Nguyen Phuoc Minh et al /J. Pharm. Sci. & Res. Vol. 11(4), 2019, 1352-1357

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Different Edible Coating Materials to Extend Shelf Life Of Longan (*Dimocarpus Longan)* During Storage

Nguyen Phuoc Minh
Faculty of Natural Sciences, Thu Dau Mot University, Binh Duong Province, Vietnam

Abstract.
Longan fruit (*Dimocarpus longan*) is a nonclimacteric tropical and subtropical fruit. It has high commercial value due to its flavor and high content of vitamin C, minerals, and bioactive polyphenols. Longan pulp has a pleasant aroma with a sweet taste, a little seed and a thin skin. It has unique nutritional and organoleptic characteristics that contribute to fruit exports to numerous countries. Harvested longan fruit has a very short shelf life of three days under ambient temperature. Pericarp browning is one of the major problems in longan fruit. The postharvest handling of longan aims to prolong its quality and value, but it is not yet adequately developed. It is necessary to use postharvest techniques for the extension of longan shelf life. Application of edible coating could be considered as a useful approach to maintain its product quality during preservation. Ojective of the present study focused on the effect of different edible coating materials (carboxy methyl cellulose, carrageenan, xanthan gum, alginate, gelatin, chitosan) on some physicochemical, microbial and sensory characteristics of longan during storage. 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 level by coating longan with 0.25% chitosan. The present study is an innovative nonchemical method of preservation using edible coating to extend the shelf life of longan.
Keywords: *Longan, chitosan, coating, preservation, physicochemical, microbial, sensory*

I. INTRODUCTION

The export quality of fruit ranges from 67 to 78 percent of the total edible fruit. The calorific value of longan fruit is 458 kJ/100 g, while vitamin C content is 60.1mg/100g fresh weight, K (324.9 mg/100 g) and Cu (0.26 mg/100 g).[1] The high sugar content and the high shelf-life of the fruit make it promising for cultivation. In the Asian cultivars, the sugar quantity is higher as compared to the other cultivar that is grown all over the world.[3] The shelf life of the fruit can be extended by processing the fruit by freezing, canning and drying.[4] Longan can be preserved by various forms like frozen, canned, dried etc and longer availability can be achieved.[5]

The longan in this respect have high sugar content and has a short shelf life of fruit. The ambient condition for harvesting longan is (25°-31°C) and delay it from harvesting may lead to ring ageing and it start turning brown within 3-4 days. This problem can be resolved by using proper method of harvesting and immediate precooling.[6] Proper storage is very important for this crop to extend shelf life for few days. Longan is subjected to hydro cooling or forced air cooling which leads to longer storage period when coupled with low temperature during storage. It is susceptible to chilling injury when stored at the temperature below 7^0 C; the symptoms include the water soaking areas and browning of the pericarp. The fruit is prevented from fungal growth by fumigation with sulphur dioxide and this is the ideal method to increase shelf life.[7] Sulphur fumigation reduces the ageing in longan by reducing the activity of polyphenol oxidase (PPO).[8] But demerit of using sulphur dioxide is toxicity to a human being. The other alternative reported is the dipping of fruits in the organic acids like malic acid, oxalic acid, formic acid and citric acid + ascorbic acid for 5-10 minutes or acid coating.[9]

The use of edible coating is another safe method of prolonging storability of perishable crops.[10] Edible coatings are mostly derived from biological sources. Application of edible coating on fresh fruits is able to reduce quality changes and slow down quantity losses, for example, moisture loss by controlling and modifying the internal atmosphere of the individual fruits.[11] The edible coating material forms thin layer on the surface of food and gives a selective barrier against moisture, oxygen, and carbon dioxide.[10] If a film or coating with the appropriate permeability is chosen, a controlled respiratory exchange can be established and thus the preservation of fresh produce can be achieved.[12]

There were several researchs mentioned to coating of longan. The effect of application of edible coating on or before ultraviolet treatment on postharvest longan fruits was compared.[13] The effects of chitosan coating in extending postharvest life of longan fruits and maintaining their quality were investigated.[14]

Longan is a tropical fruit that undergoes postharvest deterioration rapidly. It's a highly perishable fruit and easily damaged, browning very rapidly during ripening, and becomes mushy and difficult to consume fresh. Longan 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 longan fruit. Pericarp browning leads to the loss of economic value of longan 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 longan, followed by postharvest decay. Application of edible coating could be considered as a useful approach to maintain its product quality during preservation. Ojective of the present study focused on the effect of different edible coating on some physicochemical, microbial and sensory characteristics of longan during preservation.

