fruits (randomly selected) of more or less similar shape and size and free of apparent disease symptoms were used.

2.4 Application of postharvest treatments

Among 8 fruits in each replication of each treatment 4 fruits were marked to investigate pericarp browning & shelf life and the remaining 4 fruits were kept unmarked conditions for destructive sampling to examine moisture content & vitamin C. Vitamin C was estimated by using the method (Ranganna, 1979).

2.5 Methods of studying Parameter

2.5.1 Pericarp Browning

Days required to reach various stages of browning at storage period and ripening were ascertained using numerical rating scale of 1-5, where, 1 = no browning, 2 = 1-<25% brown, 3 = 25-<50% brown, 4 =50-<75% brown and 5 = 75-100% brown.

2.5.2 Moisture content

10 grams of fruit pulp was taken in a Petridis from each treatment and replication. The Petridis was placed in an electric oven preset at 80°C for 72 hours till constant weight attained. It was then cooled in desiccators and weighed once again. Percent moisture content was calculated by the following formula:

$$\text{Moisture content (\%)} = \frac{IW - FW}{IW} \times 100$$

Where,

IW = Initial weight of pulp (g)
FW= Final weight of oven dried pulp (g)

2.5.3 Vitamin C content

Reagents required for the estimation of vitamin C content of litchi pulp were (i) 3% Meta phosphoric acid (It was prepared by dissolving the sticks of HP03 in distilled water) (ii) Standard ascorbic acid solution and (iii) Dye solution (It was prepared by dissolving 260 mg of sodium salt of 2, 6-dichlorophenol indophenol in 1 litre of distilled water that contained 210 mg/litre of sodium bicarbonate). The following steps were followed for the estimation of vitamin C:

2.5.3.1 Standardization of dye solution

Five ml of standard ascorbic acid solution was taken in a conical flask and 5 ml of metaphaspharic acid (HPO3) was added to it and shaken. A micro burette was filled with dye solution. Then the mixed solution was titrated with dye using phenolphthalein indicator solution to a pink colored end point that persisted at least for 15 seconds. Dye factor was calculated using the following formula:

$$\text{Dye factor} = \frac{0.5}{\text{litre}}$$

2.5.3.2 Preparation of sample

Ten grams of fresh fruit pulp was taken in a 100 ml beaker with 50 ml 3% metaphosphoric acid and then it was transferred to a blender and homogenized with same concentration of metaphosphoric acid. After blending, it was filtered and centrifuged at 2000 rpm for 5 minutes. The homogenized liquid was transferred to a 100 ml volumetric flask and was made up to the mark with 3% metaphosphoric acid.

2.5.3.3 Titration

Five ml of the aliquot was taken in a conical flask and titrated with 2, 6-dichlorophenol dye. Phenolpthalein was used as indicator to pink coloured end point, which persisted at least 15 seconds. The vitamin C content of the samples was calculated by using the following formula:

Vitamin C content (mg/100 g) = $\frac{T \times D \times V_1}{V_2 \times W} \times 100$

Where,

T = Titre
D = Dye factor
V_1 = Volume made up
V_2 = Volume of extract
W = Weight of sample

2.4 Shelf life

Shelf life of litchi fruits as influenced by different varieties was calculated by counting the days required to ripe fully as to retaining optimum marketing and eating qualities.

2.5 Observation

Fruits used in the experiment were observed every day. Data were collected on weight loss, physical and chemical changes and rottening of the fruits during storage as influence by different postharvest treatments.

2.6 Statistical analysis

For the experiment, the collected data were statistically analyzed by Analysis of Variance (ANOVA) test. The means of different parameters were compared by least significant difference (LSD) as described (Gomez and Gomez, 1984). For percentage data arcsine transformations were carried out to satisfy the assumption of ANOVA.

3. RESULTS

The influence of different postharvest treatments in respect of reduction of postharvest browning, extension of shelf life & quality of litchi was studied. The results obtained from the present investigation are presented and interpreted in the following:

3.1 Pericarp browning

Various postharvest treatments used in the present study showed highly significant variation in respect of pericarp browning during storage. Browning score showed an increasing trend with the storage period. However, the change was very sharp in the untreated fruits. The maximum score of browning (5.00) was observed in fruits kept in ambient temperature & the minimum score of browning (3.00) was observed in litchi fruits kept at 4 ºC in 10th day of storage (Figure 1).

