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Shelf Life Improvement of Lucuma (*Pouteria lucuma*) Fruit Under N-Succinyl Chitosan Incorporated with Turmeric as Edible Coating

Minh Phuoc Nguyen

[1]*Faculty of Biotechnology, Ho Chi Minh City Open University, Ho Chi Minh City, Vietnam*

ABSTRACT

Turmeric is commonly known as a safe, nontoxic, bioactive ingredient. N-succinyl chitosan is a promising chitosan derivative developed particularly for biomedical, food and packaging applications. Edible coating not only creates good barrier to vapor and oxygen during fruit preservation but also increases its safety due to their natural bioactive component. Lucuma (*Pouteria lucuma*) is an excellent fruit due to its intense yellow colour and unique sense. It is a rich source of in carotenoids; minerals, vitamins, dietary fibres, triterpenes, phenolic subtances with numerous biomedical and pharmaceutical advantages. The main obstacle of lucuma fruit storage is its high perishibility leading to loss of firmness, soluble dry matter, carotenoid and total phenolic. We attempted to examine the effect of N-succinyl chitosan incorporated with turmeric (0.45%: 0.05%, 0.40%:0.10%, 0.35%: 0.15%, 0.30%: 0.20%, 0.25%: 0.25%) and storage temperature (8, 12, 16, 20, 24oC) to the weight loss (%), firmness (N), total soluble solid (oBrix), carotenoid (mg/100g) and total phenolic (mg GAE/100g), overall acceptance (sensory score) in lucuma (*Pouteria lucuma*) fruits during 15 days of storage. Results demonstrated that N-succinyl chitosan incorporated with turmeric (0.35%: 0.15%,) and storage temperature at 16oC could effectively maintain physicochemical, phytochemical and organoleptic attributes of lucuma (*Pouteria lucuma*) fruit for 15 days. Edible coating created semi-permeable film to successfully delay ripening and extend the storage stability of lucuma fruit.

KEY WORDS: CAROTENOID, FIRMNESS, LUCUMA, N-SUCCINYL CHITOSAN, TOTAL SOLUBLE SOLID, TOTAL PHENOLIC, TURMERIC, WEIGHT LOSS.

INTRODUCTION

N-succinyl chitosan is an acyl derivative of chitosan that is biocompatible, biodegradable, bioadhesive, water soluble in acidic as well as in alkaline media, long-term retention (Kato et al. 2000; Yan et al. 2006). It is potentially robust and is rich in reactive functional (-NH2, -OH, and -COOH) groups. It also has excellent moisture absorption and retention property, superior chelating ability, significant apoptosis inhibitory, enzyme immobilization, strong antimicrobial and antioxidant activity, and greater bioactivity than its parent molecule chitosan (Hasegawa et al. 2001; Luo et al. 2010; Zhang et al. 2014; Prashanth and Tharanathan 2007; Zhou and Wang 2009; Kong et al. 2010; Sun et al. 2006; Fan et al. 2010; Inta et al. 2014; Vinsova and Vavrikova 2011; Guo et al. 2008).

Turmeric has different biological properties, such as anti-inflammatory, antioxidant, and anti-carcinogenic attributes (Mahmoud et al., 2019). Turmeric exhibits safe,

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nontoxic, broad range of biological attributes (Boruah et al., 2012; Nazari et al., 2017; Shaikh et al., 2009). Turmeric oil consists of secondary metabolites that can act as antimicrobial agent. Nano-emulsion coated with chitosan is a promising delivery system to promote the applications of curcumin in functional food and beverage (Jinglei et al., 2016). Turmeric is includeded in the chitosan coating as innovation based on the possible synergy effect of these two components to improve the storability of strawberries after postharvest (Noorsuhana et al., 2018).

Lucuma (*Pouteria lucuma*) fruit belongs to Sapotaceae family (Marianela et al., 2019). Its pulp has an intense yellow pigment, sweet pleasant feeling and specific flavor. Its sweet taste is exploited to be used as natural food sweetener (Banasiak, 2003). Its pulp has a low moisture content but high protein and reducing sugar (Erazo et al., 1999; Brizzolari et al., 2019). It contains a great variety of carotenoids; minerals, vitamins, dietary fibres, triterpenes, phenolics beneficial for human health (Rojo et al., 2010; Fuentealba et al., 2016; Albena et al., 2019). Lucuma pulp has been widely supplemented to n various food applications (Dini, 2011). Lucuma fruit has been considered as one of super fruits (Mukta et al., 2017) due to its ability to cure antihyperglycemia and antihypertension (Marcia et al., 2009), wound healing properties (Leonel et al., 2010). N-succinyl chitosan is normally utilized in biomedical but rarely applied in fruit coating, especially luuma fruit. The objective of the present study was to examine the effect of N-succinyl chitosan incorporated with turmeric and storage temperature to the weight loss, firmness, total soluble solid, carotenoid, total phenolic, overall acceptance in lucuma (*Pouteria lucuma*) fruits during 15 days of storage.