II. MATERIALS AND METHOD

2.1 Material

Longans were collected in Soc Trang 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 blown by air to remove dirt, dust and adhered unwanted material. Besides longans we also used other materials during the research such as carboxy methyl cellulose, carrageenan, xanthan gum, alginate, gelatin, chitosan, distilled water, acetic acid, 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. Longan (*Dimocarpus longan*)

2.2 Researching procedure

2.2.1 Effect of edible coating material to physicochemical, microbial and sensory characteristics of longan during preservation

The coating solution was prepared with different coating material (carboxy methyl cellulose, carrageenan, xanthan gum, alginate, gelatin, chitosan) with the same concentration (0.05%) by spraying. All samples were air dried for 15 min at room temperature (about 28°C). The coated fruits were packed in PVC wrap and kept at 4°C in a refrigerated condition for a period of 30 days to study the shelf life and physicochemical, microbial and sensory characteristics

2.2.2 Effect of edible coating concentration to physicochemical, microbial and sensory characteristics of longan during preservation

The coating solution was prepared with different coating concentration (0.05%, 0.1%, 0.15%, 0.20%, 0.25%, 0.30%) by spraying. All samples were air dried for 15 min at room temperature (about 28°C). The coated fruits were packed in PVC wrap and kept at 4°C in a refrigerated condition for a period of 30 days to study the shelf life and physicochemical, microbial and sensory characteristics

2.3 Determination of physicochemical, microbial and sensory characteristics of longan during preservation

The longans were weighed regularly to determine weight loss which was calculated cumulatively by comparing the weights of the sample with the electronic balance. 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. Ascorbic acid content was measured by 2,6-dichlorophenolindophenol titration. The total colony forming units (CFU) was enumerated during the storage period by Petrifilm - 3M. 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. All measurements were sampled at an interval of 5 days for the total 30 days storage period and the results were expressed as percentages.

2.4 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 Effect of edible coating material to physicochemical, microbial and sensory characteristics of longan during preservation

The coating solution was prepared with different coating material (carboxy methyl cellulose, carrageenan, xanthan gum, alginate, gelatin, chitosan) with the same concentration (0.05%) by spraying. There was a signifcant difference observed between the control and coated samples while preserving longan at 4°C. Results were showed in table 1, 2, 3, 4, 5, 6. The chitosan coating was suitable to limit the respiration from coated longans.

Table 1. Effect of edible coating material to weight loss (%) of longan during preservation

Preservation (days)	0.05% edible coating concentration						
	Control	CMC	Carrageenan	Xanthan gum	Alginate	Gelatin	Chitosan
0	0	0	0	0	0	0	0
5	1.15 ±0.02^{a}	1.07 ±0.00^{b}	1.03 ±0.01^{cd}	1.06 ±0.01^{bc}	1.04 ±0.01^{c}	1.10 ±0.02^{ab}	0.92 ±0.01^{d}
10	1.49 ±0.03^{a}	1.36 ±0.00^{b}	1.20 ±0.00^{cd}	1.30 ±0.02^{bc}	1.26 ±0.02^{c}	1.40 ±0.01^{ab}	1.07 ±0.02^{d}
15	2.41 ±0.01^{a}	2.30 ±0.01^{b}	2.11 ±0.00^{cd}	2.24 ±0.02^{bc}	2.18 ±0.00^{c}	2.35 ±0.03^{ab}	1.53 ±0.00^{d}
20	3.19 ±0.01^{a}	3.00 ±0.01^{b}	2.60 ±0.02^{cd}	2.84 ±0.03^{bc}	2.77 ±0.03^{c}	3.07 ±0.01^{ab}	2.03 ±0.03^{d}
25	3.97 ±0.01^{a}	3.74 ±0.02^{b}	3.21 ±0.01^{cd}	3.65 ±0.01^{bc}	3.58 ±0.02^{c}	3.85 ±0.01^{ab}	2.34 ±0.00^{d}
30	4.24 ±0.03^{a}	4.05 ±0.00^{b}	3.72 ±0.02^{cd}	3.94 ±0.00^{bc}	3.85 ±0.0^{c}	4.15 ±0.00^{ab}	2.68 ±0.02^{d}

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%).

The weight loss of longan observed in control was due to the shrinkage of fruits by loss of moisture.