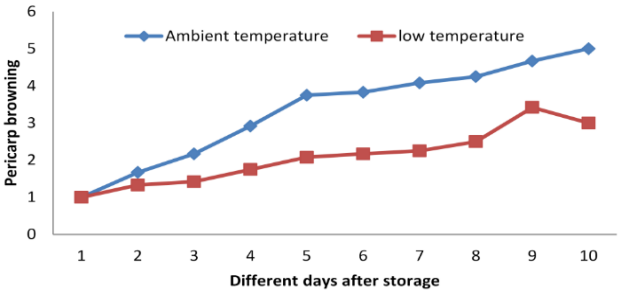

Figure 1: Main effect of temperature on pericarp browning of litchi.

Numerical browning scale: 1= no browning, 2=1-<25% brown, 3=25-<50% brown, 4=50-<75% brown, 5= 75-100% brown.

Significant variations were observed in the present study due to the effect of thickness of PP bags in respect of pericarp browning during storage. Browning was so faster in the control fruits. At the 5th day of storage the control fruits were fully brown and the browning score was highest (5.00). 50 micron, 75 micron & 100 micron thicknesses of PP bags showed the same performance at 10th day of storage & having a browning score of 3.67 (Table 1).

Table 1: Main effect of thickness of PP bags on pericarp browning of litchi of litchi

Thickness of PP bags	Pericarp browning at different days after storage									
	1	2	3	4	5	6	7	8	9	10
P_1	1	2.17	3.00	4.17	5.00	5.00	5.00	5.00	5.00	5.00
P_2	1	1.34	1.50	2.17	2.34	2.67	2.83	3.00	3.50	3.67
P_3	1	1.00	1.00	1.00	1.34	1.50	2.00	2.33	2.67	3.67
P_4	1	1.50	1.67	2.00	3.00	2.83	2.84	3.17	3.50	3.67
$LSD_{0.05}$	-	0.128	0.145	0.140	0.177	0.177	0.219	0.222	0.242	0.216
$LSD_{0.01}$	-	0.177	0.200	0.192	0.244	0.244	0.302	0.306	0.333	0.297
Level of significance	-	1.439**	4.376**	10.544**	14.374**	12.782**	9.891**	7.835**	8.023**	2.673**

** = Significant at 1% level of probability, NS = Not significant; Numerical browning scale: 1= no browning, 2=1-<25% brown, 3=25-<50% brown, 4=50-<75% brown, 5= 75-100% brown

3.2 Moisture content

Statistically significant variation was observed between the ambient and low temperatures used in the present study. Moisture content is decreased gradually day by day at all the treatments. The maximum moisture content (83.30%) was observed at litchis kept in low temperature (4ºC) at 3rd day of storage followed by litchis kept in low temperature (4ºC) at 6th day of storage. The lowest moisture content (78.32%) was observed at litchis kept at ambient temperature at 9th day of storage followed by litchis kept in ambient temperature at 6th day of storage (Table 2).

Table 2: Main effect of temperature on percent moisture content of litchi

Temperature	Moisture content (%) at different days after storage		
	3	6	9
T_1	81.67	79.58	78.32
T_2	83.30	81.83	80.01
$LSD_{0.05}$	0.171	0.113	0.192
$LSD_{0.01}$	0.235	0.155	0.264
Level of significance	15.844**	30.443**	17.238**

** = Significant at 1% level of probability, NS = Not significant

Effects of thickness of PP bags had a significant variation on the percent of moisture content of litchi during storage. Percent of moisture content was decreased day by day at all the treatments. But moisture loss was highest at control (untreated) fruits. The maximum moisture content (83.14%) was observed at litchis kept in 75 micron PP bag at 3rd day of storage. The lowest moisture content (77.72%) was observed at control (untreated) litchis at 9th day of storage (Figure 2)

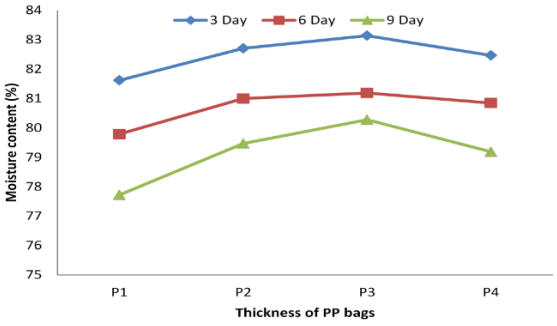

Figure 2: Main effect of thickness of PP bags on moisture content (%) of litchi

3.3 Vitamin C content

The effects of different postharvest treatments in respect of vitamin C content were statistically significant in litchi at different days of storage. The highest vitamin C content (35.61 mg/100g) was recorded in litchis kept in low temperature at 3rd day of storage and the lowest vitamin C content (22.07 mg/100g) was found in litchis kept in ambient temperature at 9th days of storage (Table 3).

