

# Effect of Arabic Gum Coating on Postharvest Quality of Litchi (*Litchi chinensis*) Fruits

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## Abstract.

Litchi is very delicate in nature and highly perishable, which accounts for its short shelf life. Pericarp browning and aril decay of litchi fruits shorten post-harvest storage and thus reduce market value. It is necessary to use postharvest techniques for the extension of litchi shelf life. Application of arabic gum as edible coating could be considered as a useful approach to maintain its product quality during preservation. Objective of the present study focused on the effect of arabic gum coating on some physicochemical, microbial and sensory characteristics of litchi during preservation. Optimal results showed that weight loss, pH, total soluble solids, titratable acidity and ascorbic acid; total plate count; sensory characteristics could be maintained at appropriate levels by coating litchi with 0.15% arabic gum. The present study attempted to investigate some of the most significant findings to extend the shelf life of litchi fruit.

**Keywords:** Litchi, arabic gum, coating, shelf life, physicochemical, microbial, sensory

## I. INTRODUCTION

The litchi (*Litchi chinensis*) is an important subtropical evergreen fruit crop belonging to family Sapindaceae. *Litchi chinensis* is an arboreal and evergreen tree; the bark is grey-black, the branches present shiny, lanceolate leaves of deep green color, and a brownish-red, dense and rounded-shape. Litchi fruits, which are similar in volume to a strawberry, are in pendulous clusters, roundish, green, and, once mature, become pinkish or reddish. The fruits of litchi have a thin and rigid peel that easily comes off to show a pearl-white jelly-like pulp with excellent flavor due to the combination of acids and sugars (Sonia Emanuele et al., 2017). Skin browning due to moisture loss is a major limitation in the retention of colour in litchi, fruit deteriorating rapidly after harvest. Its shelf life under ambient conditions is never more than 24-72 hours. Low temperature storage at 1–5°C is used to reduce pathological decay, but has only limited role in reducing pericarp browning. Moreover, the fruits deteriorate rapidly when removed from cold storage. Long-term storage of litchi at low temperature is also associated with loss of flavour and hence, poor eating quality (Jiang and Li, 2003).

There were several researches mentioned to preservation of litchi fruit by coating. A study was conducted to investigate the effects of chitosan coating on quality maintenance and shelf life extension of peeled litchi fruit (HuaqiangDong et al., 2004). Effect of different post-harvest treatments on overall quality retention in litchi fruit during low temperature storage was examined (Dharini Sivakumar et al., 2005). The experiment was conducted to test the role of chitosan coating in inhibiting skin browning and extending shelf life of cold-stored litchi fruit at ambient temperature (YuemingJiang et al., 2005). Effect of edible coatings and other surface treatments on pericarp color of Thai Lychee Cultivars was examined (Nithiya Rattanapanone et al., 2007). Effects of chitosan coating and ascorbic acid on litchi fruits storage were investigated (Dequan Sun et al., 2010). Control of post-harvest pericarp

browning of litchi (*Litchi chinensis* Sonn) was conducted (M. Neog and L. Saikia, 2010). The shelf-life of lychee fruits stored after treatment with hydrochloric acid and citric acid, associated with cassava starch and plastic packaging was evaluated (Danielle Fabíola Pereira da Silva et al., 2012). The Chitosan 1% treatment will serve as a good alternative for prolonging shelf life of litchi fruit (Ramandeep Kaur et al., 2018). The effect of radiation-processed oligo-chitosan on post-harvest loss of litchi fruit was investigated (Jesmin S et al., 2018).

Litchi is a tropical fruit that undergoes postharvest deterioration rapidly. It's a highly perishable fruit and easily damaged, softens very rapidly during ripening, and becomes mushy and difficult to consume fresh. Litchi fruit is highly susceptible to enzymatic browning that is catalyzed by oxidoreductase enzymes such as PPO and POD. Pericarp browning is one of the most significant problems in marketing and export of longkong fruit. Pericarp browning leads to the loss of economic value of litchi fruit, although it does not affect its flavor and nutritional contents. Temperature (low and high) and environmental conditions are the key factors that cause the majority of quality losses in litchi fruit, followed by postharvest decay. Application of arabic gum as edible coating could be considered as a useful approach to maintain its product quality during preservation. Objective of the present study focused on the effect of arabic gum coating on some physicochemical, microbial and sensory characteristics of litchi during preservation.

