Nguyen Phuoc Minh et al /J. Pharm. Sci. & Res. Vol. 11(3), 2019, 1063-1067

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

Application Of Cmc, Xanthan Gum As Biodegradable Coating On Storage Of Rambutan (*Nephelium Lappaceum*) Fruit

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Abstract.

Rambutan fruit is one of the most interesting of all tropical fruits. The fruit is an ovoid berry, yellow to orange-red, or bright-red to maroon in color. The flesh is juicy and translucent whitish, sweet to very mild sour in flavor. Harvested rambutan fruits suffer from a short shelf life and show rapid postharvest deterioration problems due to spintern browning and flesh decay. One way to increase the availability to the consumer, and even provide more value to the end product, is edible coating. An investigation on coating of Rambutan by using CMC and xanthan gum was investigated. Rambutan fruits which were coated with 0.6% CMC still maintained shelf-life until 30 days of preservation.

Keywords: *Rambutan, coating, CMC, xanthan gum, preservation, shelf-life*

I. INTRODUCTION

Rambutan (*Nephelium lappaceum)* fruits are edible, oval to spherical drupe, leathery skin with flexible hairy spines, mature from green to red. The fruits are distinctive for its large size, unique odor and a formidable thorn covered hersk.[1] The rambutan fruit is non-climacteric and is picked up ripe. Aril white, fleshy, edible and sweet and surrounds single large seed. The fruit weighs 22.4–64.7 g, based on cultivar and agronomic conditions.[2, 3, 4] Many phytochemical found in fruits act as powerful antioxidants that give them color, flavor, odor and protection against human diseases.[5] It has several biological activities such as antidiabetic, analgesic, antiinflammatory, immunomodulatory, antioxidant, anticancer, antimicrobial and antiviral activities.[6] The active components contained in rambutan such as ellagic acid, corilagin and geraniin are responsible for those activities (Abdul Rohman). By-products of rambutan fruit waste, i.e., seed and peel, are signifed with respect to their nutritional values and possible applications.[7]

Rambutan (*Nephelium lappaceum* L.) rapidly lose their attractive appearance after harvest due to a superficial pericarp browning. Browning of rambutan after harvest has been attributed to skin desiccation. The structure of rambutan pericarp facilitates rapid water loss, particularly through the spinterns and associated vascular tissue and stomata.[8] Storage at high humidity minimizes fruit desiccation and may, therefore, delay browning onset.[9] Due to shorter shelf life at ambient temperature, rambutan is also consumed fresh and is favored due to the bright color, striking appearance and characteristic flavor.[10] Quality changes of rambutan fruits in different packaging system was evaluated by using stretch film wrapping (SF) and polyethylene bag with banana leaf liner (PEB) and without banana leaf liner (PE). All packed fruits retained the freshness and showed minimal colour changes.[11] Changes in some chemical components and in the physiology of rambutan fruit (*Nephelium lappaceum* L.) as affected by storage temperature and packing material were examined.[12] Respiration rate at 4oC and minimal processing of rambutan were investigated (Anchalee Sirichote). Effect of carboxymethyl cellulose as edible coating on postharvest quality of rambutan fruit under ambient temperature was examined.[13]

Edible coatings are alternatives for extending the postharvest life of fresh fruits and vegetables. They form a semi-permeable barrier to gases and water vapor and thereby reduce respiration and weight loss.[14] In addition, edible coatings can potentially carry other natural active ingredients such as anti-browning agents, flavours, and nutrients.[15] The edible coating can be divided into 3 groups including lipid, protein, and polysaccharide.[16] To minimize the postharvest losses and secure the economic value of the rambutan fruit, the objective of the present study was to utilize edible coating based on CMC/ xanthan gum to conserve Rambutan as well as extend their post-harvest shelf-life.