MATERIAL AND METHODS

Material

We collected lucuma (*Pouteria lucuma*) fruits in Tien Giang province, Vietnam. They were cultivated following VietGAP to ensure food safety. After harvesting, they were quickly conveyed to laboratory for experiments. These fruits were washed under tap water to remove foreign matter. *Beside lucuma* we also used other materials during the research such as chitosan, turmeric, acetic acid, succinic anhydride, acetone, NaoH, ethanol, methanol, sodium carbonate, gallic acid. Lab utensils and equipments included biuret, refrigerator, digital weight balance, penetrometer, refractometer, spectrophotometer.

Methods: Chitosan incorporated with turmeric (0.45g: 0.05g, 0.40g:0.10g, 0.35g: 0.15g, 0.30g: 0.20g, 0.25g: 0.25g) was dissolved in 100 ml of 1 % acetic acid and stirred for 30 min at 50 °C. Then, 50 ml methanol was supplemented to dilute the solution followed by dropwise addition of already dissolved 2.0 g succinic anhydride in 25 ml acetone. The mixture was stirred at 1200 rpm at 50°C for 24 hours. After 24 hours, reaction mixture was diluted with excess 1 M NaOH solution until clear solution was obtained. The clear solution was kept under stirring for 24 hours at 50°C. Then, ethanol was added to precipitate the product followed by filtration to separate the precipitates. The precipitates were purified by redispersing in ethanol for 24 hours and washed with ethanol and acetone several times to remove the excess of reactants. Pure product was dried in vacuum oven for 8 hours at 50°C (Shahid et al. 2019). Lucuma (*Pouteria lucuma*) fruits were dipped in the film forming dispersions for 45 seconds and air-dried for 30 minutes at ambient temperature. All samples were kept in storage temperature (8, 12, 16, 20, 24oC) in 15 days. The weight loss (%), firmness (N), total soluble solid (oBrix), carotenoid (mg/100g) and total phenolic (mg GAE/100g), overall acceptance (sensory score) in lucuma (*Pouteria lucuma*) fruits were evaluated.

Physico-chemical and sensory evaluation: Weight loss (%) was evaluated by the following formula: Weight loss (%) = [(A–B)/A] x 100 where A indicates the fruit weight at the time of harvest and B indicates the fruit weight after storage intervals. Firmness (N) was measured by penetrometer. Total soluble solid (oBrix) was determined by handheld refractometer. Carotenoid (mg/100g) was evaluated by near infrared spectroscopy. Total phenolic content (mg GAE/100g) was estimated using Folin-Ciocalteu reagent procedure. Sensory score was evaluated by a group of 13 panelists using 9 point-Hedonic scale.

Statistical analysis: The experiments were run in triplicate with three different lots of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTS AND DISCUSSION

Physicochemical, phytochemical characteristics of raw Lucuma (*Pouteria lucuma*) fruit The physico-chemical, phytochemical properties of fresh Lucuma (*Pouteria lucuma*) fruit were evaluated. Results were mentioned in table 1. It's clearly noticed that Lucuma was a great source of carotenoid as well as total phenolic content.

Table 1. The chemical compositions in fresh *Lucuma* (*Pouteria lucuma*) fruit

Parameter	Firmness (N)	Total (oBrix) soluble	solid Carotenoid (mg/100g)	Total phenolic (mg/g)
Value	8.74±0.03	21.39±0.02	37.25±0.00	69.32±0.01

Note: the values were expressed as the mean of three repetitions;

Effect of different N-succinyl chitosan concentrations to weight loss, firmness, total soluble solid, carotenoid, total phenolic and overall acceptance of Lucuma *(Pouteria lucuma)* fruit: Effect of N-succinyl chitosan incorporated with turmeric (0.45%: 0.05%, 0.40%:0.10%, 0.35%: 0.15%, 0.30%: 0.20%, 0.25%: 0.25%) to weight loss (%), firmness (N), total soluble solid (oBrix), carotenoid (mg/100g), total phenolic (mg GAE/100g) and overall acceptance (sensory score) was assessed. All samples were kept at 24oC for 15 days. Results were presented in figure 1. It's obviously noticed that edible coating by N-succinyl chitosan incorporated with turmeric (0.35%: 0.15%) significantly (P< 0.05) maintained weight loss (%), firmness (N), total soluble solid (oBrix), carotenoid (mg/100g), total phenolic (mg GAE/100g) and organoleptic score of treated fruits. The appropriate edible coating would minimize respiration rate, weight loss respiration, oxidative reaction, as well as physiological disorders. Therefore fruit shelf life would be increased respectively. In one report, chitosan-starch coatings enhanced with turmeric essential oil were effective on preserving strawberry (Yusof et al., 2020).

