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Composite edible coating in the preservation of mangosteen (*Garcinia mangostana*) fruit

*Minh, N.P.

Faculty of Engineering and Technology, Nam Can Tho University, 168 Nguyen Van Cu Street, An Binh Ward, Can Tho City, Vietnam

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Abstract

Mangosteen (*Garcinia mangostana*) fruit contains high nutritional value with numerous bioactive ingredients. However, this fruit degraded quickly in postharvest due to its high respiration rate. This research examined the physicochemical quality of mangosteen fruit coated by chitosan-based coating formulated with different coating materials: carboxymethyl cellulose, guar gum, sodium alginate, xanthan gum at 1.5%; antimicrobial agents: zinc oxide, titanium dioxide, silver, and copper oxide at 0.5%; edible oils: linseed oil, coconut oil, olive oil, macadamia nut oil at 1%; curcumin ratios: 0.2-0.8 mg/L. Results showed that curcumin 0.6 mg/mL was recommended to fabricate with chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1% in preparation of coating material for preservation of mangosteen fruit during 14 days of storage at 30±0.5°C and 80–85% relative humidity. This formulation successfully reduced weight loss and suppressed anthracnose while maintaining physicochemical characteristics in mangosteen fruits.

1. Introduction

Mangosteen (*Garcinia mangostana*) was an important crop containing excellent anticancer, antioxidant, antibacterial, and anti-inflammatory characteristics due to its abundant phenolic, flavonoid, terpen, tannic acid, and vitamin contents (Eiselt *et al.*, 2025). Mangosteen had a blurry white aril with a purple outer shell. It was generally split into larger fractions that contained inedible seeds (Muhammad *et al.*, 2025). This fruit had a unique flavor and a juicy-sweet-slight sour taste (Low *et al.*, 2021). As a climacteric fruit, mangosteen has a high respiration rate and a short shelf life, making it highly perishable during postharvest (Yulianti *et al.*, 2025). Anthracnose symptoms caused by *Lasiodioplodia theobromae* seriously resulted in pericarp hardening, black spots on mangosteen fruit peel, leading to a decline in economic value (Nipaporn *et al.*, 2023). Quality degradation on mangosteen was mostly originated from improper post-harvest manipulation (Low *et al.*, 2021).

Vegetables and fruits were very sensitive to moisture removal, shrinkage, tenderness, and fungal invasion owing to their internal physiological and metabolic behaviors in postharvest (Malahlela *et al.*, 2024). The edible coating approach drew great attention in the food industry (Iftikhar *et al.*, 2022). Various sources of polysaccharides (Panahirad *et al.*, 2021), proteins (Xin *et al.*, 2023), and lipids (Devi *et al.*, 2024) in combination with multiple techniques of spraying (Dayeh *et al.*, 2024), brushing (Njombolwana *et al.*, 2013), and dipping (Tsague Donjio *et al.*, 2023) were utilized in fruit and vegetable coating to maintain their quality attributes during storage (Aziz *et al.*, 2024).

Chitosan originated from the deacetylation of chitin via enzymatic hydrolysis under alkaline medium (Sahariah *et al.*, 2024). Chitosan was generally white in color, insoluble in water and soluble in acetic acid. Chitosan coating had perfect technical properties like film-creating ability, affordability, biodegradability, biological behavior, and microbial inhibition (Cui *et al.*, 2020). Chitosan-based coating provided remarkable cost benefits over traditional methods (Dai *et al.*, 2025). Incorporation of nanoelements with chitosan created multiple advantages, such as microbial inactivation, inhibition of enzymatic activity, spoilage retardation, limitation of oxidative discoloration, improvement of mechanical strength, transparency, and water resistance. This led to minimal water evaporation, reduced weight loss and shrinkage, low respiration rate, and extended shelf life of fruit (Wang *et al.*, 2024).

*Corresponding author.
Email: *npminh@nctu.edu.vn*

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Several notable studies mentioned the formulation of chitosan-nanoelement composite for coating of fruit and vegetables in postharvest. Chitosan could be formulated with polysaccharide (Zeng *et al*., 2022), and essential oil (Long *et al*., 2022). Chitosan-hydroxypropyl methylcellulose dual-coated on citrus fruit to slow down respiration, prevent decay and stabilize nutritional content (Zhou *et al*., 2024). Chitosan was formulated with soybean protein isolate to form an environmentally friendly, reproducing, and degradable composite coating material (Chen *et al*., 2023). Chitosan-loaded lemongrass essential oil successfully prolonged shelf life of strawberries (Phuong *et al*., 2024).