The effect of application of edible coating on or before ultraviolet treatment on postharvest longan fruits was compared. When UV was applied before coating (i.e., chitosan or carrageenan), it had relatively lower PPO and PAL activities and retained higher TPC in longan pericarp. UV treatment preceded coating, the combinations of UV plus chitosan coating produced lower PPO and PAL activities and retained better cell structure with less damage than the combinations of UV plus carrageenan coating. UV plus carrageenan coating showed relatively higher weight loss and respiration rate, with cell structure exhibiting bigger intercellular spaces at the end of storage.[12]

Table 2. Effect of edible coating material to total soluble solid (^{o}Brix) of longan during preservation

Preservation (days)	0.05% edible coating concentration						
	Control	CMC	Carrageenan	Xanthan gum	Alginate	Gelatin	Chitosan
0	14.35 ±0.02^{a}	14.35 ±0.02^{a}	14.35 ±0.02^{a}	14.35 ±0.02^{a}	14.35 ±0.02^{a}	14.35 ±0.02^{a}	14.35 ±0.02^{a}
5	13.91 ±0.01^{d}	14.04 ±0.01^{c}	14.17 ±0.02^{ab}	14.08 ±0.00^{bc}	14.13 ±0.02^{b}	13.98 ±0.01^{cd}	14.21 ±0.02^{a}
10	13.77 ±0.01^{d}	13.89 ±0.02^{c}	14.05 ±0.01^{ab}	13.95 ±0.02^{bc}	14.00 ±0.01^{b}	13.82 ±0.02^{cd}	14.17 ±0.01^{a}
15	13.71 ±0.03^{d}	13.80 ±0.02^{c}	14.00 ±0.03^{ab}	13.88 ±0.02^{bc}	13.94 ±0.01^{b}	13.76 ±0.02^{cd}	14.05 ±0.03^{a}
20	13.60 ±0.00^{d}	13.70 ±0.02^{c}	13.87 ±0.01^{ab}	13.74 ±0.01^{bc}	13.82 ±0.03^{b}	13.63 ±0.03^{cd}	13.90 ±0.00^{a}
25	13.50 ±0.02^{d}	13.61 ±0.03^{c}	13.80 ±0.01^{ab}	13.66 ±0.03^{bc}	13.74 ±0.00^{b}	13.57 ±0.00^{cd}	13.85 ±0.01^{a}
30	13.29 ±0.00^{d}	13.40 ±0.00^{c}	13.59 ±0.00^{ab}	13.44 ±0.02^{bc}	13.50 ±0.01^{b}	13.34 ±0.00^{cd}	13.64 ±0.00^{a}

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 edible coating material to total titratable acidity ($^{\%}$) of longan during preservation

Preservation (days)	0.05% edible coating concentration						
	Control	CMC	Carrageenan	Xanthan gum	Alginate	Gelatin	Chitosan
0	0.40 ±0.01^{a}	0.40 ±0.01^{a}	0.40 ±0.01^{a}	0.40 ±0.01^{a}	0.40 ±0.01^{a}	0.40 ±0.01^{a}	0.40 ±0.01^{a}
5	0.34 ±0.03^{d}	0.36 ±0.02^{c}	0.39 ±0.01^{ab}	0.37 ±0.02^{bc}	0.38 ±0.01^{b}	0.35 ±0.02^{cd}	0.40 ±0.01^{a}
10	0.32 ±0.02^{d}	0.35 ±0.01^{c}	0.39 ±0.02^{ab}	0.36 ±0.01^{bc}	0.37 ±0.02^{b}	0.34 ±0.01^{cd}	0.40 ±0.03^{a}
15	0.31 ±0.01^{d}	0.35 ±0.01^{c}	0.39 ±0.01^{ab}	0.36 ±0.01^{bc}	0.37 ±0.02^{b}	0.33 ±0.01^{cd}	0.40 ±0.01^{a}
20	0.30 ±0.01^{d}	0.34 ±0.01^{c}	0.38 ±0.02^{ab}	0.35 ±0.03^{bc}	0.37 ±0.01^{b}	0.32 ±0.01^{cd}	0.40 ±0.02^{a}
25	0.28 ±0.03^{d}	0.34 ±0.00^{c}	0.38 ±0.00^{ab}	0.35 ±0.01^{bc}	0.36 ±0.01^{b}	0.32 ±0.02^{cd}	0.39 ±0.00^{a}
30	0.27 ±0.03^{d}	0.33 ±0.03^{c}	0.37 ±0.01^{ab}	0.34 ±0.00^{bc}	0.35 ±0.02^{b}	0.31 ±0.01^{cd}	0.39 ±0.01^{a}

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 4. Effect of edible coating material to ascorbic acid (mg/ 100g) of longan during preservation