## II. MATERIALS AND METHOD

### 2.1 Material

Litchi fruits were collected in Bac Giang province, Vietnam. They must be cultivated following VietGAP to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Fruits were thoroughly rolled to remove dirt, dust and adhered unwanted material. Besides litchi fruits we also

used other materials during the research such as arabic gum, distilled water, NaOH, 2,6-dichlorophenolindophenol, Petrifilm - 3M, Tween 80, glycerol, PVC bag. Lab utensils and equipments included colony counter, refrigerator, pH meter, refractometer, digital balance, grinder, centrifugator.



Figure 1. Litchi (*Litchi chinensis*)

**2.2 Researching procedure**

**2.2.1 Preparation of coat forming solution**

The coating solution was prepared by dissolving 0, 0.5, 1.0, 1.5, 2.0 g of arabic gum powder in 1000 ml of distilled water for 1 h at 25°C to dissolve arabic gum to prepare 1 L of 0%, 0.05%, 0.10%, 0.15%, and 0.20% arabic gum solutions. Then, Tween 80 and glycerol were added in the arabic gum solution.

**2.2.2 Coating application**

The surface of the fruits were disinfected with 20 ppm peracetic acid for 30 seconds and gently rinsed with distilled water, then air-dried. Fruits were separated into three groups in triplicate; each group of the fruits was quoted as control (without treatment) 0% and 0.05%, 0.10%, 0.15%, and 0.20% arabic gum coating. Each group of litchi was divided into 20 batches in triplicate (60 batches) each containing 1000±5g of whole litchi. They were dipped in the arabic gum coating solution of 0%, 0.05%, 0.10%, 0.15%, and 0.20% for 15 seconds and the samples were air dried for 10 min at ambient temperature. The coated fruits were packed in PVC wrap and kept at 4°C in a refrigerated condition for a period of 28 days to study the shelf life and physicochemical and microbial parameters.

**2.2.3 Determination of weight loss**

Three batches of litchi containing 1000±5g of whole litchi were taken at an interval of 7 days for total storage period. The litchi fruits were weighed regularly to determine weight loss, which was calculated cumulatively by comparing the weights of the sample with the electronic weighing balance at an interval of 7 days for the total 28 days storage period and the results were expressed as percentages.

**2.2.4 Measurement of pH, total soluble solids, titratable acidity and ascorbic acid**

5 g litchi pulp was homogenized in 25 ml of distilled water. Then the mixture was filtered using muslin cloth. An aliquot of 25 ml was used to measure pH with a pH meter. The TSS was measured directly from the filtered residue using a hand refractometer and expressed as brix. The titratable acidity was determined with 0.1 N NaOH. Litchi pulp (5g) from fruit was homogenized using a grinder and then centrifuged at 4000 rpm for 10 minutes; the supernatant phase was collected and analyzed to determine ascorbic acid content by 2,6-dichlorophenolindophenol titration.

**2.2.5 Measurement of microorganism load**

The total colony forming units (CFU) was enumerated during the storage period by Petrifilm - 3M.

**2.2.6 Sensory evaluation**

The acceptability of the samples was evaluated through the standard sensory evaluation techniques. The sensory attributes such as visual appearance, color, taste, flavor and acceptability was carried out by selected panel of judges (9 members) rated on a five point hedonic scale.

**2.3 Statistical analysis**

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan’s multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

**III. RESULT & DISCUSSION**

**3.1 Nutritional composition in litchi fruit**

Table 1. provided nutritional composition in litchi fruit

Table 1. Major nutrient compositions in pulp of litchi (*Litchi chinensis*)

Parameter	Moisture (g/100g)	Protein (g/100g)	Total soluble solid (°Brix)	Fibre (g/100g)	Total phenolics (mg/100g)	Vitamin C (mg/100g)
Value	48.25±0.01	9.35±0.01	18.64±0.01	24.12±0.00	4248.12±0.02	36.23±0.02

Litchi fruit is rich in carbohydrates and fibers while lipids and proteins are scarce (Sonia Emanuele et al., 2017).