II. MATERIALS AND METHOD

2.1 Material

We collected Rambutan fruits in Vinh Long province, Vietnam. They were cultivated following VietGAP to ensure food safety. After harvesting, they were conveyed to laboratory within 4 hours for experiments. Fruits were washed thoroughly under turbulent washing to remove dirt, dust and adhered unwanted material. Beside rambutan we also used other materials during the research such as CMC and xanthan gum. Lab utensils and equipments included grinder, centrifugator, pH meter, refractometer, biuret, weight balance.

Figure 1. Rambutan (*Nephelium lappaceum*)

2.2 Methods

2.2.1 Preparation of coat forming solution

The coating solution was prepared by dissolving 0, 2, 4, 6, 8 g of CMC/ xanthan gum powder in 1000 ml of distilled water to dissolve CMC/ xanthan gum to prepare 1 L of 0%, 0.2%, 0.4%, 0.6%, and 0.8% CMC/ xanthan gum solutions.

2.2.2 Coating application

The surface of the fruits were disinfected with 20 ppm peracetic acid for 1 min 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 0.2%, 0.4%, 0.6%, and 0.8% CMC/ xanthan gum coating. Each group of rambutan was divided into 20 batches in triplicate (60 batches) each containing 50±2g of whole rambutan. They were dipped in the CMC/ xanthan gum coating solution of 0%, 0.2%, 0.4%, 0.6%, and 0.8% for 1 min and the samples were air dried for 15 min at room temperature (about 25°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 and microbial parameters.

2.2.3 Determination of weight loss

Three batches of rambutan containing 50±2g of whole rambutan were taken at an interval of three days for total storage period. The rambutan 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 3 days for the total 30 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 of rambutan 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. Rambutan pulp (5g) from fruit was homogenized using a grinder and then centrifuged at 4000 rpm for 5 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 Methods 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. RESULTS & DISCUSSION

3.1 Effect of CMC/ xanthan gum coating on weight loss of rambutan

Carboxymethyl cellulose (CMC) is a derivative of cellulose and prepared by a reaction of cellulose with sodium hydroxide and chloroacetic acids.[17] Characteristics of CMC are generally odorless and tasteless, flexible, transparent, and non-toxic.[18] Xanthan gum is an extracellular hetero polysaccharide produced by Xanthomonas campestris Pammel. It's also widely used as a food additive and thickening agent. It produced by the fermentation of simple sugars; glucose, sucrose, or lactos.[19] Due to its unique rheological behavior, xanthan gum is one of the major microbial polysaccharides employed in many industrial processes. Edible coatings when applied on the surface of fruits act as physical barriers which effectively change their internal atmosphere and delay the ripening process.

The weight loss of rambutan observed in control was due to the shrinkage of fruits by loss of moisture which was not observed in the coated fruits. The CMC/ xanthan gum coating prevented the evaporation of moisture from coated rambutan. There was a signifcant difference observed between the control and coated samples. Results were showed in table 1 & 2.

Effect of carboxymethyl cellulose as edible coating on postharvest quality of rambutan fruit under ambient temperature was examined. Fruits coated with 0.5% CMCcom were not significantly different in weight loss and fruit firmness, but non-coated fruits tend to have higher weight loss and fruit firmness than coated fruits during storage. This method could maintain eating quality and vitamin C content during storage.[13]

3.2 Effect of CMC/ xanthan gum coating on pH, total soluble solids, titratable acidity and ascorbic acid of rambutan

The total soluble solids content showed a signifcant difference between the control and coated sample. At the end of preservation, there was a signifcant difference observed between the coated and uncoated samples. It is expected to decrease during storage. But the pH, titratable acidity and ascorbic acid did not vary signifcantly among the fruits treated with control. CMC had a better effect than xanthan gum in respect of pH, total soluble solids, titratable acidity and ascorbic acid in rambutan.