Preservation (days)	0.05% edible coating concentration						
	Control	CMC	Carrageenan	Xanthan gum	Alginate	Gelatin	Chitosan
0	8.25 ±0.01^{a}	8.25 ±0.01^{a}	8.25 ±0.01^{a}	8.25 ±0.01^{a}	8.25 ±0.01^{a}	8.25 ±0.01^{a}	8.25 ±0.01^{a}
5	8.11 ±0.03^{d}	8.15 ±0.02^{c}	8.22 ±0.01^{ab}	8.18 ±0.02^{bc}	8.20 ±0.01^{b}	8.13 ±0.02^{cd}	8.24 ±0.01^{a}
10	8.07 ±0.01^{d}	8.12 ±0.00^{c}	8.19 ±0.01^{ab}	8.14 ±0.02^{bc}	8.16 ±0.01^{b}	8.09 ±0.03^{cd}	8.22 ±0.02^{a}
15	8.05 ±0.02^{d}	8.10 ±0.03^{c}	8.18 ±0.02^{ab}	8.13 ±0.02^{bc}	8.15 ±0.03^{b}	8.08 ±0.03^{cd}	8.21 ±0.02^{a}
20	8.02 ±0.02^{d}	8.09 ±0.02^{c}	8.17 ±0.03^{ab}	8.12 ±0.01^{bc}	8.14 ±0.02^{b}	8.07 ±0.02^{cd}	8.20 ±0.01^{a}
25	8.00 ±0.01^{d}	8.07 ±0.01^{c}	8.15 ±0.01^{ab}	8.10 ±0.03^{bc}	8.12 ±0.00^{b}	8.05 ±0.00^{cd}	8.18 ±0.01^{a}
30	7.96 ±0.01^{d}	8.00 ±0.01^{c}	8.11 ±0.03^{ab}	8.04 ±0.01^{bc}	8.07 ±0.01^{b}	7.98 ±0.02^{cd}	8.18 ±0.02^{a}

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 5. Effect of edible coating material to total plate count (cfu/g) of longan during preservation

Preservation (days)	0.05% edible coating concentration						
	Control	CMC	Carrageenan	Xanthan gum	Alginate	Gelatin	Chitosan
0	$7.23 \times 10^4 \pm 0.01^a$	$7.23 \times 10^4 \pm 0.01^a$	$7.23 \times 10^4 \pm 0.01^a$	$7.23 \times 10^4 \pm 0.01^a$	$7.23 \times 10^4 \pm 0.01^a$	$7.23 \times 10^4 \pm 0.01^a$	$7.23 \times 10^4 \pm 0.01^a$
5	$7.34 \times 10^4 \pm 0.02^a$	$7.08 \times 10^4 \pm 0.00^b$	$6.90 \times 10^4 \pm 0.01^{cd}$	$7.01 \times 10^4 \pm 0.01^{bc}$	$6.95 \times 10^4 \pm 0.01^c$	$7.16 \times 10^4 \pm 0.02^{ab}$	$6.81 \times 10^4 \pm 0.01^d$
10	$7.40 \times 10^4 \pm 0.03^a$	$7.03 \times 10^4 \pm 0.00^b$	$6.80 \times 10^4 \pm 0.00^{cd}$	$6.97 \times 10^4 \pm 0.02^{bc}$	$6.89 \times 10^4 \pm 0.02^c$	$7.05 \times 10^4 \pm 0.01^{ab}$	$6.75 \times 10^4 \pm 0.02^d$
15	$7.64 \times 10^4 \pm 0.01^a$	$6.80 \times 10^4 \pm 0.01^b$	$6.58 \times 10^4 \pm 0.00^{cd}$	$6.71 \times 10^4 \pm 0.02^{bc}$	$6.68 \times 10^4 \pm 0.00^c$	$6.85 \times 10^4 \pm 0.03^{ab}$	$6.50 \times 10^4 \pm 0.00^d$
20	$7.71 \times 10^4 \pm 0.01^a$	$6.68 \times 10^4 \pm 0.01^b$	$6.45 \times 10^4 \pm 0.02^{cd}$	$6.60 \times 10^4 \pm 0.03^{bc}$	$6.54 \times 10^4 \pm 0.03^c$	$6.80 \times 10^4 \pm 0.01^{ab}$	$6.38 \times 10^4 \pm 0.03^d$
25	$7.84 \times 10^4 \pm 0.01^a$	$6.51 \times 10^4 \pm 0.02^b$	$6.30 \times 10^4 \pm 0.01^{cd}$	$6.45 \times 10^4 \pm 0.01^{bc}$	$6.37 \times 10^4 \pm 0.02^c$	$6.57 \times 10^4 \pm 0.01^{ab}$	$6.19 \times 10^4 \pm 0.00^d$
30	$8.13 \times 10^4 \pm 0.03^a$	$6.19 \times 10^4 \pm 0.00^b$	$6.02 \times 10^4 \pm 0.02^{cd}$	$6.14 \times 10^4 \pm 0.00^{bc}$	$6.08 \times 10^4 \pm 0.0^c$	$6.25 \times 10^4 \pm 0.00^{ab}$	$5.77 \times 10^4 \pm 0.02^d$

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 6. Effect of edible coating material to sensory score of longan during preservation