Table 2. Effect of arabic gum coating on weight loss (%) of litchi stored at 4°C

Preservation time (days)	Arabic gum concentration				
	0%	0.05%	0.10%	0.15%	0.20%
0	0	0	0	0	0
7	1.45±0.01 <sup>a</sup>	0.49±0.01 <sup>ab</sup>	0.35±0.02 <sup>b</sup>	0.20±0.03 <sup>bc</sup>	0.14±0.02 <sup>c</sup>
14	2.35±0.03 <sup>a</sup>	1.49±0.02 <sup>ab</sup>	1.28±0.01 <sup>b</sup>	0.96±0.00 <sup>bc</sup>	0.84±0.00 <sup>c</sup>
21	3.47±0.01 <sup>a</sup>	1.77±0.01 <sup>ab</sup>	1.53±0.00 <sup>b</sup>	1.27±0.01 <sup>bc</sup>	1.38±0.03 <sup>c</sup>
28	4.12±0.02 <sup>a</sup>	2.30±0.01 <sup>ab</sup>	1.97±0.01 <sup>b</sup>	1.75±0.02 <sup>bc</sup>	1.84±0.02 <sup>c</sup>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

**Table 3. Effect of arabic gum coating on pH, total soluble solids, titratable acidity and ascorbic acid of litchi stored at 4°C after 28<sup>th</sup> day of preservation**

Litchi treated with	Parameters			
	pH	Total soluble solids (o Brix)	Titratable acidity (%)	Ascorbic acid (mg/100g)
0.15% arabic gum before preservation	5.67±0.00 <sup>a</sup>	18.64±0.01 <sup>a</sup>	3.44±0.03 <sup>a</sup>	36.23±0.02 <sup>a</sup>
0.15% arabic gum after 28 <sup>th</sup> day of preservation	5.65±0.01 <sup>a</sup>	18.59±0.00 <sup>a</sup>	3.39±0.01 <sup>a</sup>	40.51±0.01 <sup>a</sup>

*Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).*

**3.2 Effect of arabic gum coating on weight loss of litchi**

The weight loss of litchi observed in control was due to the shrinkage of fruits by loss of moisture which was not observed in the coated fruits. The arabic gum coating prevented the evaporation of moisture from coated litchi fruits. There was a significant difference observed between the control and coated samples. Results were showed in table 2.

Rapid pericarp browning, softening and loss of freshness during transportation and in retail stores are the major problems in litchi fruit. Effect of different post-harvest treatments on overall quality retention in litchi fruit during low temperature storage was examined. Combined post-harvest dip treatment with potassium metabisulphite + Vapogard retained fruit marketability most effectively, preventing severe browning post-harvest diseases, and retaining fruit firmness. Potassium metabisulphite + Vapogard dip treatment also revealed superior eating quality, with a 19.5% soluble solids concentration, 0.2% titratable acidity and a decline in anthocyanin concentration. Fruit fumigated with sulphur dioxide showed increased weight loss with intensified micro-cracks on the pericarp. Chitosan was most effective in reducing the total microbial fructoplane population compared to other treatments (Dharini Sivakumar et al., 2005).

Lychee fruit were harvested at the commercial stage (90% to 100% red pericarp) in Thailand. In five separate experiments, fruit with pedicels were dipped for 30 seconds in various treatment solutions, including no dip and water as controls, ascorbic acid, citric acid, acetic acid, chitosan, HCl, and two Semperfresh products, in an effort to retard browning of the pericarp. Fruit were air-dried, and stored at 2 or 10 °C with 90% relative humidity for 1 to 3 weeks. Total soluble solids (TSS), titratable acidity (TA), weight loss, total ascorbic acid (TAA), and color (hue angle and chroma) were measured over the storage period. During storage, TSS generally increased while TA and TAA generally decreased (except for those treatments that were treated with ascorbate). Most treatments reduced weight loss compared to untreated fruit. Treatment of lychee fruit with acidified coatings including Semperfresh, acidified Semperfresh (with 2% citric acid), Semperfresh lychee treatment power (LTP) ± citric acid and chitosan + HCl sometimes resulted in brighter, redder color than control fruit, as evidenced by lower hue angle or higher chroma values (Nithiya Rattanapanone et al., 2007).