The mix of 1% xanthan gum with 0.2% chitosan nano particles coating enhanced overall quality of guava fruits during extended cold storage and shelf life periods.[20]

Table 1. Effect of CMC coating on weight loss (%) of rambutan stored at 4°C

Preservation time (days)	CMC concentration				
	0%	0.2%	0.4%	0.6%	0.8%
0	0	0	0	0	0
3	1.34±0.01[a]	0.98±0.01[b]	0.77±0.01[c]	0.57±0.01[d]	0.59±0.01[d]
6	2.29±0.02[a]	1.83±0.02[b]	1.25±0.02[c]	0.84±0.02[d]	0.77±0.02[d]
9	3.60±0.00[a]	3.27±0.01[b]	2.89±0.00[c]	2.21±0.01[d]	2.20±0.00[d]
12	4.75±0.01[a]	4.31±0.02[b]	3.65±0.01[c]	3.30±0.02[d]	3.29±0.03[d]
15	5.69±0.02[a]	5.29±0.02[b]	4.57±0.02[c]	3.90±0.01[d]	3.85±0.03[d]
18	6.78±0.01[a]	6.15±0.03[b]	5.69±0.02[c]	4.88±0.02[d]	4.89±0.02[d]
21	7.43±0.03[a]	6.66±0.00[b]	6.15±0.01[c]	5.45±0.01[d]	5.37±0.01[d]
24	8.69±0.00[a]	8.18±0.01[a]	7.69±0.02[c]	6.59±0.02[d]	6.46±0.03[d]
27	8.89±0.02[a]	8.32±0.03[b]	7.73±0.00[c]	7.24±0.01[d]	7.14±0.04[d]
30	9.24±0.01[a]	8.69±0.01[b]	8.19±0.01[c]	7.41±0.02[d]	7.40±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 2. Effect of xanthan gum coating on weight loss (%) of rambutan stored at 4°C

Preservation time (days)	xanthan gum concentration				
	0%	0.2%	0.4%	0.6%	0.8%
0	0	0	0	0	0
3	1.29±0.02[a]	1.09±0.03[b]	0.85±0.03[c]	0.65±0.01[d]	0.65±0.01[d]
6	2.31±0.01[a]	1.88±0.01[b]	1.39±0.02[c]	1.17±0.02[d]	1.15±0.01[d]
9	3.77±0.02[a]	3.27±0.00[b]	2.88±0.01[c]	2.25±0.02[d]	2.29±0.02[d]
12	4.89±0.00[a]	4.43±0.03[b]	3.76±0.01[c]	3.27±0.03[d]	3.28±0.02[d]
15	5.67±0.02[a]	5.29±0.02[b]	4.64±0.02[c]	3.93±0.01[d]	3.87±0.01[d]
18	6.59±0.01[a]	6.32±0.03[b]	5.89±0.02[c]	4.91±0.03[d]	4.88±0.01[d]
21	7.94±0.02[a]	6.85±0.01[b]	6.48±0.01[c]	5.70±0.01[d]	5.56±0.03[d]
24	8.83±0.01[a]	8.22±0.00[a]	7.33±0.03[c]	6.65±0.02[d]	6.50±0.01[d]
27	8.95±0.03[a]	8.47±0.02[b]	7.96±0.01[c]	7.41±0.01[d]	7.27±0.02[d]
30	9.83±0.02[a]	8.74±0.03[b]	8.51±0.04[c]	7.95±0.01[d]	7.84±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 3. Effect of CMC/ xanthan gum coating on pH, total soluble solids, titratable acidity and ascorbic acid of rambutan stored at 4°C after 30th day of preservation

rambutan treated with	Parameters			
	pH	Total soluble solids (^{o}Brix)	Titratable acidity (%)	Ascorbic acid
0.6% CMC before preservation	4.28±0.02[a]	18.19±0.04[a]	0.86±0.00[a]	30.80±0.03[a]
0.6% CMC after 30th day of preservation	4.30±0.02[a]	16.22±0.02[b]	0.83±0.02[a]	30.86±0.01[a]
0.6% xanthan gum before preservation	4.28±0.01[a]	18.19±0.01[a]	0.86±0.01[a]	31.00±0.01[a]
0.6% xanthan gum after 30th day of preservation	4.31±0.01[a]	15.65±0.02[b]	0.77±0.03[a]	31.27±0.03[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 CMC/ xanthan gum coating on sensory characteristics of rambutan stored at 4°C after 30th day of preservation