Preservation (days)	0.05% edible coating concentration						
	Control	CMC	Carrageenan	Xanthan gum	Alginate	Gelatin	Chitosan
0	8.29 ± 0.03^a	8.29 ± 0.03^a	8.29 ± 0.03^a	8.29 ± 0.03^a	8.29 ± 0.03^a	8.29 ± 0.03^a	8.29 ± 0.03^a
5	8.12 ± 0.02^d	8.16 ± 0.0^c	8.23 ± 0.02^{ab}	8.19 ± 0.01^{bc}	8.21 ± 0.03^b	8.14 ± 0.03^{cd}	8.25 ± 0.02^a
10	8.09 ± 0.02^d	8.14 ± 0.01^c	8.21 ± 0.01^{ab}	8.16 ± 0.01^{bc}	8.18 ± 0.02^b	8.11 ± 0.01^{cd}	8.24 ± 0.01^a
15	8.06 ± 0.01^d	8.11 ± 0.01^c	8.19 ± 0.00^{ab}	8.14 ± 0.01^{bc}	8.16 ± 0.01^b	8.09 ± 0.01^{cd}	8.22 ± 0.03^a
20	8.01 ± 0.01^d	8.08 ± 0.03^c	8.16 ± 0.01^{ab}	8.11 ± 0.03^{bc}	8.13 ± 0.01^b	8.06 ± 0.01^{cd}	8.19 ± 0.00^a
25	7.97 ± 0.03^d	8.06 ± 0.02^c	8.14 ± 0.03^{ab}	8.08 ± 0.02^{bc}	8.10 ± 0.01^b	8.03 ± 0.02^{cd}	8.15 ± 0.01^a
30	7.93 ± 0.02^d	7.98 ± 0.00^c	8.09 ± 0.02^{ab}	8.02 ± 0.02^{bc}	8.05 ± 0.02^b	7.97 ± 0.01^{cd}	8.15 ± 0.04^a

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 edible coating concentration to physicochemical, microbial and sensory characteristics of longan during preservation

The chitosan coating solution was prepared with different coating concentration (0.05%, 0.1%, 0.15%, 0.20%, 0.25%, 0.30%) by spraying. All samples were air dried for 15 min at room temperature (about 28°C). There was a signifcant difference observed between the control and coated samples while preserving longan at 4°C. Results were showed in table 7, 8, 9, 10, 11, 12. The chitosan coating 0.25% was suitable for coating longans.

Table 7. Effect of chitosan coating concentration (%) to weight loss (%) of longan during preservation

Preservation (days)	Chitosan coating concentration (%)						
	Control	0.05	0.10	0.15	0.20	0.25	0.30
0	0	0	0	0	0	0	0
5	0.92 ± 0.01^a	0.89 ± 0.00^{ab}	0.87 ± 0.01^{ab}	0.85 ± 0.01^b	0.83 ± 0.01^{bc}	0.80 ± 0.02^c	0.80 ± 0.01^c
10	2.48 ± 0.02^a	2.40 ± 0.01^{ab}	2.15 ± 0.03^{ab}	2.09 ± 0.00^b	1.94 ± 0.00^{bc}	1.80 ± 0.01^c	1.79 ± 0.02^c
15	3.85 ± 0.02^a	3.74 ± 0.02^{ab}	3.63 ± 0.02^{ab}	3.14 ± 0.02^b	3.01 ± 0.02^{bc}	2.94 ± 0.02^c	2.92 ± 0.03^c
20	5.24 ± 0.01^a	4.31 ± 0.04^{ab}	4.16 ± 0.02^{ab}	3.75 ± 0.03^b	3.45 ± 0.00^{bc}	3.04 ± 0.03^c	3.02 ± 0.02^c
25	6.73 ± 0.02^a	5.04 ± 0.02^{ab}	4.92 ± 0.03^{ab}	4.49 ± 0.00^b	4.06 ± 0.02^{bc}	3.47 ± 0.00^c	3.45 ± 0.00^c
30	8.37 ± 0.02^a	8.03 ± 0.01^{ab}	7.11 ± 0.00^{ab}	6.23 ± 0.02^b	5.47 ± 0.01^{bc}	4.03 ± 0.01^c	4.00 ± 0.02^c

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 8. Effect of chitosan coating concentration (%) to total soluble solid (^{o}Brix) of longan during preservation