**3.3 Effect of arabic gum coating on pH, total soluble solids, titratable acidity and ascorbic acid of litchi**

Arabic gum coating could maintain the respiration at a minimal rate. Effect of arabic gum coating on pH, total soluble solids, titratable acidity and ascorbic acid of litchi was clearly illustrated in table 3.

A study was conducted to investigate the effects of chitosan coating on quality maintenance and shelf life extension of peeled litchi fruit. Polyphenol oxidase (PPO) and peroxidase (POD) activities were also measured. Application of chitosan coating retarded weight loss and the decline in sensory quality, with higher contents of total soluble solids, titratable acid, and ascorbic acid, and suppressed the increase in activities of PPO and POD (HuaqiangDong et al., 2004).

The experiment was conducted to test the role of chitosan coating in inhibiting skin browning and extending shelf life of cold-stored litchi fruit at ambient temperature. Litchi fruit were treated with 2 g chitosan/100 g solution and then stored for 20 days at 2 °C and 90–95% relative humidity (RH), prior to shelf life evaluation at 25 °C and 80–90% RH. Application of chitosan coating delayed the decrease in anthocyanin content, the increase in PPO activity and the changes in colour index and eating quality, reduced the decrease in concentrations of total soluble solids and titratable acidity, and partially inhibited decay (YuemingJiang et al., 2005).

The treatment with hydrochloric acid associated with PVC was the most effective in maintaining the red color of the pericarp for a period of 20 days and best preservation of the fruit. The cassava starch associated with citric acid, and hydrochloric acid did not reduce the mass loss and did not prevent the browning of lychee fruit pericarp (Danielle Fabiola Pereira da Silva et al., 2012).

Post harvest storage studies revealed that under ambient and cold storage conditions chitosan 1% treatment showed slower rate of reduction on size of litchi fruits, weight and fruit volume and were significantly affected by treatments. There was significant effect of treatments on chemical parameters like TSS, ascorbic acid, total sugar (Ramandeep Kaur et al., 2018).

**3.4 Effect of arabic gum coating on total plate count (TPC) of litchi**

Contamination of the fruits and vegetables flesh can occur from the skin increasing the fruits and vegetables spoilage leading to biochemical deterioration such as browning, off flavour and texture break down, decreasing the fruits and vegetables quality and the risk to the consumers due to the presence of pathogenic microorganism (L.J. Harris et al., 2003). Litchi fruit is highly susceptible to decay as it is

majorly affected by fungal and bacterial infections during postharvest storage.

**Table 4. Effect of arabic gum coating on sensory characteristics of litchi stored at 4°C after 28<sup>th</sup> day of preservation**

Litchi treated with	Total plate count (TPC)
0.15% arabic gum before preservation	1.2 x 10 <sup>1</sup> ±0.03 <sup>a</sup>
0.15% arabic gum after 28 <sup>th</sup> day of preservation	1.3 x 10 <sup>1</sup> ±0.00 <sup>a</sup>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ( $\alpha = 5\%$ ).

Effects of chitosan coating and ascorbic acid on litchi fruits storage were investigated. It was suggested that chitosan and AsA play active roles in inhibiting pericarp browning, dehydration and microbial attack and maintaining membrane integrity, thus improved litchi storability being achieved (Dequan Sun et al., 2010). The effect of radiation-processed oligo-chitosan on post-harvest loss of litchi fruit was investigated. Different concentrations of irradiated (40 kGy) chitosan solution (500, 1000 and 1500 ppm) were sprayed on litchi fruits both in stalked and stalkless form. Then the treated and untreated litchis were stored in different atmospheric conditions such as at (a) room environment (open and polythene covered) and (b) at 4°C in zip-bag. Fruits coated with irradiated chitosan showed significant delays in the change of weight loss, aesthetic view and microbial count as compared with the uncoated control fruits. The best result was achieved for storage in room temperature at 1500 ppm irradiated chitosan sprayed litchis, where up to 7 days litchis were in good quality. Further improvement was achieved by keeping the litchis in zip lock bag at 4°C. In this case, litchis maintained edible quality with proper aesthetic view up to 21 days. Peeled litchis were also stored at 4°C in air-tight jar in formulated chitosan solution where they maintained edible quality up to 4 months (Jesmin S et al., 2018).