Rambutan treated with	Total plate count (TPC)
0.6% CMC before preservation	$2.8x10^{1}$±0.00[a]
0.6% CMC after 30th day of preservation	$3.0x10^{1}$ ±0.01[a]
0.6% xanthan gum before preservation	$2.8x10^{1}$±0.00[a]
0.6% xanthan gum after 30th day of preservation	$3.1x10^{1}$±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 CMC/ xanthan gum coating on sensory characteristics of rambutan stored at 4°C after 30th day of preservation

Rambutan treated with	Sensory score
0.6% CMC before preservation	4.75±0.01[a]
0.6% CMC after 30th day of preservation	4.70±0.02[a]
0.6% xanthan gum before preservation	4.75±0.03[a]
0.6% xanthan gum after 30th day of preservation	3.88±0.02[b]

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%).

3.3 Effect of CMC/ xanthan gum coating on total plate count (TPC) of rambutan

The total plate count on rambutan coated by CMC/ xanthan gum showed no significant difference by preservation time. The CMC coating on Rambutan effectively inhibited the growth of microorganisms.

Respiration rate at 4oC and minimal processing of rambutan were investigated. To obtain a longer extended shelf life (>12 days) of minimally processed peeled rambutans, further study on food additives, including acidulants and preservative used and gas composition in modified atmosphere packaging (MAP) is needed.[21]

3.4 Effect of CMC/ xanthan gum coating on sensory characteristics of rambutan

CMC/ xanthan gum coating improved the sensory quality and extended the shelf life of rambutan when compared to control. The rambutan coated with 0.6% CMC were still commercially satisfactory in color, taste, flavor, appearance and overall acceptability after 30 days of preservation. The rambutan coated with 0.6% xanthan gum had a lower sensory score after 30 days of preservation.

Changes in some chemical components and in the physiology of rambutan fruit (*Nephelium lappaceum* L.) as affected by storage temperature and packing material were examined. Changes in the development of the browning index, and contents of total soluble solids, titratable acidity and vitamin C greatly decreased during low temperature storage (10 °C); moreover, low temperature storage (10 °C) could maintain a significantly higher level of superoxide dismutase activity and lower values of malondialdehyde and cell membrane permeability. The effects of packing material were different according to the different storage temperatures. At 10 °C, the beneficial effects of anti-moisture polyethylene bags on fruit quality and physiology were observed. However, at 25 °C, fruit packed with regular low-density polyethylene proved to be of better quality than those packed with anti-moisture polyethylene bags. Packing with anti-moisture polyethylene bags and storage at 10 °C were the most suitable conditions to maintain quality and to extend the storage life of rambutan fruit.[12]

IV. Conclusion

The fruit pulp, being colorless has no pigments of bioactive nature. Rambutan fragrance is due to the presence of volatiles, namely cinnamic acid, β-damascenone, phenylacetic acid and vanillin. The rambutan fruit has been proven to possess phytochemicals that demonstrate anticancer, anti-allergic, anti-obesity, antidiabetic, anti-HIV, antimicrobial, anti-dengue, anti-hypercholesterolemic, and antihyperglycemic effects. The rambutan fruit could be considered as a sustainable candidate in developing functional foods and pharmaceuticals. Rambutan fruits are sensitive to water loss after harvest, because of the high density of stomata in the spinterns. Carboxymethyl cellulose (CMC) is one of polysaccharide edible coatings which can be extracted from plants. Coating can act as barriers to moisture and oxygen during storage of rambutan. Application of coating represents an economical advantage to extend product shelf-life. This study demonstrates the potential of using CMC coating to delay ripening and keep quality characteristics in rambutan.

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