Some studies were mentioned regarding the application of edible coating for the storage of mangosteen fruit. An amount 1.5% of soy protein isolate was used as an edible coating for the storage of mangosteen fruit (Minh *et al*., 2019). Silver nanoelements successfully prevented fruit rot disease, limited pericarp stiffening, and preserved mangosteen fruit quality (Nipaporn *et al*., 2023). Beeswax 6% formulated with chitosan 2% had the extended shelf-life of mangosteen fruit over 3 weeks of storage at 13°C (Farah and Lienda, 2024). In the current research, the effects of coating materials, antimicrobial agents, essential oils and curcumin ratios in nanoencapsulation for storage of mangosteen fruit were examined.

2. Materials and methods

2.1 Material

Mangosteen fruit at technical ripeness with diameters from 7.0 cm to 8.0 cm was collected from gardens in Vinh Long province, Vietnam. Technical ripen mangosteen fruits were manually graded to ensure their uniformity. They were washed under tap water to remove dirt and foreign matter. Chemical reagents were all analytical grade. Chitosan was supplied from Vietnam Food Company (Vietnam). Carboxymethyl cellulose, sodium alginate, xanthan gum, titanium dioxide and glycerol were bought from Foodchem International Corporation (Vietnam). Guar gum was purchased from VITACHEM (Vietnam). Zinc oxide originated from MEGA Vietnam General Business (Vietnam). Silver and copper oxide nanoparticles were supplied by ALFA Chemistry (USA). Linseed oil was purchased from KH Chemicals (Netherlands). Coconut oil was obtained from Betrimex (Vietnam). Olive oil originated from the Borges International Group (Spain). Macadamia nut oil was received from Gustav Heess (Germany). Acetic acid was supplied from Sigma Aldrich (Steinheim, Germany). Curcumin was purchased from Glentham Life Sciences GmbH (Germany).

2.2 Effect of composite-based coating materials for preservation of mangosteen fruit

Chitosan (2.5%) was combined with one of the following agents, such as carboxymethyl cellulose (1.5%), guar gum (1.5%), sodium alginate (1.5%), or xanthan gum (1.5%) to prepare the composite coating material for preservation of mangosteen fruits. Chitosan solution of 2.5% w/v was prepared by dissolving chitosan powder in acetic acid of 1% v/v at 30°C for 4 h, then added 1.45% of glycerol (w/v) into the mixture. Carboxymethyl cellulose/guar gum/sodium alginate/ xanthan gum solution of 1.5% w/v was prepared by dissolving the respective powders in distilled water at 75°C for 25 min. These separated mixtures were cooled to 30°C and then fabricated with chitosan solution to form 4 composite coatings. A chitosan solution of 2.5% w/v was used as a control coating material in this experiment.

2.3 Effect of antimicrobial agents in nanoencapsulation of composite-based coating material for preservation of mangosteen fruit

Several agents, such as zinc oxide, titanium dioxide, silver, and copper oxide, were nanoencapsulated with chitosan + guar gum to prepare the composite coating material for the preservation of mangosteen fruit. Chitosan solution of 2.5% w/v was fabricated with guar gum of 1.5%, then added one of following agents: zinc oxide, titanium dioxide, silver, and copper oxide at the same ratio of 0.5%. Chitosan solution of 2.5% w/v was fabricated with guar gum of 1.5% was used as control coating material in this experiment.

2.4 Effect of edible oil incorporation in the preparation of composite-based coating material for preservation of mangosteen fruit

A composite of chitosan 2.5% + guar gum 1.5% + silver 0.5% was nanoencapsulated with following edible oil: linseed oil, coconut oil, olive oil, macadamia nut oil at the same ratios of 1%. An amount 1% of either linseed oil, or coconut oil, or olive oil, or macadamia nut oil and 1% of lecithin as surfactant were added into chitosan 2.5% + guar gum 1.5% + silver 0.5% emulsion. Glycerol of 0.5% was added as plasticizer. Composite of chitosan 2.5% + guar gum 1.5% + silver 0.5% was used as control coating material in this experiment.