Figure 1: Effect of N-succinyl chitosan incorporated with turmeric (%:%) to weight loss (%), firmness (N), total soluble solid (oBrix), carotenoid (mg/100g), total phenolic (mg GAE/g), overall acceptance (sensory score) of lucuma (Pouteria lucuma) fruit during preservation (24oC in 15 days)

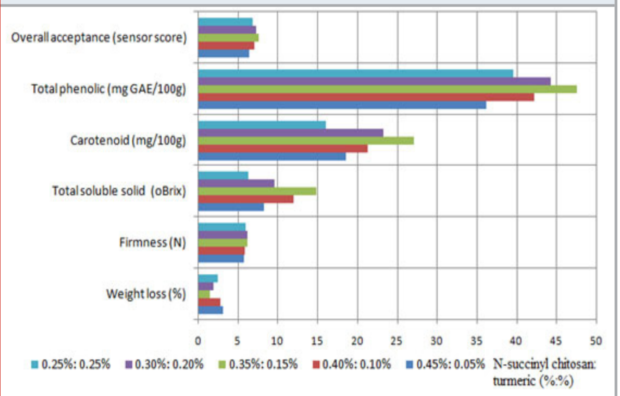
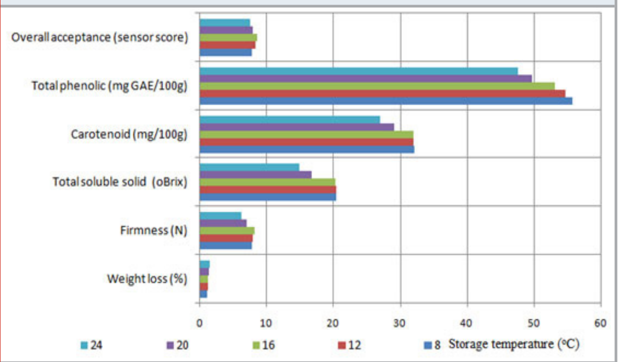


Figure 2: Effect of storage temperature to weight loss (%), firmness (N), total soluble solid (oBrix), carotenoid (mg/100g), total phenolic (mg GAE/g), overall acceptance (sensory score) of Lucuma (*Pouteria lucuma*) fruit



Effect of storage temperature to weight loss, firmness, total soluble solid, carotenoid, total phenolic, overall acceptance of Lucuma *(Pouteria lucuma)* fruit: After finding the appropriate ratio of N-succinyl chitosan: turmeric coating concentration (0.35%: 0.15%); the physicochemical, phytochemical and overall acceptance of Lucuma (*Pouteria lucuma*) fruit were also evaluated by the effect of different storage temperature (8, 12, 16, 20, 24oC) in 15 days of storage. Results were shown in figure 2. Optimal storage temperature for Lucuma (*Pouteria lucuma*) preservation was noticed at 16oC. The factors contribute to the physicochemical and phytochemical degradation in vegetable and fruit were mostly due to the moisture reduction caused by respiration and transpiration processes. By keeping a commodity at low temperature, respiration was reduced and senescence was also delayed, thus extending storage life (Halachmy and Mannheim, 1991).

CONCLUSION

N-succinyl chitosan is an amphiprotic derivative obtained from the N-acylation of chitosan. It has extraordinary biocompatibility, significantly increased aqueous solubility in acidic and basic media without altering the biological characteristics, appreciable transfection efficiency, and the capacity to stimulate osteogenesis. Lucuma is a good source of biologically active substances especially carotenoid, an excellent antioxidant activity with antihyperglycaemic characteristic. This research has successfully found out the appropriate conditions for maintaining Lucuma (*Pouteria lucuma*) fruit quality by N-succinyl chitosan incorporated with turmeric as edible coating, storage temperature. Turmeric incorporated with N-succinyl chitosan coating createed a synergistic effect to improve the stability of lucuma fruit.

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Conflict of Interest: The authors declared that present study was performed in absence of any conflict of interest.

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