Table 3: Main effect of temperature on vitamin C content of litchi

Temperature	Vitamin C content (mg/100g) at different days after storage		
	3	6	9
T_1	34.31	29.65	22.07
T_2	35.61	32.09	28.42
$LSD_{0.05}$	0.175	0.205	0.087
$LSD_{0.01}$	0.241	0.282	0.119
Level of significance	10.101**	35.795**	241.745**

** = Significant at 1% level of probability, NS = Not significant

The effect of thickness of PP bag was statistically highly significant in respect of vitamin C content (mg/100g) at different days after storage. The highest vitamin C content (35.78mg/100g) was recorded in litchis wrapped in PP bag of 75 micron thickness at 3rd day after storage followed by litchis wrapped in PP bag of 50 micron thickness at 3rd day after storage. The lowest vitamin C content (24.41mg/100g) was observed in control (unwrapped) litchis at 9th day after storage followed by litchis wrapped in PP bag of 50 micron thickness (25.08mg/100g) at 9th day after storage (Figure 3).

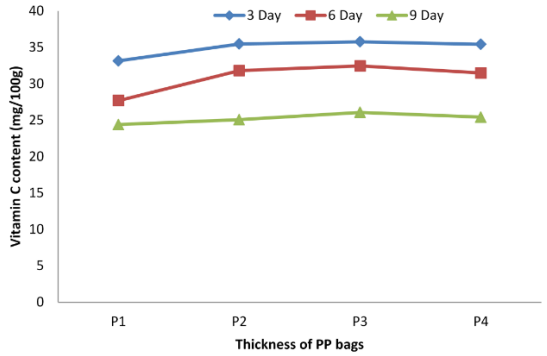

Figure 3: Main effect of thickness of PP bags on vitamin C content (mg/100g) of litchi

3.4 Shelf life

Shelf life of litchi was significantly influenced by different postharvest treatments. Results revealed that the longer shelf life (21.33 days) was observed in litchis kept at low temperature and the shorter shelf life (6.08 days) was observed in litchis kept in ambient temperature (Figure 4).

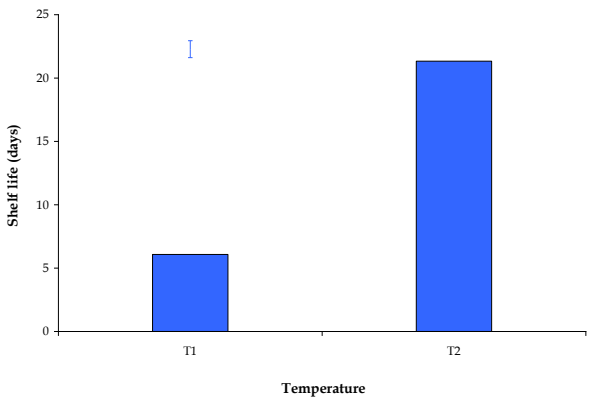

Figure 4: Main effect of temperature on shelf life (days) of litchi

Thickness of PP bag caused statistically significant variation in shelf life of litchi during storage. The longest shelf life (16.34 days) was found at litchis wrapped in 75µ PP bags followed by shelf life (15.33 days) in litchis wrapped in PP bag of 50µ thickness and the shortest shelf life (9.00 days) was found in litchi which were unwrapped. (Figure 5).