2.5 Effect of curcumin supplementation in preparation of composite-based coating material for preservation of mangosteen fruit

A composite of chitosan 2.5% + guar gum1.5% + silver 0.5% + olive oil 1% was mixed with different curcumin concentrations (0.2-0.8 mg/mL) to prepare the

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coating material in preservation of mangosteen fruit. Curcumin solution (0.2-0.8 mg/mL) prepared in 90% ethanol was supplemented into chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1% solution. Vacuum evaporation was conducted to eliminate ethanol. A composite of chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1% was used as the control coating material in this experiment.

In all 4 above experiments, mangosteen fruits were all dipped into the examined coating solutions for 15 s, the coated fruits were drained to remove excessive drip. Then these fruits were left to air-dry, preserved at 30±0.5°C and 80–85% relative humidity for 14 days. The coated and control mangosteen fruits were examined for various quality properties by measuring weight loss (%), firmness (N), titratable acidity (%), total soluble solids (°Bx), fruit decay or anthracnose index (%)

2.6 Weight loss

Weight loss (%) was estimated by comparing the difference between the initial weight and the final weight of mangosteen fruit using a digital balance.

2.7 Firmness

Firmness (N) was measured by a texture analyzer (Stable Micro Systems, model: TA.XTplusC). Equipment prepared with a 2 mm diameter nose needle that pricked via 10 mm of mesocarp at a velocity of 10 mm/s. The sample was put laterally by the needle to keep a comparable length from the endocarp paradigms. The experiments were executed in three replications, and Texture Exponent Software was utilized for data analysis of the grass jelly texture (Nishinari *et al*., 2013).

2.8 Titratable acidity

Titratable acidity (%) was determined by titrimetric method. An aliquot (10 mL) of fruit juice was titrated with standard 0.1 N of sodium hydroxide solution using phenolphthalein as an indicator (Ranganna, 2009).

2.9 Total soluble solid

Total soluble solids (°Bx) were estimated by using digital refractometer (MyBrix, Mettler Toledo). An extract of the sample was prepared by carefully blending 5 g of the sample in 10 mL of distilled water for 3 min and then filtering it via a muslin cotton. Then one drop of filtrate was put on the prism of the refractometer, and ° Bx value was noted. The observed value was multiplied by '2' as the dilution factor.

2.10 Fruit decay

Fruit decay or anthracnose index (%) was evaluated by recording disease grades according to the defected side area on the fruit (Zhemin *et al*., 2024). Grades ascribed were 0–5, corresponding to defected areas of 0%, ≤20%, 21–40%, 41–60%, 61–80%, and >80%, respectively. The percent anthracnose index was calculated using the following equation and expressed as disease index.

$$\text{Fruit decay (\%)} = (\text{disease grade} \times \text{fruit number of the grade} \times 100) / (\text{total number of fruit} \times \text{highest grade})$$

2.11 Statistical analysis

The experiments were performed in triplicate with different groups of samples. Variance and Duncan's multiple-range tests were utilized to statistically analyze all data. The results were presented with substantial letters as mean ± standard deviation (SD). Differences between means were noted as significant when $p < 0.05$. Statistical analysis was performed by the Statgraphics Centurion version XVI.

3. Results and discussion

3.1 Effect of composite-based coating materials for preservation of mangosteen fruit

Chitosan (2.5%) was combined with one of the following agents, such as carboxymethyl cellulose (1.5%), guar gum (1.5%), sodium alginate (1.5%), xanthan gum (1.5%), to prepare the coating material for preservation of mangosteen fruits. A chitosan solution of 2.5% w/v was used as a control coating material in this experiment. Table 1 shows the effect of various coating materials (carboxymethyl cellulose (1.5%), guar gum (1.5%), sodium alginate (1.5%), xanthan gum (1.5%) formulated with chitosan (2.5%). It's clearly noticed that guar gum (1.5%) + chitosan (2.5%) resulted to the lowest weight loss (8.07±0.04%) and anthracnose index (55.06±0.09%) while maintaining the highest firmness (165.24±0.48 N), titratable acidity (0.241±0.003%), and total soluble solids (8.12±0.03 °Bx) on mangosteen fruit. Hence, guar gum (1.5%) was selected to combine with chitosan (2.5%) for further experiments.

Chitosan is a biodegradable coating material that originates from deacetylated chitin (Oliveira *et al*., 2017). Antifungal effectiveness of chitosan-monocoating revealed several limitations. It's urgent to combine chitosan with other coating materials to enhance its benefits. Chitosan was combined with carboxymethyl cellulose to create a composite film for the preservation of strawberry fruit (Li *et al*., 2023). Chitosan (1%) and guar gum (2%) were formulated with lemon essential oil (3%) to produce a fabricated coating material for pear storage up to 1.5 months with minor degradation of texture firmness and low weight loss (Iftikhar *et al*.,

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Table 1. Effect of composite-based coating materials on quality attributes of mangosteen fruit.