Preservation (days)	Chitosan coating concentration (%)						
	Control	0.05	0.10	0.15	0.20	0.25	0.30
0	14.35 ±0.02^a	14.35 ±0.02^a	14.35 ±0.02^a	14.35 ±0.02^a	14.35 ±0.02^a	14.35 ±0.02^a	14.35 ±0.02^a
5	14.01 ±0.01^c	14.13 ±0.00^{bc}	14.16 ±0.01^{bc}	14.20 ±0.01^b	14.25 ±0.01^{ab}	14.34 ±0.03^a	14.34 ±0.02^a
10	13.94 ±0.03^c	14.10 ±0.00^{bc}	14.13 ±0.02^{bc}	14.17 ±0.02^b	14.21 ±0.02^{ab}	14.32 ±0.02^a	14.32 ±0.01^a
15	13.85 ±0.02^c	14.04 ±0.03^{bc}	14.11 ±0.02^{bc}	14.15 ±0.01^b	14.19 ±0.02^{ab}	14.27 ±0.01^a	14.28 ±0.01^a
20	13.80 ±0.03^c	14.01 ±0.00^{bc}	14.05 ±0.02^{bc}	14.11 ±0.03^b	14.17 ±0.00^{ab}	14.25 ±0.01^a	14.25 ±0.01^a
25	13.73 ±0.02^c	13.90 ±0.02^{bc}	13.95 ±0.00^{bc}	14.02 ±0.00^b	14.08 ±0.01^{ab}	14.20 ±0.01^a	14.21 ±0.03^a
30	13.66 ±0.00^c	13.72 ±0.03^{bc}	13.84 ±0.00^{bc}	13.93 ±0.02^b	14.01 ±0.02^{ab}	14.17 ±0.02^a	14.18 ±0.01^a

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 9. Effect of chitosan coating concentration (%) to total titratable acidity (%) of longan during preservation

Preservation (days)	Chitosan coating concentration (%)						
	Control	0.05	0.10	0.15	0.20	0.25	0.30
0	0.40 ±0.01^a	0.40 ±0.01^a	0.40 ±0.01^a	0.40 ±0.01^a	0.40 ±0.01^a	0.40 ±0.01^a	0.40 ±0.01^a
5	0.33 ±0.01^c	0.35 ±0.00^{bc}	0.37 ±0.01^{bc}	0.38 ±0.01^b	0.39 ±0.01^{ab}	0.40 ±0.03^a	0.40 ±0.02^a
10	0.31 ±0.03^c	0.34 ±0.00^{bc}	0.36 ±0.02^{bc}	0.37 ±0.02^b	0.38 ±0.02^{ab}	0.40 ±0.02^a	0.40 ±0.01^a
15	0.29 ±0.02^c	0.32 ±0.03^{bc}	0.34 ±0.02^{bc}	0.35 ±0.01^b	0.37 ±0.02^{ab}	0.39 ±0.01^a	0.39 ±0.01^a
20	0.28 ±0.03^c	0.30 ±0.00^{bc}	0.31 ±0.02^{bc}	0.33 ±0.03^b	0.37 ±0.00^{ab}	0.39 ±0.01^a	0.39 ±0.01^a
25	0.25 ±0.02^c	0.27 ±0.02^{bc}	0.30 ±0.00^{bc}	0.32 ±0.00^b	0.36 ±0.01^{ab}	0.38 ±0.01^a	0.38 ±0.03^a
30	0.23 ±0.00^c	0.25 ±0.03^{bc}	0.29 ±0.00^{bc}	0.31 ±0.02^b	0.36 ±0.02^{ab}	0.38 ±0.02^a	0.38 ±0.01^a

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 10. Effect of chitosan coating concentration (%) to ascorbic acid (mg/ 100g) of longan during preservation

Preservation (days)	Chitosan coating concentration (%)						
	Control	0.05	0.10	0.15	0.20	0.25	0.30
0	8.25 ±0.01^a	8.25 ±0.01^a	8.25 ±0.01^a	8.25 ±0.01^a	8.25 ±0.01^a	8.25 ±0.01^a	8.25 ±0.01^a
5	8.13 ±0.01^c	8.16 ±0.00^{bc}	8.19 ±0.01^{bc}	8.21 ±0.01^b	8.23 ±0.01^{ab}	8.24 ±0.01^a	8.24 ±0.02^a
10	8.11 ±0.01^c	8.14 ±0.00^{bc}	8.17 ±0.01^{bc}	8.19 ±0.01^b	8.21 ±0.01^{ab}	8.23 ±0.03^a	8.23 ±0.03^a
15	8.09 ±0.02^c	8.11 ±0.01^{bc}	8.15 ±0.03^{bc}	8.17 ±0.02^b	8.19 ±0.02^{ab}	8.21 ±0.01^a	8.21 ±0.02^a
20	8.05 ±0.01^c	8.09 ±0.03^{bc}	8.13 ±0.00^{bc}	8.15 ±0.01^b	8.17 ±0.01^{ab}	8.20 ±0.00^a	8.20 ±0.00^a
25	8.02 ±0.01^c	8.05 ±0.01^{bc}	8.10 ±0.02^{bc}	8.13 ±0.03^b	8.15 ±0.02^{ab}	8.18 ±0.02^a	8.18 ±0.01^a
30	7.98 ±0.01^c	8.01 ±0.01^{bc}	8.03 ±0.01^{bc}	8.10 ±0.01^b	8.14 ±0.01^{ab}	8.15 ±0.00^a	8.15 ±0.02^a

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%).