### 3.5 Effect of arabic gum coating on sensory characteristics of litchi

Litchi fruit during maturation had increasing activities of the pectin methylesterase and polygalacturonase and this could be the reason for decreasing fruit firmness during ripening. The pericarp of litchi is also sensitive to desiccation and turns brown and brittle once moisture is reduced to half (Bharat Bhushan et al., 2015). Pericarp browning of harvest litchi fruit was believed to be a rapid degradation of anthocyanidin by polyphenol oxidase (PPO) and peroxidase (POD) (Chen and Wang, 1989; Lee and Wicker, 1991). In addition, dehydration was another key factor leading to pericarp browning (Scott et al., 1982; Underhill and Simons, 1993). Pericarp dehydration may result in 40% decrease in water content after 48h storage at 25°C with relative humidity of 60% (Underhill and Critchley, 1994). Such a drastic change undoubtedly causes cell damage and plasmolysis. As a result, tissue wounding induces a high respiration rate which triggers faster tissue deterioration and increased contact between PPO and POD from damaged chloroplast, leucoplast, anthocyanins and

phenols from vacuole, thus accelerating enzymatic action of phenols oxidation (Jiang et al., 1997). Concisely, pericarp browning of post-harvest litchi mainly resulted from degradation of anthocyanidin by PPO and POD actions and decrease in antioxidants levels besides rapid water loss and microbial attack. As a result, active oxygen species originated from pericarp browning will inevitably do harm to cell plasma membranes of litchi flesh, thus leading to aril decay.

**Table 5. Effect of arabic gum coating on sensory characteristics of litchi stored at 4°C after 28<sup>th</sup> day of preservation**

Litchi treated with	Sensory score
0.15% arabic gum before preservation	8.12±0.01 <sup>a</sup>
0.15% arabic gum after 28 <sup>th</sup> day of preservation	8.09±0.02 <sup>a</sup>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ( $\alpha = 5\%$ ).

Control of post-harvest pericarp browning of litchi (*Litchi chinensis* Sonn) was conducted. On storage, pericarp browning increased irrespective of treatments with the decrease in pericarp specific activity, total pericarp phenol and total anthocyanin. Anthocyanin degradation index and polymeric colour increased during storage. Pre-cooled (10°C) fruits treated with 0.6% sodium metabisulphite solution for 10 min, air dried followed by dipping in 2% HCl for 5 min and packing in perforated LDPE bags recorded the lowest polyphenol oxidase specific activity (2.2 units/mg protein) with maximum retention of total anthocyanin (47.3 mg/100g) leading to the lowest pericarp browning after 9 days of storage with attractive red colour, freshness and enhanced shelf life of 9 days at ambient conditions (27.7 ± 1.2°C, RH 78 ± 4%) (M. Neog and L. Saikia, 2010).

To explore effects of exogenous melatonin on postharvest browning and its possible mechanisms in litchi fruit, 'Ziniangxi' litchi fruits were treated with an aqueous solution of melatonin at 0.4 mM and then stored at 25 °C for 8 days. The results revealed that melatonin strongly suppressed pericarp browning and delayed discoloration during storage (Yueying Zhang et al., 2018).

## IV. CONCLUSION

Pericarp browning is the major post-harvest problem of litchi (*Litchi chinensis*) fruit, resulting in reduced commercial value of the fruit. Visual quality was lost at ambient temperature when fruit were removed from storage due to browning. We have successfully optimized some physicochemical, microbial and sensory characteristics of litchi during preservation by coating with arabic gum. By this study, there will be an alternative approach to prolong litchi shelf-life during post-harvest.

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