Variables	Chitosan 2.5% +				
	0 (Control)	Carboxymethyl	Guar gum 1.5%	Sodium alginate	Xanthan gum
Weight loss (%)	16.43±0.05[a]	14.72±0.03[ab]	8.07±0.04[c]	10.25±0.02[bc]	12.07±0.05[b]
Firmness (N)	142.18±0.69[c]	149.05±0.72[bc]	165.24±0.48[a]	160.16±0.59[ab]	154.83±0.64[b]
Titratable acidity (%)	0.215±0.002[c]	0.219±0.005[bc]	0.241±0.003[a]	0.236±0.001[ab]	0.227±0.002[b]
Total soluble solid (°Bx)	7.64±0.01[c]	7.75±0.03[bc]	8.12±0.03[a]	7.97±0.02[ab]	7.86±0.00[b]
Anthracnose index (%)	69.75±0.12[a]	65.21±0.17[a]	55.06±0.09[c]	58.42±0.03[bc]	62.70±0.01[b]

Values are presented as mean±SD of triplicates. Values with different superscripts in the same row are statistically significantly different (α = 0.05).

2022). Alginate had distinctive colloidal characteristics to create a robust gel with an insoluble profile in interaction with multivalent particles to prepare a coating layer (Senturk Parreidt, Muller and Schmid, 2018). Alginate coating was demonstrated to enhance the quality and stability of strawberry and cantaloupe melon (Senturk Parreidt, Schmid and Muller, 2018; Senturk Parreidt *et al.*, 2019). Xanthan and chitosan were successfully combined to produce an edible coating for maintaining physicochemical, microbial and sensory attributes in broccoli (Pizato *et al.*, 2020).

3.2 Effect of antimicrobial agents in nanoencapsulation of composite-based coating material for preservation of mangosteen fruit

Several agents, such as zinc oxide, titanium dioxide, silver, and copper oxide, were nanoencapsulated with chitosan-guar gum to prepare the composite coating material for the preservation of mangosteen fruit. Chitosan solution of 2.5% w/v was fabricated with guar gum of 1.5%, then one of the following agents: zinc oxide, titanium dioxide, silver, and copper oxide at the same ratio of 0.5%. Chitosan solution of 2.5% w/v was fabricated, and guar gum of 1.5% was used as a control coating material in this experiment. Result showed that chitosan (2.5%) + guar gum (1.5%) + silver 0.5% resulted to the lowest weight loss (7.53±0.00%) and anthracnose index (42.74±0.12%) while maintaining the highest firmness (180.24±0.60 N), titratable acidity (0.270±0.003%), total soluble solid (8.48±0.04°Bx) on mangosteen fruit (Table 2). Hence, silver (0.5%) was selected to combine with chitosan (2.5%) + guar gum 1.5% for further experiments.

Longevity of raw pistachios extended to 35–40 days by coating material prepared from zinc oxide-chitosan composite (Taghipour, Nia, Hokmabadi and Martinez-Gomez, 2024). Cantaloupe fruit coated with a complex of chitosan and titanium dioxide had minor juice leakage compared to the control (Qiao *et al.*, 2019). Raw pistachios coated by chitosan/TiO_2 nanocomposite and stored at 4.0±0.5°C had improved quality stability for one month with minimal degradation of proximate composition, sensory attribute, and antioxidant power (Taghipour, Nia, Hokmabadi and Yahia, 2024). Chitosan blended with cassava starch and titanium dioxide significantly reduced weight loss in papaya fruit (Menezes *et al.*, 2024). In another report, 100–150 ppm chitosan-based zinc oxide/silver nanoelements were appropriate for prolonging shelf-life and stabilizing physiochemical properties of papaya (Timilsina *et al.*, 2024). A chitosan 1%-silver nanoparticles 5 mg/L solution was effective in coating of passion fruit (Duy *et al.*, 2025). A mixture of chitosan 2% w/v and copper oxide 0.5 mg/mL created a composite coating with low fruit defect, minor weight loss and retained firmness of mango (Yan *et al.*, 2023).