The effects of chitosan coating in extending postharvest life of longan fruits and maintaining their quality were investigated. The fruits were treated with aqueous solutions of 0.5, 1.0 and 2.0% chitosan, respectively, and then stored at 2°C and 90% relative humidity. The application of chitosan coating reduced respiration rate and weight loss, delayed the increase in PPO activity and the changes in colour, and eating quality, and partially inhibited decay of fruit during storage.[21]

Table 11. Effect of chitosan coating concentration (%) to plate count (cfu/g) of longan during preservation

Preservation (days)	Chitosan coating concentration (%)						
	Control	0.05	0.10	0.15	0.20	0.25	0.30
0	7.23×10^4 $\pm 0.01^a$	7.23×10^4 $\pm 0.01^a$	7.23×10^4 $\pm 0.01^a$	7.23×10^4 $\pm 0.01^a$	7.23×10^4 $\pm 0.01^a$	7.23×10^4 $\pm 0.01^a$	7.23×10^4 $\pm 0.01^a$
5	7.35×10^4 $\pm 0.03^a$	7.19×10^4 $\pm 0.00^{ab}$	7.04×10^4 $\pm 0.01^{ab}$	6.95×10^4 $\pm 0.01^b$	6.89×10^4 $\pm 0.01^{bc}$	6.40×10^4 $\pm 0.02^c$	6.38×10^4 $\pm 0.01^c$
10	7.48×10^4 $\pm 0.01^a$	7.08×10^4 $\pm 0.03^{ab}$	6.97×10^4 $\pm 0.02^{ab}$	6.90×10^4 $\pm 0.01^b$	6.83×10^4 $\pm 0.03^{bc}$	6.32×10^4 $\pm 0.03^c$	6.30×10^4 $\pm 0.01^c$
15	7.53×10^4 $\pm 0.00^a$	6.93×10^4 $\pm 0.02^{ab}$	6.86×10^4 $\pm 0.03^{ab}$	6.77×10^4 $\pm 0.01^b$	6.69×10^4 $\pm 0.01^{bc}$	6.25×10^4 $\pm 0.01^c$	6.19×10^4 $\pm 0.01^c$
20	7.61×10^4 $\pm 0.02^a$	6.82×10^4 $\pm 0.02^{ab}$	6.73×10^4 $\pm 0.01^{ab}$	6.66×10^4 $\pm 0.01^b$	6.45×10^4 $\pm 0.01^{bc}$	6.16×10^4 $\pm 0.01^c$	6.15×10^4 $\pm 0.03^c$
25	7.79×10^4 $\pm 0.01^a$	6.64×10^4 $\pm 0.01^{ab}$	6.54×10^4 $\pm 0.01^{ab}$	6.47×10^4 $\pm 0.01^b$	6.32×10^4 $\pm 0.01^{bc}$	6.03×10^4 $\pm 0.01^c$	6.02×10^4 $\pm 0.01^c$
30	7.85×10^4 $\pm 0.01^a$	6.32×10^4 $\pm 0.02^{ab}$	6.28×10^4 $\pm 0.01^{ab}$	6.11×10^4 $\pm 0.01^b$	6.02×10^4 $\pm 0.01^{bc}$	5.85×10^4 $\pm 0.01^c$	5.84×10^4 $\pm 0.03^c$

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 12. Effect of chitosan coating concentration (%) to sensory score of longan during preservation

Preservation (days)	Chitosan coating concentration (%)						
	Control	0.05	0.10	0.15	0.20	0.25	0.30
0	8.29 $\pm 0.03^a$	8.29 $\pm 0.03^a$	8.29 $\pm 0.03^a$	8.29 $\pm 0.03^a$	8.29 $\pm 0.03^a$	8.29 $\pm 0.03^a$	8.29 $\pm 0.03^a$
5	8.15 $\pm 0.01^c$	8.20 $\pm 0.00^{bc}$	8.21 $\pm 0.01^{bc}$	8.23 $\pm 0.01^b$	8.25 $\pm 0.01^{ab}$	8.28 $\pm 0.01^a$	8.28 $\pm 0.02^a$
10	8.12 $\pm 0.03^c$	8.15 $\pm 0.01^{bc}$	8.18 $\pm 0.02^{bc}$	8.20 $\pm 0.02^b$	8.23 $\pm 0.02^{ab}$	8.26 $\pm 0.01^a$	8.26 $\pm 0.01^a$
15	8.05 $\pm 0.01^c$	8.08 $\pm 0.03^{bc}$	8.15 $\pm 0.01^{bc}$	8.19 $\pm 0.01^b$	8.21 $\pm 0.01^{ab}$	8.24 $\pm 0.00^a$	8.24 $\pm 0.03^a$
20	8.00 $\pm 0.02^c$	8.02 $\pm 0.01^{bc}$	8.10 $\pm 0.01^{bc}$	8.13 $\pm 0.02^b$	8.16 $\pm 0.01^{ab}$	8.20 $\pm 0.03^a$	8.21 $\pm 0.01^a$
25	7.95 $\pm 0.04^c$	8.01 $\pm 0.02^{bc}$	8.06 $\pm 0.03^{bc}$	8.10 $\pm 0.01^b$	8.13 $\pm 0.01^{ab}$	8.19 $\pm 0.01^a$	8.19 $\pm 0.02^a$
30	7.87 $\pm 0.02^c$	7.93 $\pm 0.02^{bc}$	8.00 $\pm 0.02^{bc}$	8.07 $\pm 0.02^b$	8.11 $\pm 0.02^{ab}$	8.15 $\pm 0.01^a$	8.16 $\pm 0.01^a$