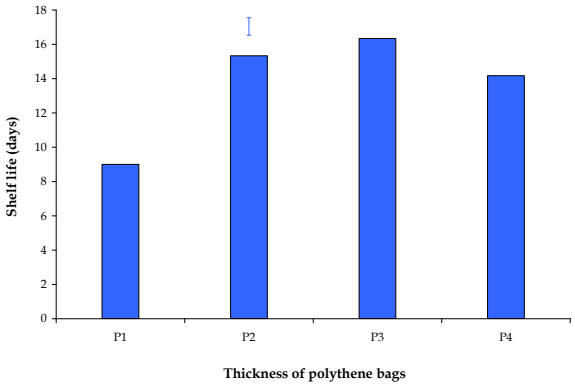

Figure 5. Main effect of thickness of PP bags on shelf life (days) of litchi

4. Discussion

The data were recorded at 1- & 3-days interval after storage (DAS) on different characteristics of physical and chemical properties and also shelf life of litchi. A group researcher found that longest shelf life (21 days) in sulfur fumigated litchi in polythene bags at 14 ºC & shortest in untreated fruits at 31 ºC (2 days) (Rajak et al., 2004). A group researcher observed that the shelf life of litchi fruits were 21 days which were treated with SO_2 fume bladder at 2±1 °C (Semeerbabu et al., 2007). Mitra and Kar reported the best results for the treatments on litchi fruits using litchi perforated polyethylene at 4 and 0 ºC, where storage life was extended up to 18 and 14 days, respectively (Mitra and Kar, 2001). According to a study, the postharvest life of litchi fruit at ambient temperature is less than 3 days (Lin et al., 2003). Litchi cultivars exposed similar pericarp development, however, distinction in the thickness of cuticle and spongy layers were seen between different cultivars (Huang et al., 2004). Pericarp browning is one of the most important landmark in relation to quality of litchi in storage period. Pericarp browning increased gradually with the increase of storage period.

The outward peel of litchi was red before storage. Low temperature inhibited browning of peel. In contrast, all the fruits in ambient temperature were fully brown (100%) at the 10th day of storage. Fruits without wrapping lost its color swiftly (at 5th day after storage). Treated fruits kept up its color at the outer and inner peel afterwards 3 to 6 days of storage period. Afterwards 6 to 9 days of storage, both the inward and outward peel had more intensity. Litchi kept in 75µ PP bag retained its absolute color for the maximum day (4th day). The pulp color was greyish-white before storage & hold this at the whole experiment time. Packing within plastic bags can minimize the rate of pericarp color change (Ketsa and Leelawatana, 1990). The perishability of the litchi keeps down marketing, particularly of exports to countries a distance from the original area of production. The skin of litchi trends brown fast after harvest or rots afterward a few days if the fruit are not operated accurately.

The loss of fascinating red color minimizes its market appeal. Though the initial pericarp browning is a fundamental cosmetic problem, it declines the commercial value of the fruits. Moreover, pericarp browning is generally associated with the loss of edible quality (Mitra et al., 2014). Paull and Chen found that browning of litchi was fast and decay was dominant after 2-3 days at 20 ˚C (Paull and Chen, 1987). The moisture content reduced with the progress in storage time (Joshi and Roy, 1988; Gaur and Singh, 1987). A quick moisture loss of litchi appears during harvesting and transit if inappropriate packaging is accustomed. Early and impetuous pre-cooling are essential in the cold bands for litchi and may dispel field heat and provide feasible temperature management during posterior storage or transmission (Bagshaw et al., 1994; Tongdee et al., 1999).

The storage tactics used in this study might be performed in the postharvest stirring of litchi and prolongs the shelf-life of fruits as established in longkong, banana 'Kluai Khai' and Gros Michale (Glahan and Adireklap, 2005; Glahan and Kerdsiri, 2001; Glahan and Chockpachuen, 2003). Vitamin C amount is one of the most significant factors in litchi at storage time. Gradually the content of vitamin C of litchi was running down. Low temperature (4 °C) decreased vitamin C loss. The litchis held in 75µ PP bag, was fixed the most feasible in checking the reduction of vitamin C content of litchi pulp. Mohajan explained that vitamin C content outspent during storage time (Mohajan, 1997).

This result was a perfect harmony with that findings. The shelf life extension of litchi has been one of the most monumental suspense of the researchers. A group researcher noticed that no browning was seen at (4±1) °C with sulfur fumes at 50 or 60g/100g fruits in a confined chamber until 33rd day (Ray et al., 2004). Pericarp browning and Moisture loss decrease the shelf life of litchi. Low temperature provides the longest shelf life (21.33 days). PP bag of 75µ thickness was observed for the longest shelf life among all the thickness. Relative humidity (RH) of 85–95% seems to be appeasement for storage (Jiang and Fu, 1999). Water soaking and decay can be occurred for higher humidity. Litchi fruits are more enduring to low temperature. For this reason, it may be stored in the lower temperature at range of 1–5 °C. But the disease development and decline in visual appearance keep down longevity. Modified control packaging is a substitute to augmentation of storage life of litchi. (Huang and Wang, 1990).

5. Conclusions

It can be concluded that keeping litchi in 75µ PP bag and stored in low temperature (4ºC) is the best way to prolong its shelf life without affecting the quality. For short-term storage of litchi, 75µ PP bag at room temperature would be recommended. For long term storage, low temperature (4ºC) preservation is recommended.

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Conflict of Interest

The authors have no conflict of interest to report.

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