3.3 Effect of edible oil incorporation in the preparation of composite-based coating material for preservation of mangosteen fruit

A composite of 2.5% chitosan + 1.5% guar gum + 0.5% silver was nanoencapsulated with the following edible oils: linseed oil, coconut oil, olive oil, and macadamia nut oil at the same ratios of 1%. An amount 1% of either linseed oil, coconut oil, olive oil, or macadamia nut oil and 1% of lecithin as surfactant were added into 2.5% chitosan + 1.5% guar gum + 0.5% silver emulsion. Glycerol of 0.5% was added as plasticizer. A composite of 2.5% chitosan + 1.5% guar gum + 0.5% silver was used as a control coating material in this experiment. Results showed that chitosan (2.5%) + guar gum (1.5%) + silver (0.5%) + olive oil (1%) resulted to the lowest weight loss (7.01±0.02%) and anthracnose index (32.48±0.05%) while maintaining the highest firmness (204.03±0.52 N), titratable acidity (0.302±0.001%), total soluble solid (8.84±0.01°Bx) on mangosteen fruit (Table 3). Hence, olive oil (1%) was selected to combine with chitosan (2.5%) + guar gum (1.5%) + silver (0.5%) for further experiments.

Linseed oil was highly effective in the prevention of microbial proliferation on orange fruits during 21 days of storage (Mezemir *et al.*, 2017). Coconut oil was quite durable under atmospheric oxidation. Coconut oil coating (3%) was suitable for improving the chemical

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Table 2. Effect of antimicrobial agents in nanoencapsulation of composite-based coating material on quality attributes of mangosteen fruit.

Variables	Chitosan 2.5% + guar gum 1.5% +				
	0 (Control)	Zinc oxide 0.5%	Titanium	Silver 0.5%	Copper oxide
Weight loss (%)	8.07±0.04^{a}	7.95±0.05^{ab}	7.69±0.01^{bc}	7.53±0.00^{c}	7.86±0.03^{b}
Firmness (N)	165.24±0.48^{c}	169.50±0.51^{bc}	176.02±0.47^{ab}	180.24±0.60^{a}	172.67±0.54^{b}
Titratable acidity (%)	0.241±0.003^{c}	0.247±0.001^{bc}	0.263±0.000^{ab}	0.270±0.003^{a}	0.254±0.000^{b}
Total soluble solid (°Bx)	8.12±0.03^{c}	8.20±0.02^{bc}	8.39±0.01^{ab}	8.48±0.04^{a}	8.27±0.02^{b}
Anthracnose index (%)	55.06±0.09^{a}	52.71±0.11^{ab}	46.21±0.07^{bc}	42.74±0.12^{c}	49.83±0.08^{b}

Values are presented as mean±SD of triplicates. Values with different superscripts in the same row are statistically significantly different (α = 0.05).

Table 3. Effect of essential oil incorporation in nanoencapsulation of composite-based coating material on quality attributes of mangosteen fruit.

Variables	Chitosan 2.5% + guar gum 1.5% + silver 0.5%				
	0 (Control)	Linseed oil 1%	Coconut oil 1%	Olive oil 1%	Macadamia nut
Weight loss (%)	7.53±0.00^{a}	7.41±0.01^{ab}	7.18±0.03^{bc}	7.01±0.02^{c}	7.30±0.01^{b}
Firmness (N)	180.24±0.60^{c}	186.35±0.37^{bc}	197.12±0.41^{ab}	204.03±0.52^{a}	190.26±0.49^{b}
Titratable acidity (%)	0.270±0.003^{c}	0.276±0.000^{bc}	0.293±0.003^{ab}	0.302±0.001^{a}	0.285±0.002^{b}
Total soluble solid (°Bx)	8.48±0.04^{c}	8.56±0.03^{bc}	8.75±0.00^{ab}	8.84±0.01^{a}	8.67±0.03^{b}
Anthracnose index (%)	42.74±0.12^{a}	40.08±0.06^{ab}	35.06±0.09^{bc}	32.48±0.05^{c}	37.65±0.07^{b}

Values are presented as mean±SD of triplicates. Values with different superscripts in the same row are statistically significantly different (α = 0.05).

and organoleptic properties of malta fruits (Manju *et al*., 2024). Coatings from chitosan at 2% (w/v) with 2% (v/v) of olive oil significantly slowed down the senescence and stabilized texture firmness of tomatoes (Dovale-Rosabal *et al*., 2015). Chitosan-alginate-olive oil composite coating was beneficial in limiting fungal vulnerability and quality variables on raw figs (Vieira *et al*., 2021). 1% macadamia nut oil formulated with 1% w/v chitosan to produce novel edible coating in controlling decay and weight loss during the preservation of tomatoes (Umbayda *et al*., 2024).