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%).

IV. CONCLUSION

Longan (*Dimocarpus longan* Lour) is the delicate fruit of immense value. Its proper postharvest management starts from judging horticultural maturity and retaining all its sensory characteristics which are important for its consumer appeal. Therefore, the longan should be preserved for a long shelf life without using chemical substances. We have successfully optimized some technical factors of edible coating to physicochemical, microbial and sensory characteristics of longan during preservation. By this study, there will be an alternative approach to prolong longan shelf-life during post-harvest.

REFERENCES

1. Marisa M. Wall. Ascorbic acid and mineral composition of longan (*Dimocarpus longan*), lychee (*Litchi chinensis*) and rambutan (*Nephelium lappaceum*) cultivars grown in Hawaii. *Journal of Food Composition and Analysis* 2006; 19: 655–663.
2. Cheng, A., Yan, H., Han, C., Wang, W., Tian, Y., Chen, X. Polyphenols from blueberries modulate inflammation cytokines in LPS-induced RAW264.7 macrophages. *Int. J. Biol. Macromol.* 2014; 69: 382–387.
3. K. Prasad, Pallavi Neha, Milan Kumar Lal and Abhay Kumar Gaurav. Longan (*Dimocarpus longan* Lour) processing: A Review. *International Journal of Current Microbiology and Applied Sciences* 2017; 6(8): 1-7.
4. Han, D.M., Guo, D.L., Pang, X.W., Li, R. and Li, J.G. Influences of fruit development progress on the physiological abscission and maturity of different varieties of longan. *Guangdong Agric. Sci.* 2011; 38(7):59-62.
5. Xu, L. Development strategies of fujian late-maturing longan. *Fujian Fruits* 2004; 3: 39-40.
6. Shi, S. Y., Li, W. C., Zhang, H. N., Liu, L. Q., Shu, B., Liang, Q. Z., Xie, J. H., Wei, Y. Z. Application of extended scale for phenological studies in longan (*Dimocarpus longan*). *Annals of Applied Biol* 2015; 167(1):127-134.
7. Li, X.H., Chen, S.W., Lai, H.L., Zheng, H.D., Chen, X.Y., Zhuo, Y.Z. and Yu, X.R.Test of formulated fertilisation on longan. *Guangdong Agric. Sci.* 2009; 10:95- 96.
8. Wu, Z.X., Han D. M., Ji Z.L. and Chen W. X. Effect of sulphur dioxide treatment on enzymatic browning of longan pericarp during storage. *Acta Hortic. Sinica* 1999; 26: 91-95.
9. Whangchai, K., Saengnil, K., Uthaibutra, J. Effects of ozone in combination with some organic acids on the control of postharvest decay and pericarp browning of longan fruits. *Crop Prot.* 2006; 25, 821-825.
10. R. K. Dhall. Advances in edible coatings for fresh fruits and vegetables: a review. *Critical Reviews in Food Science and Nutrition* 2013; 53(5): 435–450.
11. K. N. Turhan. Is edible coating an alternative to MAP for fresh and minimally processed fruits? *X International Controlled and Modified Atmosphere Research Conference* 2009; 876: 299–305.
12. E. Ayranci and S. Tunc. A method for the measurement of the oxygen permeability and the development of edible films to reduce the rate of oxidative reactions in fresh foods. *Food Chemistry* 2003; 80(3): 423–431.
13. Mee Gie Lin, Ola Lasekan, Nazamid Saari, and Siti Khairunniza-Bejo. The effect of the application of edible coatings on or before ultraviolet treatment on postharvested longan fruits. *Journal of Food Quality* Volume 2017, Article ID 5454263, 11 pages.
14. YuemingJiang, YuebiaoLi. Effects of chitosan coating on postharvest life and quality of longan fruit. *Food Chemistry* 2001; 73(2): 139-143.