3.4 Effect of curcumin supplementation in preparation of composite-based coating material for preservation of mangosteen fruit

A composite of 2.5% chitosan + 1.5% guar gum + 0.5% silver + 1% olive oil was mixed with different curcumin concentrations (0.2-0.8 mg/mL) to prepare a coating material for the preservation of mangosteen fruit. Curcumin solution (0.2-0.8 mg/mL) prepared in 90% ethanol was supplemented into chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1% solution. Vacuum evaporation was conducted to eliminate ethanol. A composite of chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1% was used as a control coating material in this experiment. There was an increasing trend of firmness, titratable acidity and total soluble solids by increasing curcumin ratio (0.2-0.8 mg/mL). Meanwhile, there was a declining trend of weight loss and anthracnose index by accelerating the curcumin ratio (0.2-0.8 mg/mL). There was an insignificant difference in quality attributes at curcumin 0.6 mg/mL and 0.8 mg/mL (Table 4). Therefore, curcumin 0.6 mg/mL was recommended to be fabricated with chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1% in preparation of coating material for preservation of mangosteen fruit during 14 days of storage at 30±0.5 °C and 80–85% relative humidity.

Curcumin, which originated from *Curcuma longa* L., was proven as a bioactive phytonutrient with powerful antioxidant and antimicrobial properties (Roy *et al*., 2022). The anthracnose preventive effectiveness of curcumin relied on applied dosage (Moghadamtousi *et al*., 2014). Curcumin at 2 mg/mL effectively prevented fungal outbreak in plant tissue culture (Upendra *et al*., 2011). The higher the ratio of curcumin incorporated, the less respiration rate and the longer the stability of apples was noticed during preservation of apples (Botalo *et al*., 2024). Coating limited the reaction of hydrolyzed enzymes by slowing down the dynamics of the metabolic pathway in senescence, leading to stabilizing fruit texture firmness (Zhou *et al*., 2008). Apples coated with edible coating, including curcumin, had low moisture loss and minor discoloration compared to the control groups. Edible nano-coating of curcumin-incorporated zein nanoelements revealed an excellent prevention of

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Table 4. Effect of curcumin incorporation in nanoencapsulation of composite-based coating material on quality attributes of mangosteen fruit.

Variables	Chitosan 2.5% + guar gum 1.5% + silver 0.5% + olive oil 1%				
	0 (Control)	Curcumin 0.2	Curcumin 0.4	Curcumin 0.6	Curcumin 0.8
Weight loss (%)	7.01±0.02[a]	6.85±0.00[ab]	6.63±0.04[b]	6.24±0.01[bc]	6.01±0.03[c]
Firmness (N)	204.03±0.52[c]	186.35±0.48[bc]	197.12±0.51[b]	204.03±0.50[ab]	190.26±0.53[a]
Titratable acidity (%)	0.302±0.001[c]	0.309±0.003[bc]	0.317±0.001[b]	0.326±0.000[ab]	0.331±0.004[b]
Total soluble solid (°Bx)	8.84±0.01[c]	8.90±0.00[bc]	8.97±0.04[b]	9.16±0.03[ab]	9.30±0.00[a]
Anthracnose index (%)	32.48±0.05[a]	30.15±0.02[ab]	28.36±0.05[b]	25.59±0.01[bc]	22.40±0.02[c]

Values are presented as mean±SD of triplicates. Values with different superscripts in the same row are statistically significantly different (α = 0.05).

Colletotrichum gloeosporioides, causing anthracnose, to prolong shelf-life in terms of less discolouration and low moisture reduction and retained firmness of mango fruits for 9-day preservation (Chuacharoen and Sabliov, 2022).

4. Conclusion

Mangosteen fruit was susceptible to perishability at ambient storage, resulting in degradation of economic value. It's important to find out the proper technique to maintain its physicochemical quality attributes with an extended shelf life while ensuring food safety. This research successfully examined the effect of different parameters in the formulation of a biodegradable coating to preserve mangosteen fruit. This research demonstrated that chitosan-guar gum-silver-olive oil-curcumin coating showed good antifungal capability and greatly suppressed anthracnose while maintaining physicochemical characteristics in mangosteen fruits.

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